INSTRUCTIONAL DESIGN FOR TEAM TRAINING:
DEVELOPMENT AND VALIDATION OF GUIDELINES

Marcel van Berlo

The research described in this dissertation was carried out at TNO Defence, Security and Safety, business unit Human Factors, P.O. Box 23, 3769 ZG Soesterberg, The Netherlands

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INSTRUCTIONAL DESIGN FOR TEAM TRAINING: DEVELOPMENT AND VALIDATION OF GUIDELINES

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SAMENVATTING

Slechts recent zijn organisaties begonnen met het trainen van teams. Het is echter niet altijd duidelijk welke, en hoe, onderwijskundige principes worden toegepast bij de training van teams. Het lijkt er op dat deze zijn afgeleid uit individuele functie-opleidingen, en dat er nauwelijks rekening wordt gehouden met de karakteristieke eigenschappen van teams, het leren door teams en het evalueren en verbeteren van teamprocessen. Als gevolg hiervan ligt bij het ontwikkelen van teamtrainingen voornamelijk de nadruk op technische en minder op onderwijskundige en leerpsychologische zaken. Het proces van het ontwerpen en ontwikkelen van teamtraining zou effectiever en efficiënter kunnen verlopen als hiervoor een meer formele en systematische methode beschikbaar is. Literatuur- en veldstudies lieten zien dat er ruimte lijkt te zijn voor verbetering van de analyse en de ontwikkeling van teamtrainingen als fasen voorafgaand aan de daadwerkelijke uitvoering ervan. Dit kan bereikt worden door het geven van ondersteuning aan het personeel verantwoordelijk voor de opleidingsontwikkeling. Het onderzoek beschreven in dit proefschrift is gericht op (a) de wijze waarop opleidingsontwikkelaars ondersteund kunnen worden bij het analyseren van teamtaken en het ontwikkelen van teamtraining scenario's, (b) het valideren van deze ondersteuning, en (c) hoe de resultaten kunnen bijdragen aan een opleidingsontwikkelingsmodel voor teamtraining. Instructional Design (ID) is gericht op het analyseren van taken en competenties, het formuleren van leerdoelen, het definiëren van trainingsstrategieën en het ontwerpen van leeromgevingen. Het eerste hoofdstuk geeft een beschrijving van en reflectie op ID expertise. De karakteristieken van teams, teamprestatie en teamleren worden beschreven in hoofdstuk 2, gevolgd door een discussie over ID voor teamtraining (hoofdstuk 3). De opleidingsontwikkelaars in dit onderzoek zijn beginnende militaire opleidingsontwikkelaars. Er wordt beargumenteerd waarom richtlijnen voor hen de meest geschikte vorm van ondersteuning zouden zijn. Huidige richtlijnen voor het ontwikkelen van teamtrainingen zijn beoordeeld, en de richtlijnen die zijn ontwikkeld ter ondersteuning van de analyse van teamtaken en het ontwikkelen van teamtraining scenario's worden beschreven. Duidelijk wordt gemaakt dat er een constante spanning aanwezig is tussen nieuwe en constructivistische paradigma's op leren, de karakteristieken van ID, de behoefte aan het systematisch ontwerpen van training en de beste wijze waarop opleidingsontwikkelaars ondersteund kunnen worden. De empirische studies die zijn uitgevoerd om de richtlijnen te valideren zijn beschreven in hoofdstukken 4 en 5. Tenslotte wordt er in hoofdstuk 6 afgesloten met een discussie.

ABSTRACT

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Promoter:
Prof. Dr. J. Lowyck, Catholic University Leuven, Centre of Instructional Psychology and Technology, Belgium.

Co-promoter:
Dr. A.M. Schaafstal, TNO Defence, Security and Safety, The Netherlands.

Correspondence address:
TNO Defence, Security and Safety
Business Unit Human Factors
Department of Training and Instruction
PO Box 23
3769 ZG Soesterberg
The Netherlands

Only recently, organisations are beginning to train their teams. The process of designing team training may be more effective and efficient if a more formal and systematic methodology would be available. Literature and field studies show that there seems to be room for improvement in the analysis and design phases, before the actual development and implementation of the team training take place. This may be achieved by offering guidance and support to the personnel responsible for the instructional design. The research described in this doctoral dissertation concentrates on (a) how instructional designers can be supported in analysing team tasks and designing team training scenarios, (b) validating the quality of this support and (c) how these results contribute to developing an Instructional Design model for training teams.

DANKWOORD

Toen ik bij TNO kwam werken was het eigenlijk een vanzelfsprekendheid dat elke wetenschappelijk medewerker vroeg of laat een academisch proefschrift zou schrijven. Ik dus ook. Ik had de vrijheid om, binnen de kaders van het lopende en voorgenomen onderzoek binnen TNO, zelf een relevant en interessant onderwerp te kiezen en verder uit te werken. Het grote voordeel van het werken aan een promotie-onderzoek als onderdeel van het reguliere werk, is de afwisseling aan onderwerpen en projecten. Het werkveld heeft dus niet alleen betrekking op het promotie-onderzoek. Dat dit tegelijkertijd een nadeel is, mag duidelijk zijn. Niet altijd is er de gelegenheid om de volle diepte te zoeken die je eigenlijk zou willen vinden. En vaak ben je aangewezen op de avonduren of het weekend. Het in deeltijd uitvoeren van het promotie-onderzoek en het schrijven van het proefschrift bleek de afgelopen jaren een constante zoektocht te zijn naar een juiste balans tussen het reguliere werk, mijn eigen opleiding en verdere ontwikkeling, en aandacht voor gezin, familie en vrienden. Deze balans is niet altijd in evenwicht geweest, en het pleit voor alle betrokkenen dat ik daar eigenlijk nooit een verwijt over heb gekregen.

Het voltooien van het proefschrift is een persoonlijke mijlpaal, maar is het ook een levenswerk? Deze vraag dien ik negatief te beantwoorden. De looptijd van het promotie-onderzoek bedraagt zo'n acht jaren, maar er waren duidelijke pieken en dalen in de tijdsbesteding. In die jaren is er namelijk veel gebeurd. Het instituut van TNO waar ik werk heeft inmiddels de eigen zelfstandigheid verloren en is een business unit geworden. Naast wetenschappelijk medewerker heb ik er twee nieuwe functies bij gekregen. Bovenal ben ik de trotse vader geworden van twee dochters en een zoon. Niet zelden heb ik op de bank gezeten met een kind in de ene arm en een protocol of een artikel in de andere. Maar tegelijkertijd is ook een studiegenoot en eetmaatje gestorven aan wie we de naam van onze tweede dochter hebben ontleend. En is het zoontje van een collega die rond dezelfde tijd is geboren als onze zoon, gestorven. Deze momenten doen je beseffen dat er meer in het leven is dan een promotie-onderzoek.

Dit proefschrift gaat voor een belangrijk deel over teams. Het schrijven van het proefschrift zelf is echter ook de inspanning van een team geweest. Een virtueel team, waarvan de leden elkaar niet altijd kenden. Met het risico dat ik een aantal mensen wellicht tekort doe, wil ik graag enkele teamleden met name bedanken. Ten eerste Joost Lowyck van de Katholieke Universiteit Leuven. Hij heeft me uitstekend ondersteund in het op de juiste wijze structureren van alle losse rapporten die ik in de loop der jaren heb geschreven, en bij het aanbrengen van een solide theoretisch kader. Bovendien heeft hij me door die beruchte

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INTRODUCTION

Technological developments have resulted in more sophisticated and complex systems in which humans have to operate. These systems are characterised by a highly dynamic and sometimes hostile environment, the variation of (often conflicting) goals, the incompleteness, uncertainty and ambiguity of information, and the involvement of teams of officers with members having different roles and responsibilities (Rouse, Cannon-Bowers & Salas, 1992). Many tasks cannot be performed by one operator alone but need to be accomplished by a team, like for instance a fire-fighting team, a surgical team, a tank platoon, and a Stinger group. A team is defined as a group of two or more people, with a common goal, a specific role assignment, and tasks/activities that are interdependent (Dyer, 1984). A team makes decisions in the context of a larger task, team members have specialised knowledge and skills relevant to the task and decisions, and the task conditions under which the team operates often include high workload and time-pressure (Orasanu & Salas, 1993; Salas, Bowers & Cannon-Bowers, 1995). The objective of any training system is to change the competencies of the trainees so they can perform their tasks in the operational environment effectively and efficiently. Team training involves the training of the members of teams, who have to co-operate with each other in the operational practice (Druckman & Bjork, 1994). A team training methodology is supposed to encompass a coherent set of guidelines, based on principles of learning and training, supporting the analysis, design, development, implementation and evaluation of instruction to enhance and maintain team performance in the operational task environment (Van Berlo, 1998a). It involves creating a learning environment in which the team members can acquire and practice the necessary knowledge, skills and attitudes required for adequate team performance. Adequate diagnosing, assessing and remediating the team's performance are essential features of a training system to be effective (Salas & Cannon-Bowers, 1997).

Despite the acknowledgement of the importance of team performance and team training, team training has been rarely conducted as a separate training with the argument that functioning as a team can best be learned in the operational environment and after each member was trained for the individual tasks. Accident reports, however, show that this ‘on-the-job team training’ does not seem to be the most effective and efficient way of preparing the team for its mission and tasks (Salas, Cannon-Bowers & Johnston, 1997). The realisation grows that just putting together a team of individual experts does not make an expert team (Salas, Cannon-Bowers, & Johnston, 1997). Only recently, organisations are beginning to train their teams. Especially within the military, virtual environments, (networked) simulators and pc-based games are increasingly being used for training teams.

However, it is often not clear which, and how, instructional principles can be applied to train the team (Salas & Cannon-Bowers, 1997). During the design of these training systems it seems that the didactics are directly derived from individual training. Although attention is paid to team performance, there is hardly any awareness about team learning, team evaluation and improving team processes. Consequently, it appears that during the development of these training systems the focus is predominantly on technical issues (the interoperability of the various technical systems) rather than on team training issues. Training scenarios are primarily based on real-life operational scenarios, rather than on adequately specified objectives. During the implementation of the team training, in many cases the to be trained team is presented with instruction and feedback at an ad-hoc basis, leaving the content and timing of instruction and feedback to the initiative of the instructor (Guerette, Miller, Glickman, Morgan & Salas, 1987). Assessing the performance of a team is more complex than performance assessment of an individual trainee (Brannick, Salas & Prince, 1997). Consequently, instructors devote much time and effort in ad hoc determining the most effective way of presenting information and measuring the team performance, and the most adequate way of providing feedback as well. It is assumed that the process of designing and developing team training may be more effective and efficient if a more formal and systematic methodology for developing and monitoring team training would be available (Guerette et al., 1987; Kribs, Thurmond & Marks, 1977; Miller, Guerette & Morgan, 1987; Rizzo, 1980; Thurmond, 1980; Van Berlo, 1996a). A major obstacle in the process of designing team training systems is the focus of current methodologies on designing training systems for the individual trainee (Armstrong & Reigeluth, 1991). However, these appear to be insufficient given the different nature and characteristics of teams and team performance (Van Berlo, 1996a). Besides, most of the methodologies have not been tested empirically (Salas, Bowers & Cannon-Bowers, 1995), though this point of critique is valid for training systems directed at individual trainees as well (Andrews & Goodson, 1980; Gustafson, 1991; Van Berlo, 1996b). The refinement and validation of methodologies, especially in field settings, are critical endeavours that should be undertaken (Salas & Cannon-Bowers, 1997).

In our own research, TNO is confronted with questions related to the training of all kinds of teams, for instance: military teams (Navy, Army, Airforce), crisis management teams (both government and industry), and rescue services (e.g. fire brigade, police). In order to shed light on the design complexity of team training, a preliminary literature was conducted. A field study was carried out in order to get a grip on the problems (military) organisations are facing with respect to team training. The literature study was primarily based on conference proceedings, book chapters and technical reports. Articles in (peer reviewed) journals hardly ever deal with instructional (systems) design for team training. Several databases (ERIC, Picarta, Psychinfo, RAND and Stinet) have been searched for relevant contributions over the past 25 years. Searches were conducted using combinations of the terms ‘team training’, ‘instructional design’, ‘guidelines’ and ‘methodology’, further refined with the term ‘validation’. In addition to what has already been referred to in this introduction, the preliminary literature study showed the following results (for a more detailed description, see Van Berlo, 1996a, 1998b). The required output of a team training system (e.g. what constitutes a good team performance) needs to be defined in a more complete way (Armstrong & Reigeluth, 1991; Cannon-Bowers, Salas, Tannenbaum & Mathieu, 1995; Guerette et al., 1987; Miller et al., 1987; Salas, Morgan & Glickman, 1987). The performance deficiencies of a team need to be identified but this is still lacking (Salas & Cannon-Bowers, 1997). Based upon these performance deficiencies, the training needs of the team can be analysed (Salas, Bowers & Cannon-Bowers, 1995) and a selection of the to-be-trained tasks can be made (Bowers, Baker & Salas, 1994). Further, there still is not a connection node between the way a team matures, the specific training needs, and how these can be linked with specific training strategies, including proper performance assessment methods and strategies for remediation (Guerette et al., 1987; Salas, Bowers & Cannon-Bowers, 1995). Ascertaining which principles of learning and training are prevailing, and how these principles can be applied in team training systems, is a major research question. Instructional systems development for team training is only partially described in methods and in guidelines that can support both instructional designers and instructors (Salas & Cannon-Bowers, 1997). The cost-effectiveness of a training system is neglected in many cases, but it is difficult to clearly define the precise effects or benefits, and to transform these in monetary value (Blomberg, 1989).

The primary research method of the field study consisted of conducting 12 interviews with persons responsible for designing and executing team training in their organisation. All but one of these interviews were conducted within military organisations. Other sources of information (Yin, 1984) were documents/archival records (e.g. reports of interviews and visits), observation (e.g. attending team training exercises) and physical artefacts (e.g. training simulators). The interview questions used and the organisations that participated in the field study can be found in Appendix A and Appendix B respectively. The field study showed that a general and encompassing methodology for developing team training systems is not available, but is very much wanted for. There are many activities in the field of team training but these activities are not very well structured: instructional designers have no clear tools and guidelines that can be of help. Conducting a task analysis is regarded as essential in specifying the instructional objectives, as these are the basis of the actual design and development of a training system. With respect to team training, however, no proper task analyses are being conducted, resulting in an inadequate specification of the instructional objectives. The lack of explicit instructional objectives hinders the development of team training scenarios. The primary drive for designing a training scenario is that it resembles reality as much as possible and that it is exciting. It is not based on systematically derived training objectives describing the to be trained behaviours and guiding the performance measurement and feedback. Consequently, in many cases the feedback does not relate to the (implicit) learning needs of the trainees, and it only focuses on the quality of standard work procedures. Measuring the performance of a team and providing feedback are regarded as complicated. The field study showed only one case in which a rather sophisticated measurement and feedback system has been developed. In all other cases, the issue of performance measurement and feedback raised many questions with no explicit answers. Finally, lessons learned are not formulated to relate the training exercise to the operational practice, nor is the feedback being used as input for follow-up training. The quality of the training programme is hardly ever evaluated in order to determine whether the actual training need has been really met. More detailed results of the field study can be found elsewhere (Van Berlo, 1997a).

A major part of the problems with respect to team training seems to deal with the analysis of the training needs and the team tasks, the formulation of instructional objectives and how this relates to the design of adequate training scenarios, and impacts the team performance measurement and feedback. There seems to be room for improvement in the analysis and design phases, before the actual development and implementation of the team training take place. This may be achieved by offering guidance and support to the personnel responsible for the instructional design. The Dutch military recognised these problems and asked TNO to start a research program aimed at improving the quality of team training. The research described in this doctoral dissertation is conducted as part of this research program. It concentrates on (a) how instructional designers can be supported in analysing team tasks and designing team training scenarios, (b) validating the quality of this support and (c) how these results contribute to developing an Instructional Design model for training teams.

Analysis and design are two phases of what is identified as Instructional Systems Design (ISD). ISD has a broad scope and covers all aspects of constructing a learning environment. The phases of analysis and design together are known as Instructional Design (ID). ID is less broad in scope and focuses on analysing competencies, defining training strategies and designing a learning environment. The first chapter will give a description of and a reflection on, ISD and ID expertise. The characteristics of teams, team performance and team learning will be described in chapter 2. Next, ID for team training will be discussed (chapter 3) as this research focuses on supporting the analysis and design phases of designing instruction for teams. The ID practitioners in this research are novice military instructional designers and within this context, guidelines were regarded as the most appropriate form of support for them. Current guidelines for designing team training have been reviewed, and the guidelines that were developed supporting the analysis of team tasks and the design of team training scenarios will be described in chapter 3. It will become clear that in this doctoral dissertation a constant tension is apparent between new and more constructivist paradigms of learning, the characteristics of ID, the need for systematically designing instruction and the best way to support ID practitioners. The empirical studies conducted in order to validate the guidelines are described in chapters 4 and 5. Finally, chapter 6 concludes with the overall discussion.

1. DESIGNING INSTRUCTIONAL SYSTEMS

In this chapter designing instructional systems is reviewed. First, Instructional Systems Design (ISD) itself will be explained (1.1), followed by a reflection on Instructional Design (ID) (1.2). The chapter will end with a description of the nature of ID expertise (1.3).

1.1 Instructional Systems Design (ISD)

The objective of any training system is to change the competencies of the trainees so that they can perform their tasks in the operational environment more effectively and efficiently. The actual task, the context in which it has to be accomplished, and the required competencies make up the conditions for the instructional systems design process. After the Second World War, systems analysis made its entrance in training design. Systems analysis is a powerful problem-solving approach because it uses (a) an interdisciplinary team of experts to bring as much relevant information to a problem as possible, (b) models to reduce complex problems to analysable proportions and (c) systematic yet dynamic problem-solving methods that can be modified by the team of experts at any point during the analysis to better handle the specific problem (Hays, 1992). The first efforts to employ this method were called the Systems Approach to Training (SAT) and served as prototype for the subsequent development of Instructional Systems Design (ISD). According to Schiffman (1986), instructional systems design is a synthesis of theory and research related to:

a) How humans perceive and give meaning to the stimuli in their environment
b) The nature of information and how it is composed and transmitted
c) The concept of systems and interrelationships among factors promoting or deterring efficient and effective accomplishment of the desired outcomes
d) The diffusion of the (instructional) solution, and
e) The consulting, interpersonal, and managerial skills in order to meld points ‘a’ to ‘d’ into a coherent whole.

A single designer is not expected to have all of the necessary knowledge and skills, so a design-team of experts is desirable. Whenever instruction is being designed, an appeal must be made to educational theory and research, system analysis, diffusion, consulting/interpersonal relations, and project management. In this view the development of training and instruction systems is a continuous and iterative process. Examples of ISD-models that have had a major impact in the field of training system design, are the Instructional Development Institute (IDI) model (National Special Media Institute, 1971), Interservice Procedures for Instructional Systems Development (IPISD) (Branson, Rayner, Lamarr Cox, Furman, King & Hannum, 1975), the Romiszowski model (Romiszowski, 1981, 1984), and the Dick and Carey model (Dick & Carey, 1996) that is strongly related to the Gagné model (Gagné, Briggs & Wager, 1992). The models differ in scope: some do not cover all phases of instructional design, while others are developed for application in specific organisational settings (Verstegen, 2004). There is a diversity of instructional design theories and models that often are used and further developed in isolation (Dijkstra, 2001). Looking at so many theories, apparently so at odds with one another, Duchastel (1998, p. 2) wonders whether this is “a healthy situation, one where creativity is blossoming, or one where Babel reigns instead?” According to Hannafin (1992, p. 50), however, “the differences among models often are related more to level of detail, terminology, and emphasis than to clearly differentiated foundations, assumptions, and learning paradigms”.

A description of the task that has to be learned, and the way in which this will be implemented in a training program, is the output of several consecutive steps. These steps can be subsumed under the headings of analysis, design, production, implementation and evaluation/maintenance (Tennyson, 1993). These phases follow an iterative process: the design of an instructional component can be implemented in a prototype and subsequently be evaluated and refined. Moreover, the phases are not strictly separated and show considerable overlap (Van Merriënboer, 1997) which is characteristic of the so-called fourth generation instructional systems development (Tennyson, 1995; see Figure 1.1). In the analysis phase the task(s) and the operational environment are described in detail. A mission and task analysis identify the tasks required for accomplishing the mission, the interrelations of the tasks, the major components/constituents of each task and their interrelations, the conditions in which the tasks have to be executed, and the criteria/norms that apply to them. The analysis phase is perceived as the most important phase in the ISD process, but probably the most difficult as well (McCombs, 1986; Ryder & Redding, 1993). Task analysis is a methodology broadly based on principles rather than a rigidly prescribed technique (Annett, 1996), and is sometimes even considered to be more of an art than a science (Schraagen, 1998). A target-group analysis provides insight into the current proficiency level of the trainees. A training need exists if the competencies are insufficiently available within the target group for executing the (team) task(s). This sets the basis for specifying the instructional objectives. In the phase of *design* the instructional objectives are categorised, allocated to a learning environment and sequenced. The instructional strategies are defined, and scenarios for instruction and practice are developed. Also the functional and technical specifications of the training devices are drawn up. This is followed by the production (or development) phase in which specifications are implemented into instructional products. During the implementation phase, the instructional products are disseminated and implemented in the particular organisation. In the evaluation (or maintenance) phase, the instructional products are maintained and evaluated and, if necessary, revised and refined.

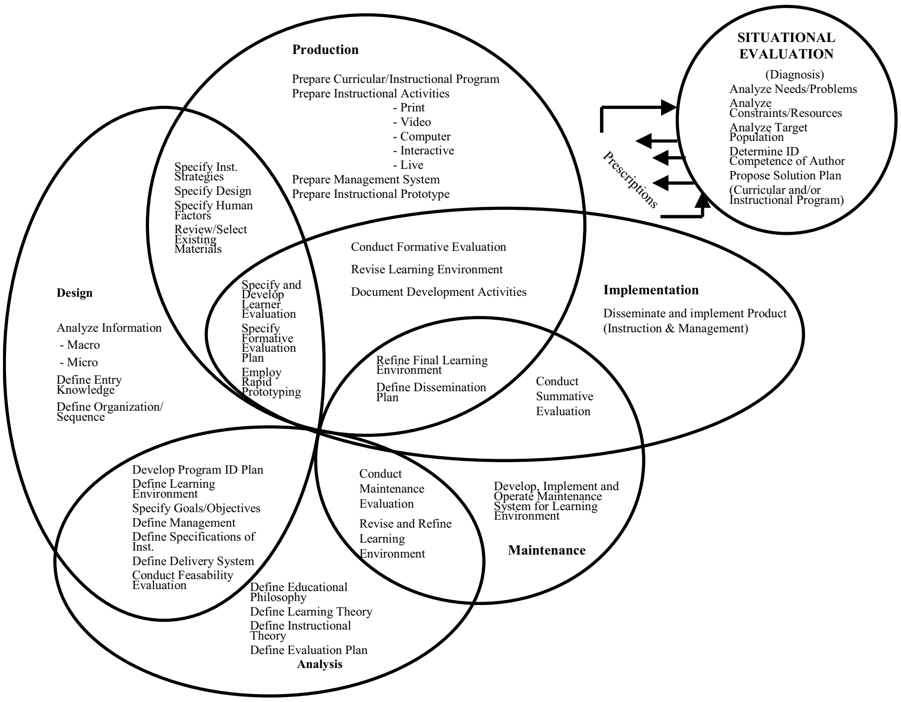

Figure 1.1. Fourth generation instructional system development, ISD4 (Tennyson, 1995, p. 35)

In her review of ISD, McCombs (1986) identified several factors critical for success. First of all, the instructional designer needs to be trained in applying the distinct steps, and needs to have profound knowledge of learning theories. This should guarantee a consistent application of standardised procedures, although the designer might be flexible in the implementation of techniques and formats. Further, a management plan is required that needs to be adapted continuously to the current situation. The needs and the to-be-trained tasks should be properly analysed, and the results of all ISD steps evaluated. It is important that all activities and results are documented and that ISD is regarded to be a team effort, rather than an individual's activity. Finally, according to Duchastel (1990, p. 442) an essential designer's task demand lies at the conative level: "the sense on the part of the designer that (s)he is the one in creative charge of the design process. Without this, the design process will not proceed effectively, neither efficiently."

1.2 Instructional Design (ID)

As already described in the Introduction, within the military there seems to be room for improvement before the actual development/production and implementation of team training systems, namely in the analysis and design phases (Van Berlo, 1996a, 1997a). These phases are part of the entire ISD process and are indicated as Instructional Design (ID). ID is a field of both applied research and development activities that aims at formulating, executing, and testing theoretically sound solutions for instructional problems in real-life situations. 'Problems' may pertain to the nature of the environment that most adequately fosters the accomplishment of learning tasks or the process of designing and developing such environments. 'Solutions' may pertain to the identification of parameters to be taken into account or procedures (methods, instruments, rules) to be applied (Elen, 1994).

The last twenty to thirty years, within the Instructional Design community, a paradigm shift has occurred. Views on learning psychology and instructional design have shifted from a behaviouristic view, via a cognitive view, towards a constructivist view (Greer & Verschaffel, 1990; Vanmaele, 2002). This paradigm shift is related to conceptions of the relationship between the individual learner and reality, as well as how the individual acquires knowledge (Vanmaele, 2002). This will be briefly described next. In the *behaviouristic* view, learning by an individual is externally controlled by instructional agents (e.g. a tutor, teacher or computer-program), and is aimed at acquiring observable behaviour. The learning content is described in observable terms. It is fragmented into chunks, presented in a linear and stepwise fashion, hardly situated in a learning domain or real life context, and simply needs to be reproduced by the learner. With respect to instructional design, this process is linear and proceeds from a predefined beginning throughout distinguishable substeps to a predefined ending. Descriptions and lessons-learned from psychology can be easily translated into prescriptions for instructional design.
In the *cognitive* view, learning is aimed at acquiring complex, cognitive processes. Gagné, Briggs and Wager (1992) distinguish five types of learning goals: intellectual skills, cognitive strategies, verbal information, motoric skills, and attitudes. The intellectual skills encompass a variety of underlying skills ranging from symbol learning to problem solving. Every learning goal on a higher level includes the learning goals on a lower level. This

view implies that the learner can regulate his/her own learning process. Not only the final outcome, but the learning process itself is regarded as an important focus of instruction. The learning content is derived from an extensive analysis of the subject matter from an expert point of view. Instructional design clearly delineates the path the novice learner has to follow to master this expert behaviour. Learning content is regarded as coherent units, applicable in real contexts (see also Van Merriënboer, 1997). Just as in the behaviouristic view, descriptions and lessons-learned from psychology can be translated into prescriptions for instructional design.

In the *constructivist* view, learning by an individual is regarded as self-directed and constructive. However, learning goals and criteria for assessment cannot be prescribed in advance. The learning process and the resulting changing needs of the learner continuously constitute new and changing learning goals. Not the instructional designer is regulating the learning process, but the individual learner: (s)he is interpreting the learning environment and determines the goals and the path towards these goals. Instructional design here is focused on designing open learning environments in which the learner is confronted with a complex and challenging (simulated) reality, inviting him/her to explore new domains and to construct knowledge based on previous learning experiences. This requires a complex balance between structured didactical support and self-guidance on the one hand, and creating the appropriate conditions required for long term self regulation on the other (De Corte, 1996; Duffy & Jonassen, 1992; Verschaffel, 1995). Following the complexity and unpredictability of the learning process, descriptions from psychology are hard to translate into prescriptions for instructional design.

Within the constructivistic view, three variants can be positioned on a continuum: a strong, mild and weak constructivist view (Lowyck & Elen, 1993). Strong constructivistic theories assume that knowledge is not tied to external reality, but that it is based upon personal experiences of the individual learner (Jonassen, 1990). They see learning as an essentially cognitive activity, which is completely and deliberately initiated and monitored by the learner him/herself (Lowyck & Elen, 1993). Although self-regulated learning might be an ideal, the mild constructivist theories argue that most learning involves the interaction between internal (i.e. cognitive) and external (e.g. instructional materials) monitoring and that learning processes can be initiated both internally and externally. According to the weak constructivist theories cognitive activities and processes are essentially mediating variables: the learning process itself results from and is monitored by external stimuli (Lowyck & Elen, 1993).

Irrespective the view or theory one adapts, it is recognised that learners are active beings: rather than having to control the entire learning process, instructional design should foster their learning capabilities. Following Lowyck and Elen (1993), this doctoral dissertation advocates a mild constructivistic view on instructional design and acknowledges the difficulties of translating descriptive research outcomes into design prescriptions. Lowyck and Elen (1993) define instructional design as (1) a theory-based discipline offering not only procedures that work, but also explanations why they work in given circumstances, (2) prescription-oriented, implying that theory-based and empirically validated rules, procedures and/or instruments are built enabling more deliberate decision-making in concrete situations, and (3) an applied discipline focusing on the applicability in concrete situations of outcomes from basic research.

All of these views form the basis for many different ID models. The role of models in ID is "to provide conceptual and communication tools that can be used to visualise, direct, and manage processes for generating episodes of guided learning" (Gustafson & Branch, 1997, p. 77). There are many ID-models, but these differ only on details (Andrews & Goodson, 1980; Hannafin, 1992). Besides, little is known about the validity of these models, and there is serious doubt whether the models adequately describe how designing instruction really occurs (Elen, 1994). An ID model is assumed to capture the dynamic nature of the ID process, implying regular evaluations of results. But most of all, a useful model reflects the necessary skills and knowledge: besides procedural knowledge, it includes the declarative (Anderson, 1982) and strategic knowledge (making action plans) involved in the ID process (McCombs, 1986; Perez, Fleming Johnson & Emery, 1995). Not just the steps that comprise the ID process are important, but also knowing how and why to conduct the distinct activities.

ID is rooted in a strong behaviouristic tradition. Most of the ID models aim at controlling specific learning outcomes by offering guidelines that enhance the probability that these learning outcomes will appear. Therefore, an essential feature of most models is their controlling, rather than enabling nature (Lowyck & Elen, 1993). Although prescriptive design models are aimed at helping designers to improve their instructional material (Braha & Maimon, 1997), making decisions during the design process is hard to support. According to Verstegen (2004) this has several reasons:

- The models give contradictory advice regarding the kind of instructional materials best suited for specific learners, goals and settings;
- In practice, decisions are heavily influenced by pragmatic reasons rather than by theoretical reasons;
- Decisions are influenced by different members of the design team and/or stakeholders who may have different opinions and interests;
- The models prescribe which decisions need to be taken, but not how this should happen.

It is not the intention to present an encompassing review of ID models in this chapter: this can be found elsewhere (e.g. Andrews & Goodson, 1980; Dijkstra, 2001; Dijkstra, Seel, Schott & Tennyson, 1997; Gustafson, 1991; Reigeluth, 1983, 1999; Tennyson, Schott, Seel & Dijkstra, 1997). More specifically, behaviouristic models are described in Case and Bereiter (1984) and Merrill, Kowallis and Wilson (1981), cognitive models are described in Elen (1995), Merrill, Li and Jones (1990a, 1990b), and constructivist models in Elen (1995), Lowyck and Elen (1993) and Jonassen (1992). One instructional design model, however, that will be described in more detail, is the Four-Component Instructional Design Model (Van Merriënboer, 1997; Van Merriënboer, Clark & De Croock, 2002).

The Four-Component Instructional Design (4C/ID) meets the definition of instructional design (Lowyck & Elen, 1993), namely a theory-based, prescription-oriented and applied discipline. It is also relevant for training teams because the model is primarily aimed at designing learning environments for learning complex cognitive skills. As will be described in chapter 2, important factors in performing as a team are the team processes, like communication, co-ordination and supporting behaviour. These team processes have a substantial cognitive component, are difficult to learn and are often neglected during team training programs. In line with the mild constructivist view on learning, the 4C/ID model stresses the importance of learning to co-ordinate and integrate the separate skills that constitute real-life task performance. The constituent skills can be either recurrent or nonrecurrent. Recurrent constituent skills are highly similar from problem to problem situation; this is routine behaviour driven by rules that link particular characteristics of the problem situation to particular actions. The whole-task approach implies that the recurrent aspects of performance are not trained separately but can only be practised in the context of the whole learning task. Nonrecurrent constituent skills vary from problem to problem situation. Behaviour in these novel situations is guided by cognitive strategies routing the problem-solving behaviour and allow for reasoning about the domain based on mental models (Van Merriënboer, Clark & De Croock, 2002).

The 4C/ID model consists of four layers (Van Merriënboer, 1997). In the first layer, the complex cognitive skills are decomposed into a hierarchy of recurrent and nonrecurrent constituent skills ('principled skill decomposition'). In the second layer, the constituent skills, their relationships and the underlying knowledge structure are analysed (using algorithmic methods for recurrent skills and heuristic methods for nonrecurrent skills). In the third layer, the instructional methods are selected and specified. In the fourth layer, a detailed blueprint for the learning environment is designed, and the learning environment is developed. Looking more into detail to the third layer, the 4C/ID model presupposes that well-designed learning environments for complex learning always consist of four components: (a) learning tasks, (b) supportive information, (c) procedural information, and (d) part-task practice.

(a) Learning tasks are represented in an ordered sequence of task classes that represent simple-to-complex versions of the whole task. These learning tasks will confront the learners with all constituent skills that make up the whole complex skill. Each task class starts with one or more learning tasks with a high level of embedded support, continues with learning tasks with a lower level of support, and ends with conventional tasks without support.

(b) The supportive information is presented just-in-time to work on the nonrecurrent aspects of learning tasks within the same task class. For each subsequent task class, additional supportive information is presented to enable the learners to perform the more complex version of the whole task.

(c) The procedural information is presented just in time to work on the recurrent aspects of the learning tasks. This support preferably takes the form of direct, step-by-step, or how-to instruction and supports the automation of this behaviour. It should quickly fade away for subsequent learning tasks.

(d) Part-task practice may be provided if a high level of automaticity is desired for particular recurrent aspects. In these cases, the learning task itself may not provide enough opportunities for repetition. The additional part-task practice starts only after the learners have been introduced to the recurrent aspects in the context of the learning tasks.

Along with the paradigm shift in ID, the definition of 'design' is changing as well (Elen, 1995). Initially, design refers to making decisions on, and the application of, procedures, methods, prescriptions and tools for realising effective, efficient and productive learning (Romiszowski, 1981). The introduction and increasing use of open electronic learning environments leads to the definition of a “grounded learning systems design” (Hannafin, Hannafin & Land, 1997, p. 102), defined as “the systematic implementation of processes and procedures that are rooted in established theory and research in human learning.” This leads to a fading of the traditional borders between design, development and implementation (Lowyck, 2000; Tennyson, 1995). Designing is no longer perceived as a linear and externally directed activity, but a flexible and iterative process involving all actors (e.g. learners, coaches, instructors, designers). This interaction perspective looks to be the core of designing powerful learning environments (Lowyck, 2000), taking into account the characteristics of the learners, the domain knowledge, authentic assessments, and the community resulting in an integration of learning in and out schools/organisations (Resnick, 1987).

Elen (1995) described the relation between description and prescription in terms of the components comprising an ID-model. Figure 1.2 depicts these components and their interrelations.

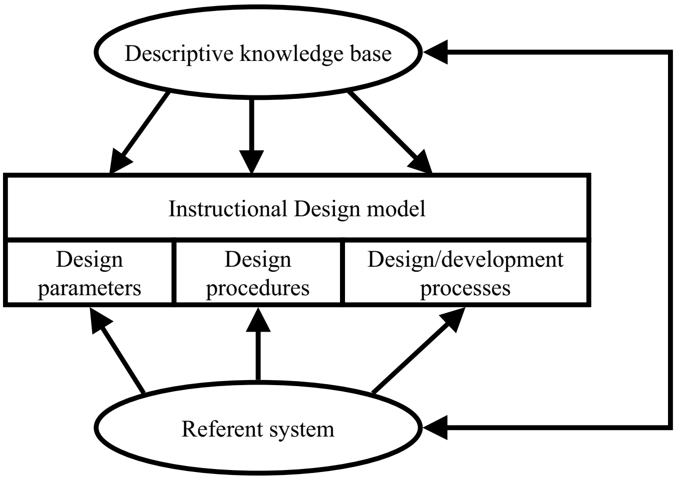

Figure 1.2. Components of ID-models (Elen, 1995, p. 18)

Elen (1995) distinguished three types of outcomes of ID research: design parameters, design procedures and design/development processes. Design parameters are the descriptive elements of an ID-model, and refer to which parameters the model takes into account. Two kinds of parameters are distinguished, namely learning parameters (variables of the learners) and instructional parameters (variables of the instructional environment). Design procedures refer to how these parameters are instrumented. With other words, these are the concrete prescriptions offered by the model supporting the design decision-making process. The design/development processes are the specific steps to be taken while designing/developing specific instances of instruction. The content of these components is determined by two additional components, namely the descriptive knowledge base and the referent system that have an interactive relationship. The descriptive knowledge base reflects the theoretical background of the model. The referent system indicates the particular kind of instructional situation the model is elaborated for and is validated in; it refers to the scope of the model defined in terms of, for instance, characteristics of the target group, types of goals and kinds of instructional materials. Consistency between all components is an essential characteristic of theoretically sound ID models (Elen, 1995).

1.3 The nature of ID expertise

ID is regarded as a problem solving process involving a large-scale interplay of possibilities and evaluations (Duchastel, 1990). According to Greeno, Korpi, Jackson and Michalchik (1990), design tasks differ in two ways from other problem solving tasks: the problem solution space is open (because of the creativity involved) and the final state is a matter of judgement. In a multi-domain study on the structure of design problem spaces (not restricted to instructional design), Goel and Pirolli (1992) state that design has two elements: a logical and a creative one. Both are necessary, but require very different abilities. Research on the design methodology is supposed to aim at developing systematic external methods and tools to carry out the logical analysis better, and to unburden the designer to engage in the creative aspects of problem solving. Goel and Pirolli (1992) identified, amongst others, the following characteristics of 'design problem spaces': structuring of the problem, distinct problem-solving phases, modularity/decomposability of the design process, incremental development of artefacts, control structure, making and propagating commitments, personalised stopping rules and evaluation functions, and a hierarchy of abstractions. The implication is that these characteristics can also apply to the domain of instructional design. Further, one of the most robust findings in the literature on problem solving in design is, according to Goel and Pirolli (1992) the incremental development of products, caused by the fact that:

- The problems are large and, given the sequential nature of information processing, can not be completed in a single processing cycle;
- Because there are few logical constraints on design problems and no right or wrong answers, there is little basis for giving up partial solutions and starting over from scratch. It makes more sense to continue to develop what already exists;
- Incremental development is compatible with the generation and evaluation of design components in multiple contexts. Besides, when the designer cycles back, it is not to the previous knowledge-state, but rather to a previous topic instantiated in the current context. This is indicative of some higher-level control structure.

ID is often perceived as an intuitive, artistic endeavour (Lowyck, 1991) and as an ill-defined domain, characterised by few constraints, multiple correct solution paths, and few a priori design rules in the process (Perez et al., 1995). Identifying the characteristics of expert and novice designers can provide valuable information for developing support during the ID process. Visscher-Voerman (1999) interviewed professional instructional designers with the purpose of finding patterns of design activities; she concluded that this was not possible. Rather, she identified four paradigms reflecting different stances toward design, namely the instrumental, communicative, pragmatic and artistic paradigm (Visscher-Voerman & Gustafson, 2004). Especially the analysis and evaluation phases were not executed as elaborately as often prescribed. Hoogveld, Paas, Jochems and Van Merriënboer (2002) found that teachers, when they design instructional materials, do not give much attention to the analysis of the design problem and the preparations necessary to be able to carry out evaluations.

Rowland (1992) showed that experts make a detailed problem analysis, approaching the task from different perspectives thereby using several sources of information to obtain reliable data; after this analysis, the experts move on to the design phase, and do not question the problem analysis again. They also come up with other, additional, solutions as well, for instance developing job-aids and improving the personnel selection procedures. Experts develop a kind of a template of the instructional solution, specify this template into more detail in several iterative steps, and relate the current problem to previously encountered design problems. Finally, experts try to determine the effects of certain instructional strategies, rather than selecting these strategies explicitly based on the typical conditions (as prescribed in guidelines). Perez et al. (1995) found that experts use more design principles and rely on a variety of knowledge sources, spend more time in front-end analysis or planning, and in trying to understand the domain (rather than merely identifying it). Expert design models are characterised by breadth first, and the integrating, reiterating and cycling through the design process. Experts relate current design problems to previous experiences, and use their creativity and logic. Designers need a broad knowledge base, rich and varied enough to see the problem from many points of view (Wilson, 2004).

Novices, on the other hand, have no systematic plan of action because they lack the strategic knowledge. They rely on general instructional strategies rather than adequately defining the problem. Novice designers are characterised by a deterministic linear way of tackling the design problem (Perez et al., 1995) and making a less detailed problem analysis: they only identify the problem, but do not understand it. Experts spend more time on problem understanding than the novices do (Rowland, 1992, 1993). Greeno et al. (1990) found that instructional designers did spend time on shaping the problem space, but that they spent far more time on the design itself. This has the risk in it that the real problem will not be tackled by the proposed solution. Besides, the problem-representation and the solution-generation are heavily intertwined. Blessing (1994) found that novice designers tend to stick to their solution and do not execute evaluation in a proper way. Although novices may have enough knowledge about instructional design principles and models because they had finished several courses on the topic, they still lack the strategic knowledge that is necessary to translate theory into practice (Perez et al., 1995). In fact, these differences between experts and novices are in line with results of research on other cognitive tasks (Glaser & Chi, 1988).

Baker and Salas (1996) conducted a study on the selection of team tasks to be included in a training program. They found that the level of experience of the subject-matter experts involved affected the ratings on the tasks. Inexperienced subject-matter experts emphasised criticality of error, difficulty of performing, difficulty of learning, and importance for training, while the more experienced subject-matter experts emphasised time spent performing the behaviour. This implies that task analysts are required to involve subject-matter experts from a variety of experience levels to ensure that all critical team behaviours are included in the team performance analysis (Baker & Salas, 1996). This relates to the results of Hoogveld (2003) who found that low achieving instructional designers performed better when they worked collaboratively then when they worked individually. It also stresses the importance of a target group analysis: the behaviours that define effective team performance may change as team members gain experience. Teams are dynamic and evolve over time (Salas, Morgan & Glickman, 1987). The level of experience of the team members determines whether the results of the analyses are used for initial or proficiency training.

According to Hannafin (1992), procedures supporting the ID process have proven efficient, effective, and valuable across a wide array of problems and settings. Several other authors, however, question the effectivity and efficiency. A major point of critique is the reductionistic approach of infinitely breaking down the task and the requisite skills and knowledge (Winn, 1990), based on the behaviouristic model of learning, neglecting the cognitive processes underlying the learning process (Perez et al., 1995). Related to this is the problem of over-proceduralization of complex steps and processes to the point that they are trivialised (McCombs, 1986). Although specified rules are provided, these guidance documents emphasise the procedural knowledge ('what en how to do') of training development and not the declarative knowledge ('why to do') (McCombs, 1986; Perez et al., 1995) nor the conditional knowledge ('when to do'). According to Wilson and Cole (1992, p. 73) "there is a growing indication that instructional designers do not apply formal models in a lock-step fashion. Indeed, ID models often fail to capture expert designers' knowledge and skill. This common problem between theory and practice is aggravated when the 'prescriptive' ID models are represented in a highly technical and rigidly proceduralized fashion". The problem with prescriptive guidelines is that these "contain statements of the learning principles that accurately describe the mechanisms of cognitive change (i.e. learning) to be used in designing instruction and training. The use of these theories of instructional design in practice has always been problematic because they require that the designer derive general principles of instruction from general principles of learning and apply these to a specific task or domain" (Perez et al., 1995, p. 338). Wilson and Cole (1992, p. 76) state that a "procedural approach has two problems associated with it: (a) the procedural prescriptions often go far beyond our knowledge base about learning and instructional processes and are often at odds with that knowledge; and (b) instructional designers tend to follow models in a principled-based, heuristic manner in spite of detailed procedural specifications". Instructional models are not deductive theories in the manner that merely following the steps will automatically result in effective training systems (Carroll, 1990; Winn, 1990). According to Winn (1989, cited by Lowyck, 1991, p. 4), "Recipes only work sometimes, and only in contexts that are remarkably similar to those in which the recipes were developed." Therefore, analogical reasoning could be the driving force behind ID rather than a more orderly rule-based reasoning (Duchastel, 1990). But because many designers lack this knowledge, skills and/or experience, the quality of the output is rather disappointing (McCombs, 1986). Besides, both the complexity of the ID process and the designer's proficiency level, cause ID to be costly, labour intensive and time consuming, and the distinct steps to be conducted only partly or less profound (McCombs, 1986; Perez et al., 1995; Rowland, 1992). Finally, because personal experience and creativity are critical factors of success, the ID process is often regarded as an art rather than a science (Lowyck, 1991; McCombs, 1986; Winn, 1990).

Novices need to be confronted with cases in order to gain experience that can be applied in future design problems (Duchastel, 1990; Rowland, 1992). According to Wilson and Cole (1992, p. 73), the "expertise lies embedded within the expert practitioner and can only be acquired through extended opportunities of practice in authentic settings, with appropriate coaching, mentoring, and other guidance with feedback. This guidance is less in the form of general principles and rules and more in the form of contextualised reasoning based on the specifics of a case". Although guidance for the designer should not be too general, highly detailed rules prescribing what to do, are also considered as ineffective support. An intermediate way of support in the form of applicable heuristics and scientific principles will allow practising designers to adapt the concepts to a greater variety of instructional situations (McCombs, 1986; Romiszowski, 1981, 1984; Wilson & Cole, 1992). Attempts to structure the design process are sometimes valued, but are frequently viewed as restrictive (Odenthal, Kuiper, Voogt and Terwindt, 2000). Any support that structures the design process should leave ample room for flexibility, especially for novices (Rowland, 1992).

1.4 Summary

Instructional Systems Design (ISD) has a broad scope and covers all aspects of constructing a learning environment. The phases of analysis and design together are known as Instructional Design (ID). ID is less broad in scope and focuses on analysing competencies, defining training strategies and designing a learning environment. ID is a knowledge intensive process (see also Verstegen, 2004), heavily grounded in the personal experience, insight and creativity of the designer, and expertise in the subject matter (Duchastel, 1990; McCombs, 1986; Perez et al., 1995). Therefore the ID-community is looking for more flexible procedures that do not offer rigid prescriptions, but enable instructional designers to make their own decisions (Elen, 1995). In order to develop guidelines adequately supporting the process of designing team training systems, it is important to take into account the nature of instructional design and the required expertise (Elen, 1995):

- ID is an iterative process;
- An adequate analysis of the problem is of paramount importance;
- Various solutions to the design problem are possible and can be equally adequate;
- A weak relation between problem and solution is rather common: this indicates that ID is both a science and an art;
- The design process is affected by the social context (e.g. design team, organisation) in which it takes place;
- Support for the instructional designer should not only be procedural of nature, but strategic as well; meaningful considerations and illustrative examples support the designer in choosing the most adequate solution for his/her specific problem;

As a result, an instructional designer is supposed to possess the underlying knowledge base in learning, instructional design and analysis, and basic problem-solving skills involved in planning, decision making, and evaluation of alternatives relevant to each step in the ID process (McCombs, 1986). It is clear that a tension is apparent between new and more constructivist paradigms of learning, the characteristics of ID, the need for systematically designing instruction and the best way to support ID practitioners, also taking into account the characteristics of the (military) organisation they are employed at. In chapter 3, in which we will focus ID towards team training, we will argue how we have dealt with this tension in this dissertation. But first we will discuss the characteristic features of team performance and team learning in the next chapter.

2. TEAM TRAINING FOR TEAM PERFORMANCE

A training system for teams has to meet the specific characteristics of team performance and incorporate the way teams learn. First, the characteristics of team performance will be described (2.1), followed by a reflection on team training and team learning (2.2).

2.1 Team performance

Over the years, many models of team performance have been developed each varying in scope, focus and detail. It is not the intention to present an encompassing review of these team performance models in this chapter: this can be found elsewhere (e.g. Ford & Associates, 1997; Guzzo & Salas, 1995; McNeese, Salas & Endsley, 2001; Rasker, 2002; Swezey & Salas, 1992). A model that is rather broad and encompasses many factors influencing team performance, is the Team Effectiveness Model developed by Tannenbaum, Beard and Salas (1992) strongly based on the work of Levine, Brannick, Coovert and Llobet (1988). Team performance is the outcome of dynamic processes reflected in the co-ordination and communication pattern that teams develop over time. The team processes are continuously influenced by situational and organisational characteristics, by task and work characteristics, and by individual and team characteristics. An important feature of this model is the interaction among four classes of input variables, namely the characteristics of the task, the work, the individuals, and the team (Urban, Bowers, Cannon-Bowers & Salas, 1995). Training interventions can be directed at both the input and process variables in order to enhance team performance (Salas, Dickenson, Converse & Tannenbaum, 1992).

Figure 2.1 depicts a slightly modified version of the Team Effectiveness Model. The modifications were made based on a literature review of team performance models (Van Berlo, 1998a) and are briefly summarised next. The 'organisational and environmental context' more explicitly includes the environmental factors that can influence team effectiveness, as well as the mission of the system the team is part of, the standards of performance, the educational system and the information system. At the input side of the model, an additional 'task characteristic' is the work content (or stuff) as indicated by Hackman (1990). Within the 'work characteristics', an explicit distinction is made between member proximity (the physical distance between members of a team) and communication modality (the nature of the medium through which team members engage in their interactions). One additional 'team characteristic' is the team structure (the assignment of particular components of the team's collective task to individual team members: Urban, Bowers, Cannon-Bowers & Salas, 1995), and another one is the experience the members have as a team (Hackman, 1990).

At the throughput side of the model, an additional aspect that is explicitly distinguished within the 'team processes' is time management (Hackman, 1990). Other relevant features of team processes are the level of effort, task performance strategies (Hackman, 1990) and the human-machine interaction (Levine et al., 1988). 'Leadership' is a throughput variable on its own, rather than a component of the team processes. Leadership is primarily bound to an individual team member (the team leader), but has a strong reciprocal relationship with the team processes (Kozlowski, Gully, Salas & Cannon-Bowers, 1996).

The output variable 'team changes' also refer to the processes, but related to this aspect, the shared mental models within the team probably will have been changed as well. As indicated by Nieva, Fleishman and Reick (1978), the individual task performance is an integral part of the team performance, and should be taken into account. An important additional 'individual change' concerns the team member's well being: a decrease in the member's well being has a negative effect on the team's performance (Hackman, 1990).

Additional 'interventions' are coaching and consultation, influencing the input and throughput variables as well. Finally, 'feedback' from the output also affects the throughput (both team processes and leadership). Besides, the feedback could also influence the interventions, and the organisational and environmental context.

Because of the complexity of team performance, it is important to note that training can not be the sole contributor to enhance team effectiveness. But carefully identifying and analysing the variables affecting team performance, and taking into account these factors in the process of instructional systems design, will probably positively impact the effectiveness of the team training. The various components of the Team Effectiveness Model will be briefly exemplified next.

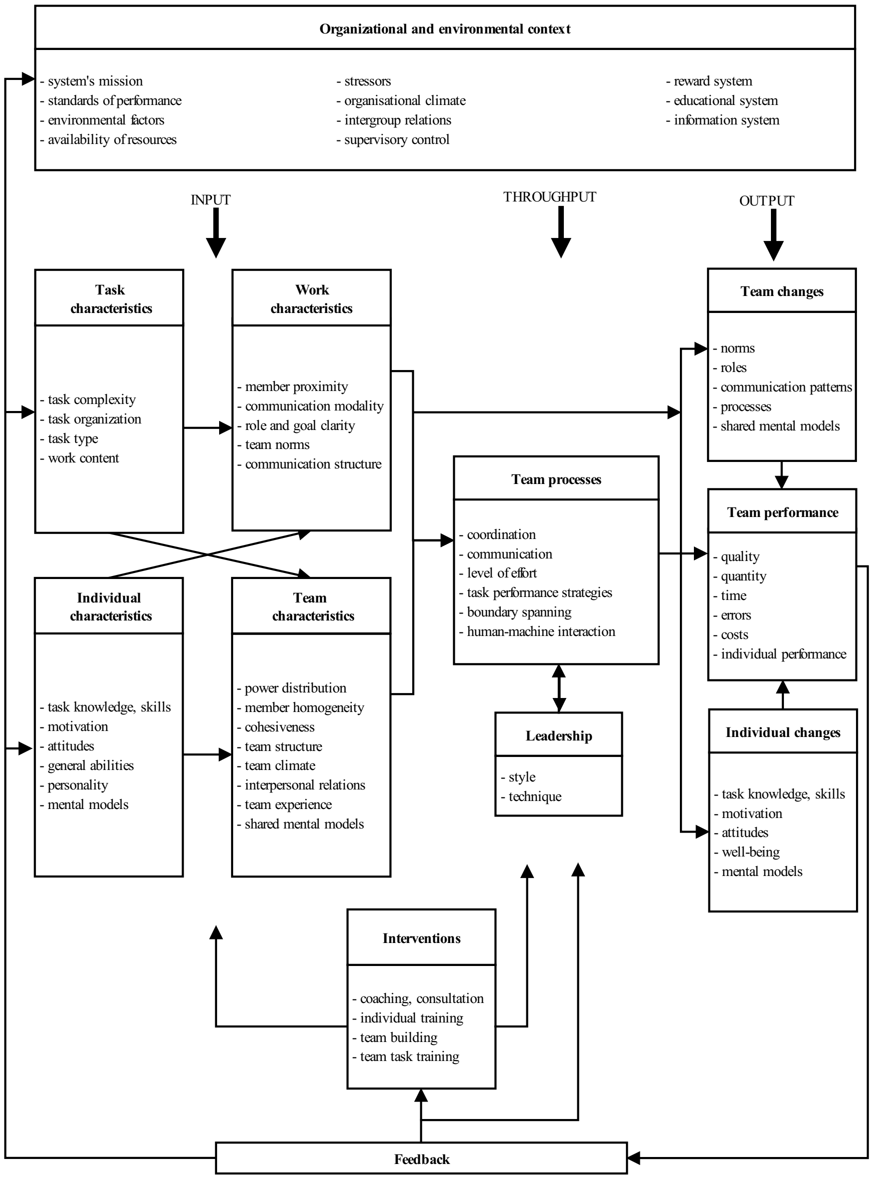

Figure 2.1. A modified version of the team effectiveness model (Van Berlo, 1998a, p. 24, adapted from Tannenbaum, Beard & Salas, 1992, p. 23).

The organisational context and group structure affect the member interaction process, which in turn affects the quality of team performance (Hackman, 1983, 1990). It is important to note that no single factor determines team effectiveness: effectiveness is the product of multiple, non-independent factors whose influence depends on the fact that they are redundant

(Hackman, 1990). With respect to reaching a sufficient level of proficiency within the team, a team leader should continuously perform three kinds of activities: creating favourable performance conditions for the team, building and maintaining the team as a performing unit, and coaching and helping the team in real time. Team effectiveness is also determined by group processes like open communication, conflict, and discussion of strategy, and moderated by group task demands like task complexity, environmental uncertainty, and the level of team interdependence (Gladstein, 1984). Further, it is already known for nearly twenty years that a team changes over time, growing from an unskilled and immature team towards a skilful and mature team (Dechant & Marsick, 1992, referred to by Druckman & Bjork, 1994; Glickman, Zimmer, Montero, Guerette, Campbell, Morgan & Salas, 1987; Montero, Campbell, Zimmer & Glickman, 1987; Morgan, Glickman, Woodward, Blaives & Salas, 1986; Salas, Morgan & Glickman, 1987).

In contrast to individual tasks, no proper definition of a team task has been presented. In some studies (e.g. Drucker & O'Brien, 1981; Olmstead, Cleary & Salter, 1975, referred to by Levine et al., 1988) the system an individual is part of, has been analysed. For instance, a gunner is part of the system 'tank'. Both individuals and teams are part of the system. From an analysis of the system's missions, the tasks of the operators can be derived and further analysed. The problem, however, is that the usual focus is on the individual tasks and that team tasks have been largely neglected. Levine et al. (1988) made an explicit distinction between individual and team task behaviours. The team task behaviours are indicated as 'functions', as contrasted to individual task behaviour (see also Nieva et al., 1978). But this does not seem to be a clear distinction. In order to perform its missions, a system has to be able to accomplish so-called system-functions (Van Rooij & Van Berlo, 1996). Functions are accomplished by the system rather than by humans. For instance, the mission of a mobile weapon system (like a tank) is the elimination of a hostile weapon system. In order to accomplish this mission, the system has the following system-functions: mobility, target acquisition and engagement, co-ordination, and system maintenance. In order to accomplish these functions, individuals and teams have to conduct tasks making use of the possibilities the system offers (e.g. locking on an enemy target). In this view, functions are accomplished by the system, while tasks are performed by human personnel (Van Rooij & Van Berlo, 1996). This brings us to a definition of a team task: a task performed by at least two individuals whose subtasks/activities are interdependent, and has to be accomplished under conditions of high workload and time pressure; the activities and responsibilities of each team member are clearly specified. The main difference between a team task and an individual task is that a team task can not be performed by just one individual. A team task is therefore more than a simple aggregate of a distribution of individual tasks (Cooke, Stout & Salas, 1997).

Characterising of team tasks is the distinction between taskwork and teamwork. Taskwork refers to the cognitive and technical skills necessary to perform a task, while teamwork refers to the social and communicative skills required for functioning within a team. Smith-Jentsch, Johnston and Payne (1998) have further delineated the competencies constituting teamwork, and they identified four dimensions underlying effective teamwork: information exchange, communication, supporting behaviour, and initiative/leadership. Information exchange includes seeking information from all available sources, passing information to the appropriate persons before being asked, and providing situation updates on a regular basis. Communication includes using proper phraseology, providing complete internal and external reports, avoiding excess chatter, and ensuring communications are audible. Supporting behaviour includes correcting team errors, and both providing and requesting backup or assistance when needed. Finally, initiative/leadership includes providing guidance or suggestions to team members, and stating clear team and individual priorities. These four generic teamwork competencies can be regarded as key competencies of any member of a team. Learning how to work together is especially important for teams consisting of team members that frequently vary. In these cases, team members should possess adequate teamwork competencies.

According to Annett and Cunningham (2000), the basic processes underlying team performance are 'communication' and 'co-ordination'. Communication is described in terms of sending messages (accuracy, clarity, timeliness: relation with situational awareness), receiving messages (partly dependent on controlled attention to significant sources) and discussion (clarification of communication, arranging joint activity or changing plan of action resulting in modification of mental model(s), and including discussion of alternative courses of action). Co-ordination is described in terms of collaboration (e.g. re-allocation of duties) and synchronisation (working independently according to a common plan, often without direct communication). Annett and Cunningham (2000) developed a model of command team processes (see Figure 2.2) containing four main variables:

- Product, comprising the (sub)goals of the team and subteams.
- Process, comprising the communication and co-ordination within the team and between teams (stated in observable behaviours).

- Cognitive processes, involving the construction and maintenance of mental models. There are various mental models: of the world (the context in which the team has to operate), of people (e.g. other members of the team: what they do, what they are about to do, how well they are doing it) and of team plans (what plans and goals, what strategies and techniques are available and employed).
- Affective processes, comprising group morale and cohesiveness. These variables are hard to measure and may well be the result of success rather than contributory factors.

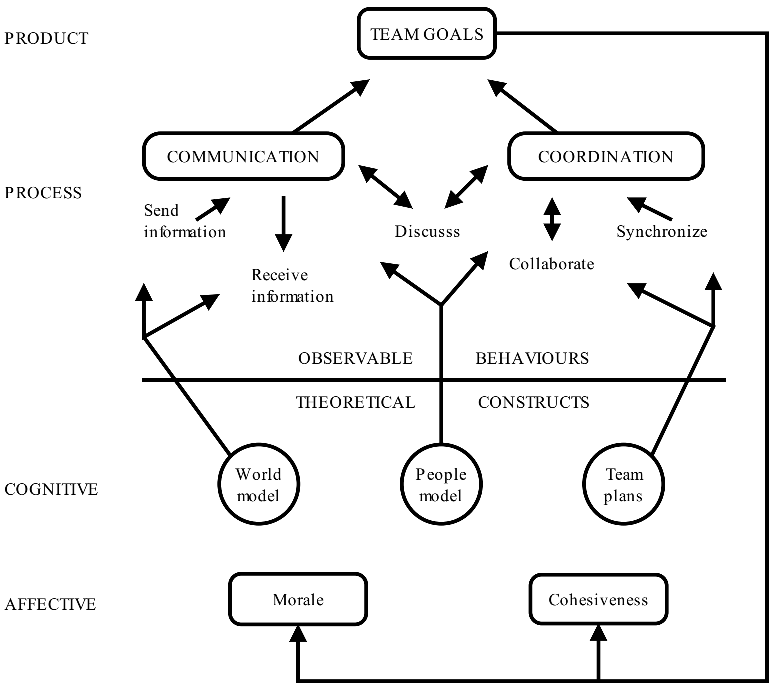

Figure 2.2. Model of command team processes (Annett and Cunningham (2000, p. 405).

Affective, cognitive and behavioural indicators that are shared among team members are the basis of adequate team processes (Bowers, Morgan, Salas and Prince, 1993). Shared affect relates to interaction norms, mutual attraction and group cohesion. Shared cognition relates to the individual cognitive structure and shared team mental models. Shared behaviour relates to mutual performance monitoring, mutual error detection, resource sharing, and load balancing. This shared affect, cognition and behaviour across the team is called team coherence or cohesiveness. Team coherence is assumed to provide a firm basis for improving co-ordination and adaptability within the team (Kozlowski et al., 1996). An important feature of the shared cognition, are the mental models within a team. A mental model can be defined as "the mechanisms whereby humans are able to generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions (or expectations) of future states" (Rouse & Morris, 1986, quoted in Rouse, Cannon-Bowers & Salas, 1992, p. 1300). Shared mental models are "knowledge structures held by team members that enable them to form accurate explanations and expectations about the team task and, in turn, to co-ordinate their action and adapt their behaviour to demands of the (team) task and other team members" (Cannon-Bowers, Salas & Converse, 1993, p. 228). Rather than one mental model that is shared by all team members, it is more likely that there are multiple mental models in a team. Rouse et al. (1992) and Cannon-Bowers et al. (1993) identify models of the equipment (e.g. equipment functioning and operating procedures), the task (e.g. likely scenario's, task strategies, and environmental constraints), and of the team (e.g. teammates' skills and teammates' preferences) and the team interaction (e.g. roles/responsibilities, interaction patterns, and role interdependencies). There is no need for all team members to share every mental model in full detail in order to perform effectively as a team. The extent of shared cognition within a team required for effective team performance still requires more research (Cannon-Bowers et al., 1993; Schaafstal & Bots, 1997; Volpe, Cannon-Bowers, Salas & Spector, 1996).

2.2 Team training and team learning

As described above, a team needs to master different types of competencies. According to the Dutch Educational Council it is not possible to define competency in a uniform way. Nevertheless, the Educational Council emphasises that a competency always has to do with applying what has been learned, the integration of at least two of the components 'knowledge', 'skill', 'attitude' and 'personal trait', and stable capabilities that are less affected over time (Onderwijsraad, 2002). A definition incorporating these characteristics is provided by Mulder (2000) who defines a competency as integrated performance capabilities comprising clusters of knowledge, cognitive, interactive, affective and psycho-motor skills, attitudes and beliefs prerequisite for job and task performance. Cannon-Bowers, Tannenbaum, Salas, and Volpe (1995) define a team competency as the combined application of knowledge, skills and attitudes to complete the team's mission and the constituent team tasks. Dependent on the characteristics of the task and the team, several types of competencies can be distinguished. Cannon-Bowers, Tannenbaum et al. (1995) state that there are team generic and team specific competencies. Team generic competencies are held by an individual team member and can influence team performance regardless of the particular teammates involved (e.g. communications skills, interpersonal skills). Team specific competencies on the other hand only have impact with respect to specific team members (e.g. certain compensation strategies).

As described in the previous section, the team task performance consists of both taskwork and teamwork. Furthermore, an individual or a team can perform tasks. The relationship between the content (taskwork or teamwork) and the level (individual or team) determines the competencies being trained. This is depicted in Table 2.1 (Van Berlo, 1997b).

Table 2.1

A distinction of competencies with respect to training teams and team members (Van Berlo, 1997b, p.7)

	Content	
Level	Taskwork	Teamwork
Individual	1. Individual task competencies (e.g. plotting of data)	2. Social and communication competencies to function in a group (e.g. leadership)
Team	3. Team task competencies (e.g. conducting an evacuation plan)	4. Social and communication competencies to function as a team (e.g. supporting each other)

Following the categories of Table 2.1, four different types of competencies can be identified that are relevant to adequate team performance (Van Berlo, 1997b). Although all are important for the functioning of the team, different kinds of training need to be applied in order to acquire these competencies. In practice, the distinction between the four cells is not that strict. The four types of training, aimed at training the four types of competencies mentioned above, will be shortly described below.

1. Training aimed at the individual team member, and focussed on the task, is a frequently occurring kind of training. The trainee learns competencies that are needed to perform a certain task, for example driving a car. Training can take place in a group in which several trainees are trained collectively for the same position (and prerequisite skills and knowledge) within a team. In this case, the group is used as a way of stimulating learning, as is done in some co-learning programs.
2. Social and communication competencies training is also aimed at the individual team member, but is focussed on the social competencies to be able to function in a group. The primary objective is to teach the trainees the social and communicative

competencies to function in a group: for instance leadership training, competencies for participating in meetings. The training often takes place in a group, but is aimed at the individual team member. The competencies are applicable across groups.

3. The third kind of training is aimed at a team, and focuses on team task competencies (for example who communicates with whom, how to support each other, et cetera.). The primary topics are the relations and interdependencies between the various team members' tasks. An important feature of this kind of training is that several team members are trained at the same time. This type of training is often compared to instructional methods like co-learning, but the two can not be considered to be entirely the same. Team training is aimed at trainees occupying different positions within the team, whereas in co-learning programs the focus is often on a group of people who will eventually occupy similar positions and carry out identical functions. An example of a method that is often used to train communication and decision making within a team is simulator-based training, in which a simulator is used to present various situations to the team members.
4. The final type of training is aimed at teams as a whole and focuses on motivation, cohesion and the social and communicative competencies to function as a team. Most teambuilding courses would fall within this category of training. Because of its focus, it is important to conduct the training with the intact team, that is, with the actual team members.

For a team to perform adequately it is required that the individual team members are sufficiently proficient to act as part of a team. Therefore, each team member must master both his individual task(s) and the team task(s). An individual team member's task is a task performed by the individual officer alone. For instance, the sonar operator is the only one to listen to and discriminate between the sound signals the sonar provides. But because the sonar operator is a member of a subsurface warfare team, he has to communicate the interpretation of the signals to the other team members, on the basis of which another team member determines the most appropriate action. Besides just performing his individual task, he has to act as a member of a team.

It becomes increasingly clear that just putting together a team of individual experts does not make an expert team (Salas, Cannon-Bowers, & Johnston, 1997). In recent years, it has been shown that a good approach to training teams with complex training technology is linking training goals to events in training scenarios in a controlled fashion. This is called the 'event-based approach to training' (EBAT: see Figure 2.3) (Hall, Dwyer, Cannon-Bowers, Salas & Volpe, 1993; Cannon-Bowers, Burns, Salas & Pruitt, 1998).

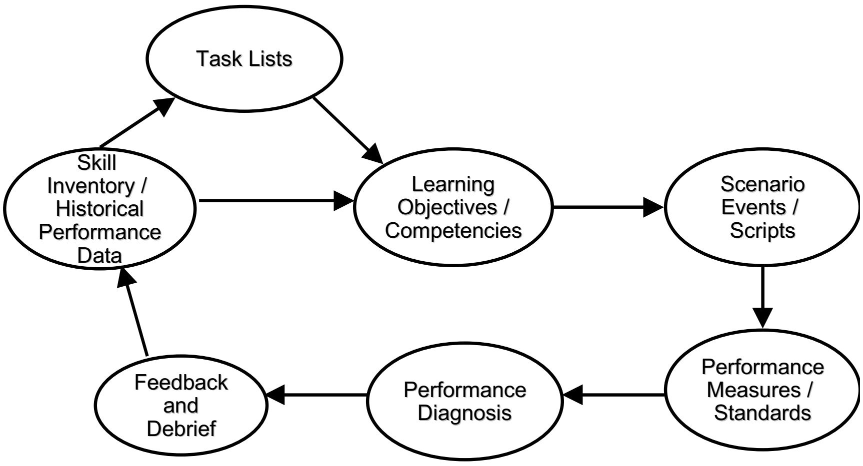

Figure 2.3. The EBAT framework (cf. Cannon-Bowers, Burns, Salas & Pruitt, 1998, p. 366).

The EBAT framework starts at the top left hand side with the tasks to be performed by the team. The basic assumption is that training should provide opportunities for practice, enabling a team to develop critical competencies to conduct their mission, or, to manage an emergency. The team and individual behaviour indicating these competencies is explicitly described in the learning objectives. Based on these learning objectives, the training scenario is developed. A training scenario consists of several events that are specifically designed to trigger the team members' behaviour as described in the learning objectives. Events are critical incidents that can occur during the course of the emergency and on which the team is supposed to react. For every event, the observers know what behaviour the team should demonstrate, and which prototypical mistakes could be made. This facilitates a systematic observation of the team members' behaviour. Based on these measurements the training staff is able to make a valid diagnosis of the performance and to assess to what extent the learning objectives have been achieved. During the debrief, feedback is provided to the team and, together with the team, the lessons learned are formulated. The strength of EBAT is the systematic linkage among these components. Without this linkage it is impossible to ensure that team members will have learned anything from the training.

The concept of team training is, however, often confused with the concept teambuilding. Although the ultimate goal of both team training and teambuilding is the same (i.e. improving team performance), there are some considerable differences between the two. As illustrated in Table 2.1, training the members of a team can be primarily aimed at competencies required for adequate team task performance, or at social competencies required for functioning as a team (taskwork vs teamwork). Team training is focusing on the taskwork with an explicit relation with the teamwork. Teambuilding has its focus primarily, and often solely, on teamwork. Teambuilding is not specifically aimed at tasks a team has to perform in the operational task environment, while team training explicitly focuses on these tasks. Both team training and teambuilding are a kind of training, but each type is aiming at different competencies required for adequate team performance. Training is a systematic enterprise to enable the trainees to acquire the competencies required for adequate task performance. Based on instructional objectives the contents and structure of the training are determined in such a way that the objectives will be met. Teambuilding, however, is more like a set of activities with the intention to give (groups of) individuals a deeper understanding of their behaviour and their interpersonal relationships. Although a general framework can be formulated in advance, in most cases the specific content of the teambuilding intervention is more dependent on discussions, between trainees and with the trainer, during the intervention. A final distinction between teambuilding and team training is that teambuilding activities are often performed with the persons comprising the actual team: in view of the general goal of teambuilding it would be undesirable to involve other persons into this effort. Team training does not necessarily need to be conducted with the actual team members. Every team member receives training aimed at the own role and the own tasks within the team (independent of who will be the other team members), so it is not a disadvantage per se that different persons play the roles of other team members. On the other hand, because of the explicit link between taskwork and teamwork, the effect of team training will probably increase if the trainees are actually each other's operational teammates.

Team training is also sometimes wrongly conceived of as co-operative or collaborative learning (defined as co-learning: Van Berlo & Baartman, 2003). Again, there are similarities, but distinctions as well. All learning appears to involve at least some social aspects (Salomon & Perkins, 1998), whether the learning takes place in a school class, in a distributed web-based environment, or on the job. Although learning might be conceived of as an individual activity, in many cases the student has interactions with coaches, other students, instructors, colleagues on the job, or teammates he has to work and learn with. According to Salomon and Perkins (1998), social learning is a distinctive phenomenon, distinguishable from individual learning. Figure 2.4 depicts the relationship between the concepts of social learning, group-based learning, co-learning, team training and teambuilding (Van Berlo & Baartman, 2003) that will be explained next.

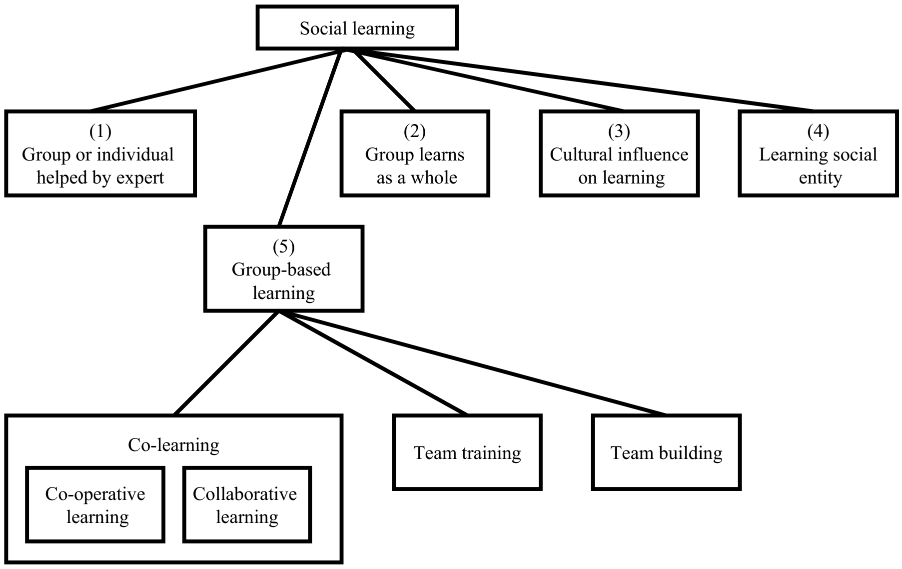

Figure 2.4. Relationship between the concepts of social learning, group-based learning, co-learning, team training and teambuilding (Van Berlo & Baartman, 2003, p. 6).

Salomon and Perkins (1998) distinguish four different meanings of social learning and suggest how these might be related to individual forms of learning. The first and simplest form of social learning exists when a more experienced person (e.g. the teacher in a classroom) helps an individual or a team to learn (see the first box in Fig. 2.4). This is clearly distinguished from the second form of social learning in which people help each other to learn within a group, without guidance of an expert. In this latter version of learning, the learning products (knowledge, skills, and attitudes) are jointly constructed through interaction, and evenly distributed over the social system (box 2). The third meaning of social learning is even more generally mediated in the sense that a learning individual is always influenced and helped by the shared cultural and historical artefacts of a society, for instance symbol systems and language (box 3). The last form of social learning considers the social entity as a learning system in itself. An organisation as a whole can learn and acquire knowledge, without necessarily using an agent helping it to learn (box 4). A different form of social learning not described by Salomon and Perkins (1998) is group-based learning (box 5). The term group-based learning is used for a number of didactical methods in which the group is used as a means of improving the learning of the individual participants. When looking at the different meanings of social learning as described by Salomon and Perkins (1998), group-based learning is a form of social learning that can be placed more or less between their first and second category. Within group-based learning, people help each other to learn within a group, but an expert is always present to guide the interaction and to provide necessary knowledge and skills when necessary.

Co-learning methods are aimed at stimulating individuals to work together in a learning situation; the group can be utilised as a didactical tool to enhance the learning of individual competencies (e.g. Brown & Palincsar, 1989). Davydov (1995) and Dillenbourg (1994) state that internal cognitive processes result from external, visible behaviour. Social communication and co-operation precede these internal cognitive processes: trainees acquire new knowledge by gradually internalising social behaviour and culture (Lowyck, 2000). This 'learning apart together', however, does not occur automatically by forming a group and assigning learning tasks to the group (Slavin, 1990): groupwork should be structured and focused. Within computer supported collaborative learning (CSCL) environments specific attention can be paid to enabling trainees to interact and collaborate in a sensible manner as to improve (individual) learning. Dillenbourg (2004) suggests the use of scripts to promote and guide the collaboration, and embedding the CSCL environment into a coherent learning trajectory (including e.g. classroom-based instruction).

2.3 Summary

Team performance is affected by many different variables, both within the team itself and in the organisational and operational context. Therefore, training can not be the sole contributor to enhance team effectiveness. But carefully identifying and analysing the variables affecting team performance, and taking into account these factors in the process of instructional systems design, will probably positively impact the effectiveness of the team training. Training teams is more than just putting team members together in a learning environment. Learning together in a group is not the same as learning to perform as a team. In order to define as clearly as possible the field of research, the differences and similarities were discussed between team training on the one hand, and teambuilding and co-learning on the other. It is important to note that team performance consists of both taskwork and teamwork, and that both an individual and a team as a whole can perform tasks. The relationship between the content (taskwork or teamwork) and the level (individual or team) determines the competencies to be trained. Instructional design for team training specifically needs to address these two types of content and levels in order to prepare teams for their operational tasks. In the next chapter, ID for team training will be discussed in more detail, as well as the type of support that was developed and tested in several design experiments.

3. INSTRUCTIONAL DESIGN FOR TEAM TRAINING

As indicated in the introduction, this research focuses on supporting instructional designers during the analysis and design phases. Team training not only needs to take into account the principles underlying team effectiveness, but also principles of (team) learning and instruction. These principles are described briefly in section 3.1. Next, current guidelines supporting ID for team training, as described in the literature, will be reviewed and discussed (3.2). This is followed by an overview of the guidelines that were developed in this study to support the ID practitioners in analysing team tasks and designing team training scenarios (3.3).

3.1 Principles of team learning

Cannon-Bowers, Salas, Tannenbaum and Mathieu (1995) and Salas and Cannon-Bowers (1997) identified several principles of training teams and requirements for designing team training environments. Complementary to the previous description of the ISD phases (see 1.1), in this section the specific principles for training teams will be described. During the analysis phase, the nature of task interdependency and the interaction between team members need to be emphasised (Salas, Cannon-Bowers & Blickensderfer, 1997). This relates specifically to the behavioural and cognitive requirements of the task, particularly with respect to the team processes identified as information exchange, communication, supporting behaviour and initiative/leadership (Smith-Jentsch et al., 1998).

With respect to the design phase, it is suggested that individual proficiency can best precede team training: during the individual training the team members can be prepared for the team training. Further, after an initial separation, teambuilding (primarily aimed at the teamwork) and team task training (aimed at the taskwork in relation to the teamwork) should be integrated. Different learning environments (e.g. classroom, simulator, virtual reality environment or operational environment) need to be varied in a sensible and coherent way such that theory and practice (hands-on) are frequently interchanged. Training is supposed to create systematic opportunities to practice the required team competencies: in order to evoke the target behaviour, relevant stressors need to be incorporated in the scenario (Hall et al., 1993), like, for instance, time pressure, ambiguous and incomplete information, conflicting orders, and wounded/killed teammates. In order to develop shared mental models within a team, cross training is regarded as an effective team training strategy. In this kind of training, team members are trained in several aspects of each other’s tasks

(Cannon-Bowers et al., 1993; Schaafstal & Bots, 1997; Volpe, Cannon-Bowers, Salas & Spector, 1996). With respect to performance measurement and feedback during the team training, it is important to measure both the product (e.g. accomplishment of mission, completion of tasks) and the process (the way the missions/tasks have been accomplished) of the team performance. Process measures are a necessary addition to task outcome measures for assessing the moment-to-moment team interactions and the team performance (Coovert, Cannon-Bowers & Salas, 1990). Moreover, the focus of the team performance measurement should not only be at the team level, but also at the individual level. It is important for trainees not just to know that something went wrong, but also why this happened. Mere knowledge of results is not sufficient: this needs to be supplemented with information regarding why which behaviour was incorrect, and how this might be improved. Guided by the instructor, the trainees reflect on their performance, and discuss why specific actions have been undertaken and which improvements can be made. During the implementation phase, the instructor needs to be trained on observing a team's behaviour, on interpreting observation results and output files of computerised training devices, and on the use of these data during an after action review, in order to provide specific feedback on the individual's and team's performance. In addition to this external feedback, it is worthwhile to learn individuals and teams to monitor their own performance themselves, to critically reflect on their performance and to adjust their learning goals accordingly (Smith-Jentsch et al., 1998). The combination of this self-regulated learning (Butler & Winne, 1995) and externally provided feedback increases the quality of the team's learning.

Proposing principles or team training strategies does not imply that it is yet clear for the instructional developer how to design and implement these principles into a team training system. Nevertheless, a great deal of the training system's success depends on an adequate implementation of these principles. Therefore, the principles need to be further translated into practical applicable tools to support the instructional designer. Support can be provided in various different formats. This can range from a handbook covering a team training methodology, to specific guidelines or a computer-based tool to support the conduct of distinguished ISD phases. Moreover, it can range from training courses and/or workshops, to job-aids providing support for designers and/or instructors, and coaching on the job by a more experienced colleague. In this research, the support is provided in the form of guidelines. Several reasons underlie this choice. This research is conducted as part of a project for the military. Therefore, the supporting tools need to be suited for military instructional designers. In general, military personnel are used to work with procedures, guidelines and specific work instructions, and so do the military instructional designers.

Moreover, as indicated in the introduction, ID for team training is a relatively immature area of expertise. With respect to ID for team training, the military instructional designers can be regarded as novices. An additional complicating factor within the military organisations of the Netherlands is that military personnel, including ID practitioners, has to switch jobs after three years. As a result, there is hardly any opportunity to construct a solid ID knowledge base and to grow from novice towards professional: a process that takes many years (Chi, Glaser & Farr, 1988). In order to be useful within this context, ID support needs to be as concrete as possible. Indeed, the intention of guidelines is to closely and concretely correspond to the way people work. In this way we tried to deal with the tension, as already indicated in chapter 1, between new and more constructivist paradigms of learning, the characteristics of ID, the need for systematically designing instruction and the best way to support ID practitioners, also taking into account the characteristics of the military organisation they are employed at. Another useful manner of providing support would be a training course or workshop. But in order to provide this kind of support, the specific content of the support should be clear. It was therefore decided to first develop and test guidelines, and then to determine whether a workshop might be useful (Van Berlo, 1997c).

3.2 Review of current guidelines supporting ID for team training

In this section, current guidelines supporting ID for team training, as described in the literature, will be reviewed and discussed. First, more general ID guidelines will be reviewed (3.2.1), followed by guidelines specifically focusing on the analysis of team tasks (3.2.2) and the design of team training scenarios (3.2.3). Section 3.2.4 concludes with a discussion.

3.2.1 Review of more general current ID guidelines

One of the first systematic approaches to develop team training is presented by Kribs, Thurmond and Marks (1977). This approach aims at developing learning/instructional strategies using computer-aided instruction for team training. The authors prescribe some methods of instruction, which indicate several team development phases. For beginning team training the strategies are drill and practice, tutorial, and testing. For integrated team training these are Socratic tutorial, simulation, and testing. Finally, for emergent team training the strategies are simulation, game, and testing.

The Team Instructional Processes Model (Guerette et al., 1987; Miller et al., 1987) links the team development phases describing the growth from an unskilled and immature team towards a skilful and mature team (Morgan et al., 1986) with specific training strategies. The Team Instructional Processes Model consists of ten steps beginning with a target group analysis based on which the instructor makes an outline of the instructional program. The determination of the instructional strategies for each step is dependent on the team's initial level of proficiency and attitude. On both dimensions the team can be rated either high or low, resulting in four categories of teams. On the basis of this categorisation the instructor selects the method of instruction. Supervised by the instructor the team practices the tasks. An evaluation halfway the training may result in an adjustment of the instructor's initial outline of the training strategy, or lead to the conclusion that the team appears not to be capable of accomplishing the tasks: in that case the training will be terminated. If the training is continued, the team gets trained more specifically. Finally, it is evaluated whether the team can perform the team task in an adequate way and this assessment is followed by a joint debrief.

The Team Instructional Prescriptions (Armstrong & Reigeluth, 1991) contain the output, the conditions, the instructional methods, and a set of prescriptive guidelines in which output, conditions and methods are integrated. The 'output' of team training is twofold: it is directed at both teamwork and the team task (see Salas et al., 1987). The 'conditions' influencing team training are comprised of three types of variables: the team development phases (Morgan et al., 1986), the task process dimensions (interdependency between subtasks, uniformity of task performance), and relationships between tasks (super-ordinate, co-ordinate and subordinate). The 'instructional methods' are described at three levels. At the macro level the trainees are informed about the context in which the team task is performed and the relationships with other tasks. At the mid-level the sequence of the distinct steps comprising a task is explained and at the micro level it is demonstrated how one single concept, procedure or principle can be trained. Output, conditions and instructional methods are integrated into a set of prescriptive guidelines, depending on the team development phase: the more the team matures role-instruction and practice will be more specific.

Swezey, Llaneras and Salas (1992) constructed two checklists supporting the development and evaluation of team training systems: the Teamwork Characteristics checklist and the Instructional Characteristics checklist. The Teamwork Characteristic checklist contains 30 items addressing a variety of topics. Examples are: the team's organisational chain of command, responsibilities of all team members, selection of team operations and tasks, specific attitudes of team members, definition of performance criteria, and fidelity of the learning environment. The Instructional Characteristics checklist contains 41 items. Example items are: specification of behavioural objectives, form and amount of feedback, summative and formative evaluation, learning styles and learning rate of the target group, architecture of the training program, modalities of instruction, and correspondence between training objectives and media. In both checklists, for each item it is indicated whether the training program includes the respective (teamwork or instructional) characteristic. Next, the importance of every characteristic is scored on a five-point rating scale. By combining these two results, shortfalls in the training system can be easily identified (Swezey, Llaneras & Salas, 1992).

Smith-Jentsch, Johnston and Payne (1998) have further delineated the competencies underlying effective teamwork, and they identified four dimensions: information exchange, communication, supporting behaviour, and initiative/leadership (see section 2.2). Team Dimensional Training (TDT) is a training methodology designed to aid instructors in training and evaluating teamwork competencies (Smith-Jentsch et al., 1998). This is accomplished through a four step training cycle: briefing a team, observing a team's performance during a training exercise, diagnosing this performance, and debriefing the team about its performance. During the briefing phase the four teamwork dimensions delineated by TDT, and behaviours associated with each, are presented to the team by the trainer. During the exercise itself, the observers gather positive and negative examples of behaviours that fall under each TDT dimension, using an observation scheme. For the debrief, one or two of the best examples (i.e. most relevant to the training objectives) under each dimension are summarised. During the debriefing phase, the trainer facilitates the discussion of the team's performance, providing positive and negative examples of team behaviour. Ultimately, the aim is to learn the teams to monitor their own performance themselves, to critically reflect on their performance and to adjust their learning goals accordingly (Smith-Jentsch et al., 1998).

In the next sections more specific current ID guidelines for team training will be described, namely guidelines supporting the analysis of team tasks (3.2.2) and the design of team training scenarios (3.2.3). This is followed by a conclusion (3.2.4).

3.2.2 Review of current guidelines supporting the analysis of team tasks

Task analysis is defined as the study of what an operator (or team of operators) is required to do, in terms of actions and/or cognitive processes, to achieve a system goal (Kirwan & Ainsworth, 1992). A team task analysis can be conducted for several reasons. This can range from designing complex new man-machine systems (Endsley & Jones, 2001; Essens, Post & Rasker, 2003; Zachary, Ryder & Hicinbothom, 2000) to measuring the team's performance (Elliott, Schiflett, Hollenbeck & Dalrymple, 2001; Perusich, 2001). Moreover, it can range from improving the team decision making process (Klein, 2000) to designing training programs and technologies (Annett & Cunningham, 2000; Blickensderfer, Cannon-Bowers, Salas & Baker, 2000; Swezey & Salas, 1992). The primary purpose of task analysis, in the case of system design, is to compare the demands of the system on the operator with the capabilities of the operator, and if necessary, to alter those demands, thereby reducing error and achieving successful performance. This process usually involves data collection of the task demands, and representation of those data in such a way that a meaningful comparison can be made between the demands and the operator's capabilities (Kirwan & Ainsworth, 1992).

With respect to training system design, the goal of a task analysis is the identification of the competencies and the underlying knowledge, skills and attitudes required for adequate task performance, and the definition of the conditions and standards of performance. A team task analysis needs to especially gain insight in identifying the characteristics of good team task performance, and describing the relationships and interdependencies between the team members. Without this information it is hard to formulate proper instructional objectives, and, consequently, to design adequate training scenarios. This has the risk of an inadequate training resulting in ineffective operational performance. Team task analysis is supposed to look at team performance as more than a simple aggregate of the results of analyses of tasks performed by individual operators (Cooke et al., 1997). Based on the instructional objectives, the team training scenarios aim at the acquisition of shared mental models with respect to the task, the team, the interactions within the team and the available tools and equipment (see section 2.1). In this section existing guidelines supporting the analysis of team tasks are described.

The Multiphase Analysis of Performance (MAP) system (Levine & Baker, 1991; Levine et al., 1988) consists of a taxonomy for team training. First, the instruction can be aimed at the individual team member or at the team as a whole. Next, both individual and team can be either experienced or inexperienced. Finally, training can be directed towards interpersonal skills or production skills. Combining these levels results in an eight-cell job analysis taxonomy for team training. For each cell, the authors have indicated the descriptors characterising the team task, the sources of data that can be regarded, the most adequate methods of data collection and the methods of data analysis. These will be briefly illustrated next. Examples of job analysis descriptors are: required professional and legal standards, products and services provided by the team and team members, team and team member tasks/activities, physical and psychological demands on team members, and tools and equipment. Examples of sources of data are higher ranking officers/executives, technical experts, team members, team instructors and written documents. Adequate methods of data collection in case of training experienced teams are individual or group interviews and technical conferences (interactive group sessions with subject matter experts). In cases of training inexperienced teams, additional methods are observation, reviewing specifications of equipment, and doing the work your self. Examples of methods for analysing and synthesising data are making clusters of tasks and activities, and using scales applied to units of work or team member attributes. The MAP system has been tested in the field: the results were that the tasks could be described in an adequate way, that the MAP system could be applied efficiently, and that it is a user friendly system. The subject matter experts involved perceived the MAP system as a valuable method in the process of developing team training (Levine & Baker, 1991).

In order to develop a training system as efficiently and cost-effectively as possible, only those team tasks need to be selected that are most suited. Baker and Salas (1996) identified five dimensions on which teamwork behaviour can be measured. These are criticality of error, difficulty of performing, time spent performing the behaviour, difficulty of learning how to perform the behaviour correctly, and importance for training. However, novices and experts place different emphases (Baker & Salas, 1996). Bowers, Baker and Salas (1994) suggested that more objective rating methods, rather than only subjective questionnaires, may result in more significant data. They further argue that more sources of information and several methods of data collection are required to enhance the probability that reliable data are gathered.

Describing a team task poses additional demands on the documentation and registration of results compared to an individual task. For instance, flowcharts might be developed where tasks require co-ordination. Chenzoff and Folley (1965) developed a methodology for task analysis for training device design, of which the way of documenting the results may also be used in the process of team task analysis. The method contains four steps. The first step is an analysis of the total system resulting in a sequence of activities, functions and tasks, leading to the accomplishment of the system's mission or goal. The second step is preparing task-time charts. In these so-called Multiple Activity Process Charts, the tasks and (temporal) relations among tasks and team members are depicted. In step three, the tasks are analysed resulting in a description of activities to carry out tasks, and the relationships among the activities. In the fourth and final step the characteristics of the identified activities are described in detail. A positive feature of this model is that both the team functions (steps one and two) and the individual functions (steps three and four) within the system are identified and described. Although the temporal relations among tasks and team members are delineated, the specific co-ordination and communication interactions between the team members are not clearly identified (Chenzoff & Folley, 1965).

This disadvantage is countered by the so-called 'Operational Sequence Diagrams' (OSD's) (Helsdingen, Bots, Riemersma, Schijf & Van Delft, 2000; NATO RSG 14, 1992). OSD's have been especially developed for depicting information flows. They contain symbols for sending information (triangle), receiving information (circle), processing information (trapezium), making decisions (hexagon) and utilising the information/performing an action (square). In a similar way, a Team Operational Sequence Diagram (TOSD) can be constructed. Figure 3.1 shows the format of such a TOSD. The team processes can be visualised by horizontally depicting different team members, and, in a time-dependent sequence, delineating the steps comprising the team task performance. The dependencies can be made explicit by placing horizontal lines between the columns. A continuous process is made explicit by a vertical bold line in a column. This way of representing team tasks is applied to the tank platoon and proved to be a valid way of representing team tasks and the interaction between team members (Helsdingen et al., 2000).

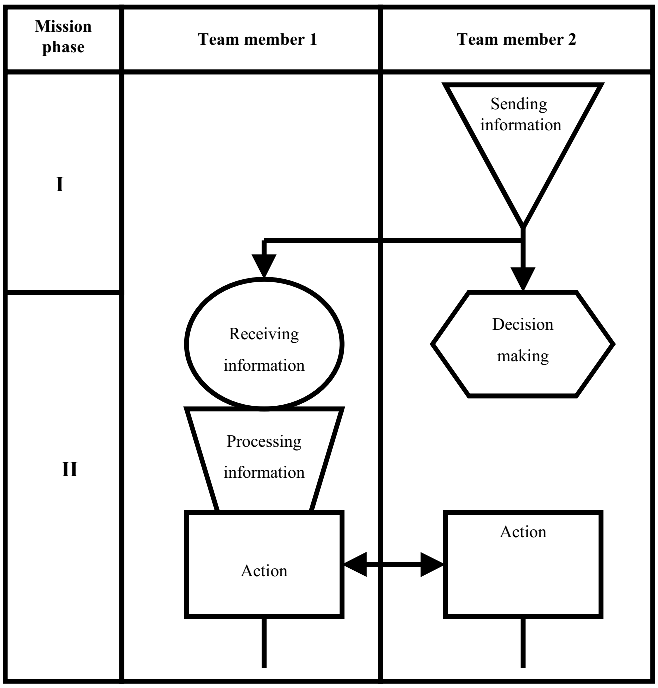

Figure 3.1. Format of a Team Operational Sequence Diagram (TOSD) (cf. Helsdingen, Bots, Riemersma, Schijf & Van Delft, 2000, p. 19).

3.2.3 Review of current guidelines supporting the design of team training scenarios

A critical aspect of a successful training system is the design of training scenarios supporting the development of task proficiency. However, the design of team training scenarios has been a relatively ill structured and often unsystematic process (Bowers et al., 1993; Van Berlo, 1997a). Training scenarios are mostly designed by experienced subject-matter experts who may not recognise the differences among the various dimensions of teamwork, overlook the relevance of some training tasks for the operational practice, or emphasise only one aspect of the mission performance. Without careful analysis and guidance, it is possible for scenario developers to place trainees into practice situations that do not require specific target behaviours and that may even have a negative effect on performance. Besides, without appropriate training, instructors are at risk of providing feedback that is derived solely from their personal experience and biases (Bowers et al., 1993). This results in a lack of standardisation, so evaluation is hardly possible. In this section existing guidelines supporting the design of team training scenarios, including the measurement of team performance, are described.

Prince, Oser, Salas and Woodruff (1993) formulated guidelines for simulator scenario development with respect to crew resource management training. The focus on simulator-based training does not seem to be a restriction for other kinds of team training: Beard, Salas and Prince (1995) formulated rather identical guidelines focussing on role-play. A precondition for developing training scenarios is that the tasks and abilities are analysed well and that the instructional designer has domain specific knowledge. The guidelines are separated into five categories: (1) scenario overview, (2) objectives, (3) realism, (4) role of the facilitator and (5) technical tips. The category 'scenario overview' considers the segments that comprise a scenario, and what the briefing phase needs to include. Further, the trainees need to have ample opportunities to display the to-be-learned behaviours. The category 'objectives' includes that the scenario is supposed to be developed based on the instructional objectives, that a scenario is part of a total training program and that the scenarios can mutually vary in levels of difficulty. The category 'realism' includes that scenarios are real world and real-time, including dull and irrelevant aspects. Many items can contribute to simulating reality more reliably, especially when these items have a constraining influence on the performance, like headphones, gloves, helmets and uniforms. The category 'role of the facilitator' includes that the facilitator needs to be well prepared and trained for his role(s), and focuses on the objectives of the scenario during the debrief. The category 'technical tips' includes conducting a try-out, and the modular architecture of a scenario to enhance the interchange of distinct components.

Gentner, Cameron and Crissey (1997) also identify multiple roles the instructor/observer can have during the course of training. These authors identify briefing the trainees and letting them familiarise with the training equipment, giving instruction to the trainees, playing roles in the scenario, monitoring the team's performance, giving feedback and conducting the after action review. Depending on the size of the team and the particular tasks to be trained, it is advisable to have several instructors/observers, each having their own roles: in this case a supervisor can co-ordinate their activities. Besides, an instructor/observer must have the knowledge and skills with respect to the particular military tasks (the subject matter); leadership, management, and supervision; teaching, training, and group facilitation; and effective use of simulation technologies in case of computer- or simulator-based training (Gentner et al., 1997).

The TARGETs methodology is a team performance measurement methodology, and refers to Targeted Acceptable Responses to Generated Events or Tasks (Fowlkes, Lane, Salas, Franz & Oser, 1994). It is an event based methodology (see section 2.2), meaning that acceptable task responses to each event (defined in observable behaviour) are identified a priori, in accordance with task analyses, standard operating procedures, subject-matter experts, and other sources of information available. The behaviours (targets) are highly specific with regards to actions of individual operators as well as teams, and can be directly identified by an observer. A team task analysis needs to identify and analyse the mission the team tasks are part of, the events that trigger the behaviour of both individuals and team, the action of the operator(s) required in a particular situation, and what constitutes this action (the critical behaviour). The TARGETs methodology facilitates the construction of an observation form that can be used by the instructors and/or observers during the conduct of the scenario. Besides, these structured observations are valuable input for the after action review as well as for constructing a Take Home Package, including a summary report of the particular training exercise, that can be handed out to the trainees after completion of the training program (Rankin & Gentner, 1996).

Schank, Fano, Bell and Jona (1993/1994) designed and developed Goal-Based Scenarios that can be performed by the trainees in a computer-based learning-by-doing environment. A Goal-Based Scenario (GBS) emphasises that a training scenario is task-oriented, with clearly specified objectives. Schank et al. (1993/1994) identified seven general criteria that a GBS design is supposed to meet: thematic coherence, realism/richness, control/empowerment, challenge consistency, responsiveness, pedagogical goal support and pedagogical goal resources. A GBS consists of several components that need to be identified successively: (1) the mission, (2) the mission focus, (3) the cover story and (4) the scenario operations. First, the mission specifies, in general terms, the goal the trainee should accomplish. The mission is specified in the mission focus, describing the predominant activity/task to be performed by the trainee. A mission can have more than one mission focus. Next, the cover story defines the role the trainee is playing, the set up, and the scenes in which the action takes place. Finally, the scenario operations describe the actual activities the trainee will be performing while engaging in a GBS. For each of the four components guidelines are presented (Schank et al., 1993/1994).

3.2.4 Conclusion

Only a limited number of existing guidelines specifically focusing on supporting ID for team training have been found in the literature. The guidelines are rather general in nature. Steps describe what an instructor and/or designer should do, but do not clarify how and why to perform these steps. For instance, the Team Instructional Prescriptions emphasise the different levels of analysis at which a team task can be viewed, the context in which the team task is performed and the conditions of task performance. However, how to analyse the team task is not explained. Some guidelines try to link the team development phases, as described by Morgan et al. (1986), with prescriptive instructional guidelines. Then again, the transition from one team development stage towards another stage is not explained. Also in the checklists, it is not quite clear what criteria can be applied when checking the items, how the results can be interpreted and which actions the instructional designer can undertake after completing the checklists. However, formulating clear criteria in advance is hard, especially because the criteria and the interpretation of the results are dependent on the particular training situation. Several authors have already indicated that the guidelines still need an empirical validation. Nevertheless, the Team Dimensional Training (TDT) method has proven to be an effective means of training teams (Smith-Jentsch et al., 1998). It clarifies the teamwork competencies, and enables a structured way of training and evaluating these competencies. TDT guides the team in learning how to evaluate and improve the team processes, and the instructor is supported in how to facilitate this process.

With respect to the analysis of team tasks, hardly any guidelines are described in the literature. An exception is the Multiphase Analysis of Performance (MAP) system. However, the usability of the MAP system in developing team training systems can be questioned. The results of the analysis during the field test have not been used for actually designing a team training program, although this would be the only reliable check of its usability. Further, subject-matter experts in the field study indicated difficulties with respect to generating the knowledge, skills, abilities and other personal characteristics required for performing the (team) task (Levine & Baker, 1991). However, this is crucial input for defining the instructional objectives. A positive feature of the Multiple Activity Process Charts is that both the team and individual functions within a system are identified and described. Although, according to the authors (Chenzoff & Folley, 1965) the temporal relations among tasks and team members are delineated, the specific co-ordination and communication interactions between the team members are not clearly identified. A Team Operational Sequence Diagram (TOSD) can solve this problem. Interactions between the team and the environment, as well as the processes within the team, can be visualised in a time-dependent sequence. The TOSD's also proved to be useful tools in the knowledge elicitation process while interviewing subject-matter experts (Helsdingen et al., 2000).

With respect to designing team training scenarios, the guidelines presented by Prince et al. (1993) are the only ones available. However, these guidelines do not cover the entire design process: how to develop a blue-print, how to implement it into a prototype, and how to conduct a try-out are steps that have been described only partially. Further it is not clear when artificial or realistic feedback should be provided, nor the moment (direct or delayed) it might be presented: yet these are important features of a training scenario. Although not specifically focused on team training, the framework presented by Schank and his co-workers (1993/1994) can be useful because of the realistic and dynamic scenarios that result from this structured approach. The value lies in the stratified architecture of a scenario. The mission can be specified into different tasks, which in turn can be detailed into operations. A scenario can be developed on each of these distinct levels, more or less resembling the mission- and task analysis of the analysis phase in the instructional systems development. Another significant aspect is the skill-based approach. The value for designing team training scenarios is that it emphasises the need for precisely defining the target-task and the target-behaviour the training is supposed to be aimed at. How to do this, is adequately presented in the TARGETs methodology.

Summarising, this review of existing ID guidelines for team training in general, and of guidelines supporting the analysis of team tasks and the design of team training scenarios in specific, shows that existing guidelines offer only partially support and that an empirical validation is often lacking. A coherent set of pedagogically sound, useable and empirically validated guidelines supporting the analysis of team tasks and the design of team training scenarios is still absent. This doctoral dissertation tried to make a step forward in supporting ID practitioners for team training. Based on both the literature study and the field study as well as on our own experiences within TNO, we designed and developed new guidelines supporting ID for team training. These guidelines are described in the next section. The empirical validation of this support will be presented in chapters 4 and 5.

3.3 Design and development of the team ID-guidelines

Proposing principles or team training strategies does not imply that it is yet clear for the instructional developer how to design and implement these principles into a team training system. Nevertheless, a great deal of the training system's success depends on an adequate implementation of these principles. Therefore, the principles need to be further translated into practical applicable tools to support the instructional designer. In this research, the support is provided in the form of guidelines. Because this research is conducted within the context of a larger research program for the military in the Netherlands (Royal Netherlands

Navy, Army and Airforce), it was the intention to develop generally applicable supporting guidelines.

As already stated in the first chapter, a constructivist view on ID requires a balance between structured didactical support and self-guidance on the one hand, and creating the appropriate conditions required for long term self regulation on the other (De Corte, 1996; Verschaffel, 1995). Following the complexity and unpredictability of the learning process, descriptions from psychology are hard to translate into prescriptions for instructional design. This research follows a mild constructivist view on ID implying that although self-regulated learning might be an ideal, most learning involves the interaction between internal (i.e. cognitive) and external (e.g. instructional materials) monitoring which implies that learning processes can be initiated both internally and externally (Lowyck & Elen, 1993).
This view affects the way ID might be supported. As previously stated (3.1), in this research the support is aimed at the instructional designers and is provided in the form of concrete guidelines. In section 1.3 several problems of ID guidelines were discussed. Yet the main reasons for selecting this kind of support are that military instructional designers are used to work with procedures and guidelines, and that they, with respect to ID for team training, can be regarded as novices. Furthermore, because of the obligatory switching of jobs within three years, the ID practitioners hardly have an opportunity to grow from novice towards professional. Therefore the guidelines have an analytical structure, comprising various steps and substeps. This has the risk in it of causing cognitive overload to the instructional designers. On the other hand, the guidelines need to support the novice instructional designer in a step-by-step manner, at the same time capturing the dynamic nature of ID. This has led to several steps having overlap with, and shading off into, other steps and cross-references between steps. Further, opportunities to explicitly evaluate the (intermediate) results of the analysis and design process are frequently offered. As a result, the nature of the guidelines can be characterised as in between linear and iterative.

The content of the guidelines is based on the results of both the literature study and the field study as well as on our own experiences within TNO. As described in section 1.2, the 4C/ID model (Van Merriënboer, 1997) is theory-based, prescription-oriented and applied. The model is primarily aimed at designing learning environments for learning complex cognitive skills: therefore it is also relevant for training teams because important factors in team performance are the team processes, having a substantial cognitive component, which are difficult to learn (see chapter 2). Specifying the content of the guidelines supporting ID for team training was inspired by the 4C/ID model. A distinction has been made between tasks and skills that occur regularly and that are non-routine or especially difficult. These tasks and skills are analysed into their constituent components. Further, a whole-task approach is advocated: training missions are defined including all relevant aspects of the team task performance (both task- and teamwork) that can be trained in progressing levels of difficulty and complexity. Designing team training scenarios evolves from a general structure (training mission) to a detailed version of the training scenario (script/blueprint) in which the elements ‘content’, ‘training strategies’, ‘performance measurement and feedback’, ‘role of the instructor/observer’ and ‘training media’ are progressively further specified.

This research concentrates on how instructional designers can be supported in analysing team tasks and designing team training scenarios, on validating the quality of this support and on how these results contribute to developing an Instructional Design model for training teams. As described in section 1.2, ID models consist of several components (Elen, 1995): design parameters (variables of the learners and of the instructional environment), design procedures, design/development processes, the descriptive knowledge base and the referent system. Applying these components to this research, the learners are adult military personnel that have to perform in operational teams; they have a more or less technological background, and generally prefer practice-oriented rather than theoretical instruction (learning by doing). The instructional environment can vary from a classroom in which a role-play is conducted to a high-fidelity training simulator or to a real-life environment in which a field exercise is carried out. The design procedures are the prescriptive guidelines as described in sections 3.3.1 and 3.3.2 (and Appendices C and D, respectively). The design/development processes are the specific steps to be taken while designing/developing specific instances of instruction; although practical considerations and decisions are called upon, this parameter has not been specifically elaborated in detail because the intention was to develop generally applicable supporting guidelines. The descriptive knowledge base, i.e. the theoretical background of the model, is based upon the mild constructivist view on learning (chapter 1) and on the learning and performance of teams (chapter 2). With respect to the referent system, the model can be applied to military teams that have to learn to perform all aspects of the team task performance (both task- and teamwork). To some degree, the referent system has been dominant in designing the whole research study.

An expert-evaluation of the first draft of the prototype guidelines was conducted. Experts in the field of team training at TNO Human Factors evaluated the prototype guidelines supporting the analysis of team tasks. In two half-day sessions the group of experts applied the guidelines to the experimental team task TANDEM (Tactical Navy Decision-Making) (Weaver, Morgan & Hall, 1993). During these expert-sessions the guidelines were critically reviewed and commented on, and valuable suggestions for improvement have been made (Van Berlo, 1998b). With respect to the guidelines supporting the design of team training scenarios, there was no opportunity to conduct a similar expert-evaluation. Nevertheless, these guidelines have been evaluated and critiqued upon twice by external reviewers (Van Berlo, 1998c, 1998d). Based on the results of the expert-evaluations, the guidelines were revised (Van Berlo, 1999). The guidelines supporting the analysis of team tasks and the design of team training scenarios are described in sections 3.3.1 and 3.3.2, respectively. It is recognised that this version of the guidelines is intermediate and needs to be adjusted based on the results of the experiments. The empirical studies conducted in order to validate the guidelines will be described in chapters 4 and 5.

3.3.1 Guidelines supporting the analysis of team tasks

Conducting a task analysis is an iterative process; in subsequent steps the required information is gathered and analysed into more detail, resulting in the specification of the instructional objectives that will guide the design of a training program. Supporting guidelines need to have a balance between completeness and detail on the one hand, and applicability and usability on the other. Because of the specific characteristics of team tasks (especially with regard to the communication and co-ordination demands) and the characteristics of team performance, results from research on individual-level tasks only partly generalise to the team level.

In this section the guidelines supporting the analysis of team tasks are briefly presented. A more detailed description can be found in Appendix C. Analysing team tasks comprises three phases: (I) Prepare, (II) Conduct and evaluate, and (III) Present. Every phase consists of several steps. During the entire process of conducting the team task analysis evaluations are performed on a regular basis. Although the primary sequence of the phases is ‘prepare’ → ‘conduct and evaluate’ → ‘present’, based on the results of the evaluations the task analyst can decide to go through previously followed phases and/or steps. The phases and steps will be described next.

Phase I - Prepare a team task analysis, consists of six steps (see Figure 3.2):
(1) Determine the goal of the analysis
(2) Determine the scope of the analysis
(3) Establish a project team
(4) Make up an analysis and evaluation plan
(5) Present the analysis and evaluation plan

(6) Evaluate the results.

The steps one through four are followed in an iterative way: in first instance a linear sequence is followed, but the results can determine the analyst to return to a previous step, in order to check the results or to look for more detail information. Even a reconsideration of the original goal of the analysis is possible. After completion of the definitive analysis and evaluation plan, it is presented to the management of the organisation.

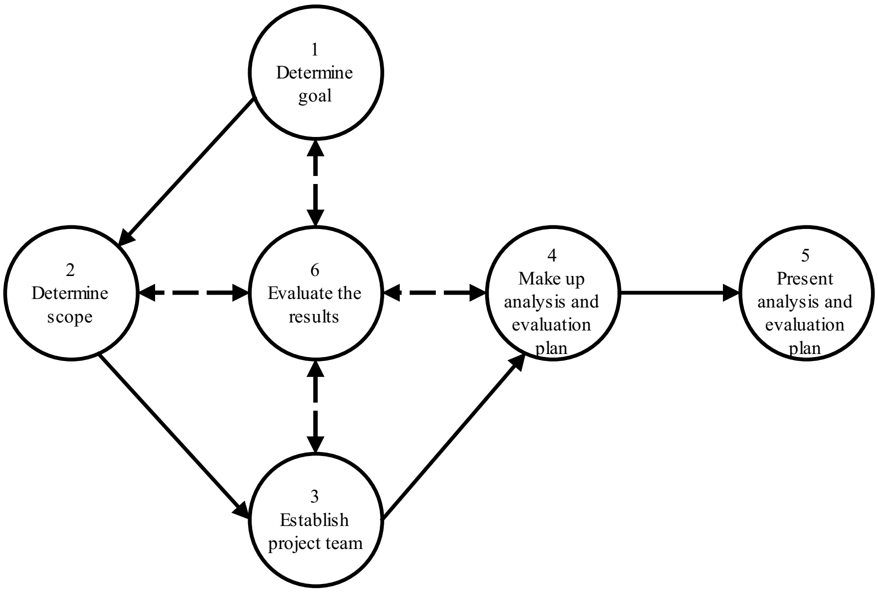

Figure 3.2. Prepare a team task analysis.

The input of Phase II – Conduct and evaluate, is the output of the first phase, namely the analysis and evaluation plan. Conducting and evaluating a team task analysis is an iterative, rather than a linear, process. During the conduct of the analysis the task analysis project team continuously needs to monitor which information has been collected, the quality of the information, whether additional information is required, and whether additional information resources need to be analysed. Based on these (intermediate) evaluations it is decided whether the conduct of the team task analysis needs to be adjusted. Conducting and evaluating the analysis are therefore an integrated process comprising the following six steps (see Figure 3.3):

(1) Orientate on the domain

(2) Conduct a system analysis

(3) Analyse the tasks that are performed by the team

(4) Determine the prerequisite knowledge, skills and attitudes required for adequate task behaviour
(5) Formulate the instructional objectives
(6) Evaluate the results.

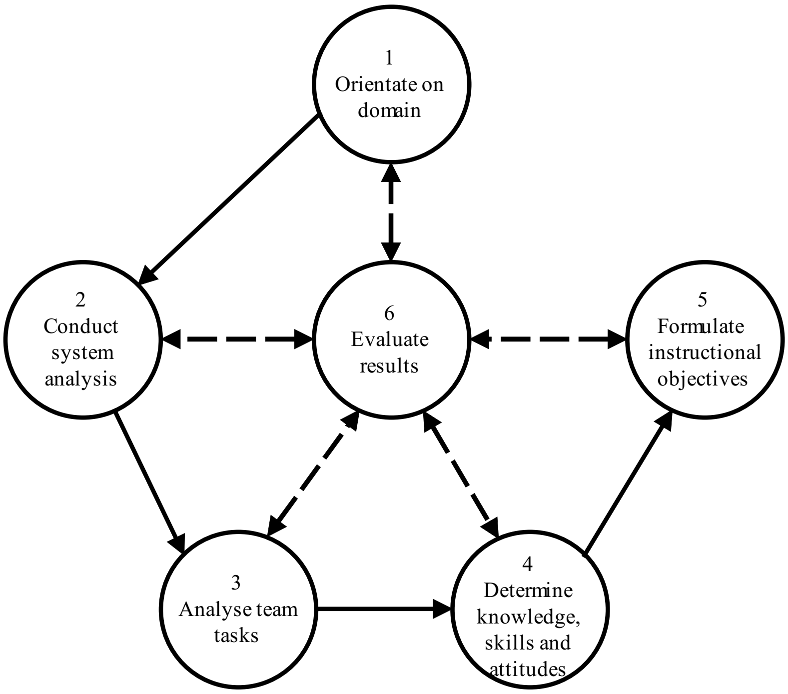

Figure 3.3. Conduct and evaluate a team task analysis.

Because many characterising features of the team performance are not directly observable (the team processes), a behavioural analysis is conducted complemented by a cognitive task analysis in step 3. The behavioural analysis is conducted by dividing the team tasks into subtasks by applying the Hierarchical Task Analysis (HTA) method. A HTA is a description of the task at various levels: it provides insight into the way tasks are divided into subtasks and the sequence in which these tasks and subtasks should or could be performed. An HTA produces a description of the context in which the task is conducted and the requirements posed on the performance, identifies the problematic and difficult task elements, and the subtasks that require complex cognitive skills. Next, the team tasks are analysed into more detail by using Team Operational Sequence Diagrams (TOSD's) in order to gain insight in the cognitive aspects of the team behaviour. A TOSD is a description of the team task at one level and gives a better time order of the tasks than a

HTA does: a TOSD is therefore more suited for team tasks conducted in a rather fixed sequence. The format of a TOSD is already presented in Figure 3.1. The advantage is that the specific moments of transferring information or other co-ordinating activities, relative to the other steps in the team process, can be made visible. The team processes can be visualised by horizontally depicting different team members, and, in a time-dependent sequence, delineating the steps comprising the team task performance. In an additional column expanding the format of a TOSD, for every part of the team task the expert information may be described, for instance specific considerations, tips and tricks, and shortcuts for team task performance. Although first the HTA method is applied, followed by producing a TOSD, in some cases several iterations are needed to obtain all relevant information. Depending on the specific domain certain information can be obtained by either a HTA or by using a TOSD: the point is, however, that at the end all relevant information has been gathered.

In Phase III - Present the results, a report of the final results of the team task analysis process is made up and reported to the management. It is important that the management commits itself to these results. This commitment guarantees that the team task analysis, as input for the next phase in the instructional design process (i.e. designing team training scenarios), will not be brought up for discussion anymore. In other words, in this phase the instructional objectives for the team training program are definitively established.

3.3.2 Guidelines supporting the design of team training scenarios

In this section a framework and guidelines supporting the design of team training scenarios are presented. A more detailed description can be found in Appendix D. The framework is depicted in Figure 3.4. The output of the team task analysis (i.e. the instructional objectives) is the input for designing the team training scenarios. Designing scenarios is an iterative process. This is indicated by the circular relationship between ‘design’ and ‘evaluate’: the products of the design process should be evaluated regularly. Designing scenarios evolves from a general structure (training mission) to a detailed version of the training scenario (script/blueprint). Within the cycle ‘design’ - ‘evaluate’ a problem space emerges comprising the elements ‘content’, ‘training strategies’, ‘performance measurement and feedback’, ‘role of the instructor/observer’ and ‘training media’. By getting involved in this problem space, the instructional designer progresses from a general training mission to a detailed script/blueprint of the training scenario.

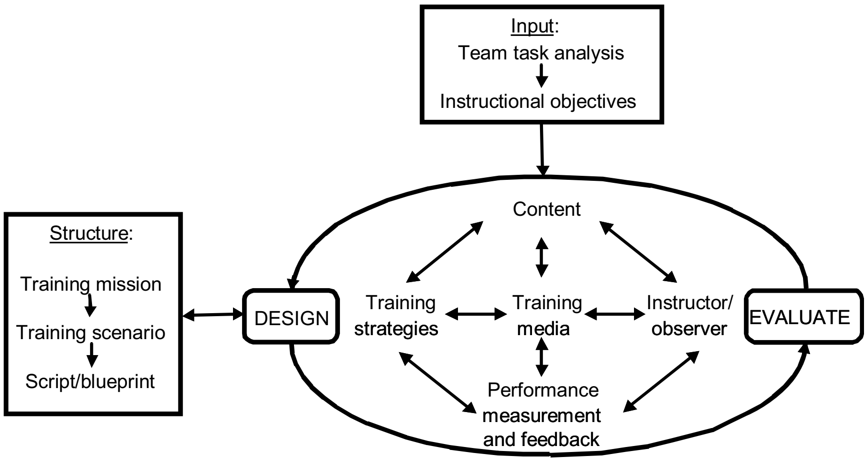

Figure 3.4. Framework for designing team training scenarios.

The intention of the guidelines is to provide support in designing scenarios in which team task skills are trained irrespective of the specific learning environment: field exercises, computer-based training, (distributed) simulator-based training, instrumented battlefield exercises, et cetera. The major difference between these learning environments is level of control over the training situation and the trainees' learning process, implying a varying level of detail in executing the respective guidelines. The guidelines consist of three phases: (I) prepare, (II) design, and (III) evaluate; every phase contains several steps. During the entire process of designing team training scenarios evaluations are conducted on a regular basis. In this way the project team can closely monitor the whole process. Although the primary sequence of the phases is 'prepare' $\rightarrow$ 'design' $\rightarrow$ 'evaluate', based on the results of the evaluations the design project team can decide to go through previously followed phases and/or steps. The phases and steps will be described next.

Phase I - Prepare, consists of five steps (see Figure 3.5):
(1) Determine the goal of the design process
(2) Establish a project team
(3) Determine the conditions
(4) Make up a design and evaluation plan
(5) Evaluate (intermediate) results.

The results of (intermediate) evaluations can bring the design team to return to previous steps, including a reconsideration of the goal of the design process.

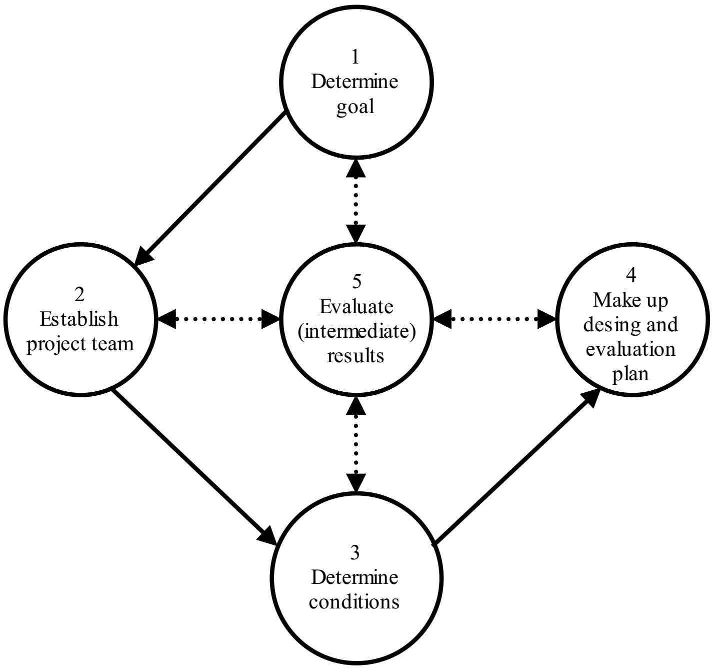

Figure 3.5. Prepare the design process.

Phase II – Design consists of nine iterative steps and is depicted in Figure 3.6. The results of (intermediate) evaluations can cause the design team to return to previous steps or even back to phase I. This implies that the design of team training scenarios progresses from a preliminary design, via refinements to a detailed design: the design of scenarios follows an incremental development process. The following steps are identified:

(1) Review the instructional objectives
(2) Specify the context and conditions
(3) Determine the key events and participants
(4) Combine the events into a coherent scenario
(5) Determine the ideal course of action for each scenario
(6) Determine for each event in a specific scenario the prototypical mistakes and errors trainees make
(7) Determine the most adequate training strategies
(8) Specify the timing, modality and content of feedback (especially for the mistakes)
(9) Evaluate the results.

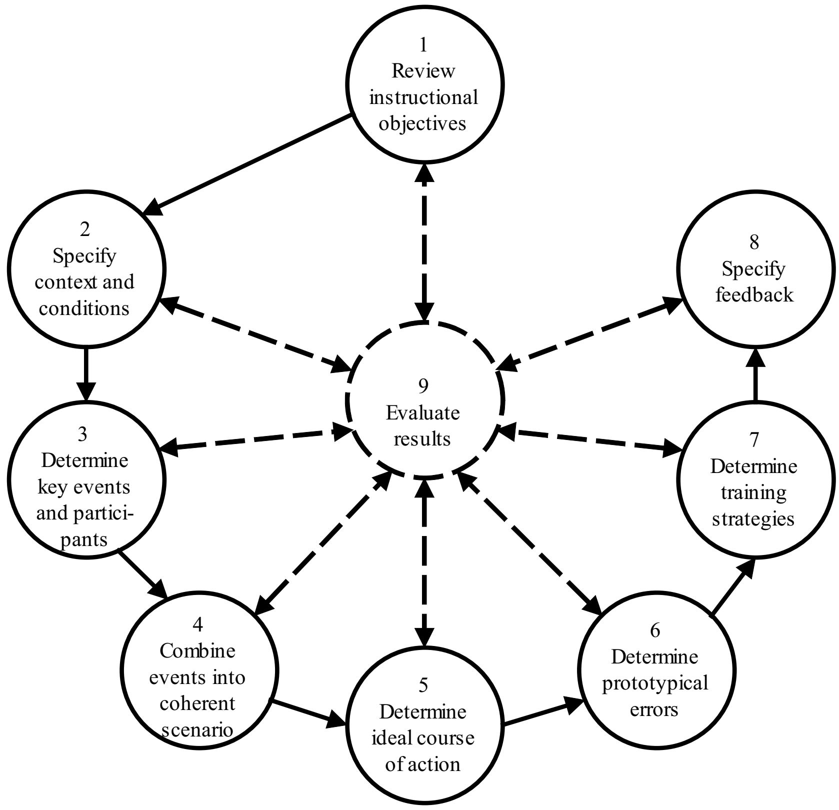

Figure 3.6. Design a team training scenario.

A model delineating the execution of team training scenarios is depicted in Figure 3.7. At the on-set of the execution of a training scenario, the instructional objectives are presented to the trainees: in this way the importance and relevance of the objectives can be made clear, which increases the trainees' willingness to learn. After an optional pre-discussion of the scenario, the trainees engage into the execution of the training scenario. In order to enhance the trainees' learning, the instructor can apply several training strategies and didactical methods. During the execution of the scenario, the team's performance is measured and feedback provided. This feedback can be provided both during and after the execution of the scenario. Because it is simply not possible to practice all tasks under all conditions, reflecting on the task performance is an elementary part of the after action review (AAR). Guided by the instructor the team members reflect on the team's performance, discuss which actions have been conducted, why certain choices and decisions have been made and which improvements can be made. In this way, a critical function in the team's learning process can be realised: reflecting on the own behaviour in order to gain a deeper understanding of the characteristics of effective team performance.

The reflection is primarily aimed at the instructional objectives and the execution of the training scenario. After the reflection the team will execute the next scenario, or repeat (parts of) the same scenario.

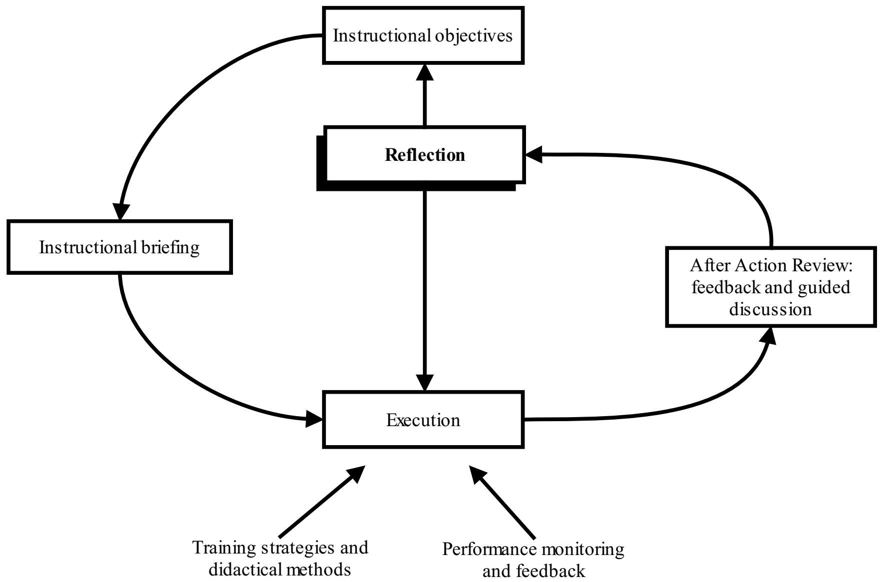

Figure 3.7. Model for the execution of team training scenarios.

Phase III – Evaluate, consists of five steps (see Figure 3.8):

(1) Make an evaluation plan

(2) Conduct formative evaluations

(3) Conduct a try-out

(4) Conduct a pilot-study

(5) Evaluate results.

In first instance these steps should be followed in a linear sequence, but based on the results of the evaluations the design project team can determine to return to one or more previous steps.

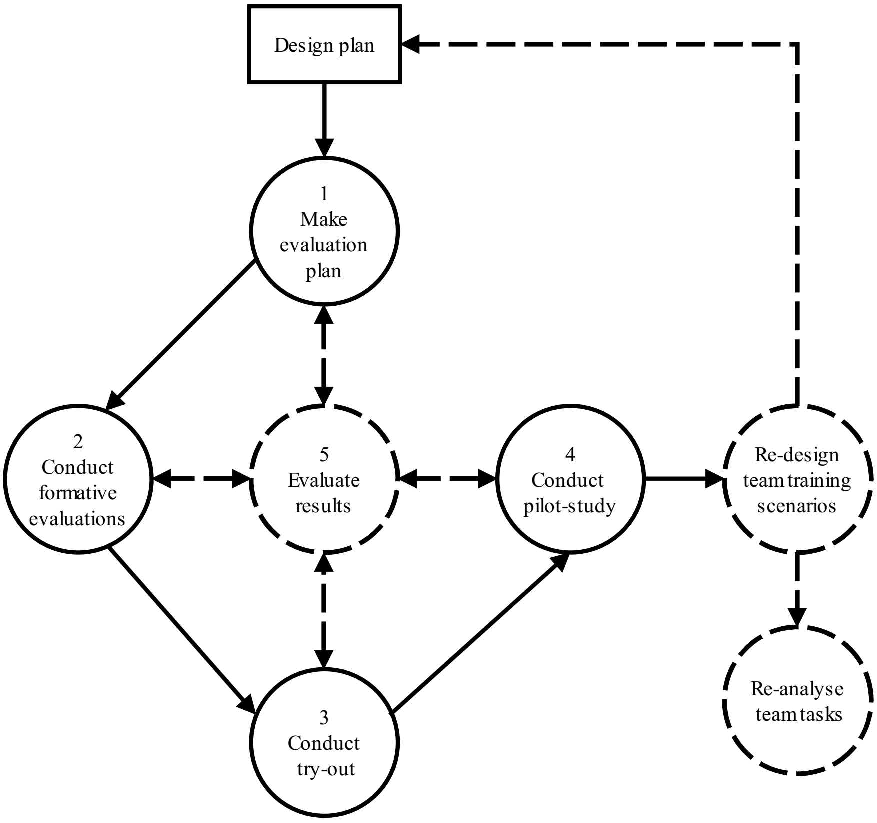

Figure 3.8. Evaluate the design process.

3.4 Summary

A review of current team training ID guidelines showed that guidelines only partially support the ID phases of analysing team tasks and designing team training scenarios, and that an empirical validation is often lacking. Based on literature, field studies and own experiences, guidelines have been developed aimed at supporting the instructional designer during these ID phases. In this research, a constant tension was apparent between new paradigms of learning, the characteristics of ID, the need for systematically designing instruction and the best way to support ID practitioners. An additional complicating factor within the military organisations of the Netherlands is that military personnel, including ID practitioners, has to switch jobs after three years: as a result, there is hardly any opportunity to develop a more longitudinal learning approach to construct a solid ID knowledge base and to grow from novice towards professional. Within this context, it was decided to provide the support for the ID practitioners in the form of guidelines. This choice is made because our research is conducted as part of a project for the military, implying that the support needs to be suited for military instructional designers. Military personnel, including the instructional designers, are used to work with procedures, guidelines and specific work instructions. Moreover, the military instructional designers can be regarded as novices with respect to ID for team training. Therefore the guidelines have an analytical structure, comprising various steps and substeps. This has the risk in it of causing cognitive overload to the instructional designers. On the other hand, the guidelines need to support the novice instructional designer in a step-by-step manner, at the same time capturing the dynamic nature of ID. This has led to several steps having overlap with, and shading off into, other steps and cross-references between steps. Further, opportunities to explicitly evaluate the (intermediate) results of the analysis and design process are frequently offered. As a result, the nature of the guidelines can be characterised as in between linear and iterative. In order to be useful, the support needs to be as concrete as possible. Indeed, the intention of guidelines is to closely and concretely corresponding to the way people work. Investigating the way the military ID practitioners work and if this needs to be changed, was not the purpose of this research. There was no opportunity within the military to actually change the way people work and offering the respective support. Another kind of support that was possible within the context of this research, was a workshop. Nevertheless, we decided to first determine and validate the contents of the guidelines, before organising and testing the effect of a workshop. The results of the empirical validations, however, may offer more insight into the way the ID practitioners work, if this is the most optimal way, and if the support that is offered is the most adequate. In the next chapter the empirical validation of the guidelines will be discussed, and in chapter 5 the effect of an interactive workshop.

4. TESTING THE EFFECT OF THE GUIDELINES

As described in chapter 1, ISD is a complex and iterative process encompassing several phases each comprising several steps. In every phase several actors can be identified, like for instance instructional designers, instructors, subject-matter experts, students, managers of the organisation and evaluators. All these actors influence the quality of the final product: the degree to which trainees learn to perform their operational tasks. In order to keep control over this complex field, the focus of this research is on only one of the identified actors, namely the instructional designers. Moreover, as argued in the previous chapter, guidelines were chosen as the specific kind of support during the process of ID for team training. These restrictions have of course implications for the generalisability of the results of this research, though this research can generate new insights and hypotheses for ID research as well.

The empirical validation of the guidelines is an essential step. Empirical research is needed in order to formulate theoretically sound and validated design specifications. Because of the practical nature of ID-research, this research should have ecological validity (Elen, 1995). This ecological validity is achieved, as much as possible, in a naturalistic environment and by conducting design experiments. A design experiment focuses on engineering innovative educational environments and simultaneously conducting experimental studies of those innovations (Brown, 1992). It is a kind of research aiming at bridging the gap between the researcher's knowledge base (with respect to a topic and student's learning) and instructional support. A design experiment is an empirical study in which instructional support is designed, implemented, validated and revised in an iterative, recurrent way (Brown, 1992; De Corte, 2000). The goal is to link descriptive and prescriptive research. Descriptive research aims at describing, explaining and understanding reality, while prescriptive research looks for possibilities to change that reality by means of interventions (Elen, 1995). This need has already been stated by Munsterberg (1899, quoted by Dewey, 1900) who expresses the need for a linking science between educational sciences and educational practice. Hilgard (1964) described five stages to relate both kinds of research, ranging from pure psychological research on learning not related to education (e.g. animal studies) to try-outs of interventions in an ecological context, resulting in its adoption and implementation in classrooms. Kalmykova (1970) made a distinction between an ascertaining and a teaching experiment. An ascertaining experiment is a descriptive study in which the researcher acquires knowledge about the students' learning. A teaching experiment aims at transforming the descriptive research into educational prescriptions following two stages: (1) the searching or testing experiment and (2) the verifying or validating experiment. According to Glaser (1976), designing is not done in a single generate-and-test cycle, but through an iterative series involving the generation of alternatives, testing and revising them, and so on. A recent example of a design experiment following the iterative testing and revision of the instructional interventions, is provided by Vanmaele (2002; Vanmaele & Lowyck, 2004). Design experiments may be regarded as structured case studies, generating and exploring, rather than testing hypotheses. Nevertheless, it is important to note that the naturalistic environment, in which design experiments are conducted, does not necessarily hinder achieving experimental control. In this research, hypotheses have been formulated in order to structure the data analysis and to formulate accurate conclusions, realising the restricted generalisability of the results.

This research concentrates on how instructional designers can be supported in analysing team tasks and designing team training scenarios, on validating the quality of the support and on how these results contribute to developing an Instructional Design model for training teams. At the beginning of the research, the focus was on defining the contents of the guidelines: which steps and substeps, in which order and to what level of detail. Because this research is conducted within the context of a larger research program for the military in the Netherlands (Royal Netherlands Navy, Army and Airforce), it was the intention to develop generally applicable supporting guidelines. In the line of this focus, two design experiments were carried out to validate the guidelines. The purpose of the first experiment was to determine the effect of the guidelines supporting the analysis of team tasks (Van Berlo, 2002a, 2000b). The purpose of the second experiment was to determine the effect of the guidelines supporting the design of team training scenarios (Van Berlo, 2003). These two experiments will be discussed in this chapter. Later on during the research, the focus shifted from the contents of the guidelines towards supporting the instructional designers how to use the guidelines. Along this line, a third design experiment was conducted. The third experiment tested the effect of an interactive workshop providing for a more elaborate introduction of the two sets of guidelines (Van Berlo & Baartman, 2004) and will be discussed in the next chapter.

With respect to the experiments testing the effect of the guidelines, first the method will be explained (4.1), followed by the presentation of the results (4.2) and the conclusions (4.3).

4.1 Method

Two experiments were conducted aimed at testing the effect of the guidelines supporting the analysis of team tasks and the design of team training scenarios. This section describes the hypotheses (4.1.1), the participants (4.1.2), the task and the materials (4.1.3), the design of the experiment (4.1.4), the procedure followed during the experiment (4.1.5) and the data collection and analysis (4.1.6). For both experiments the method was nearly the same, except small differences due to the time available. In the following section, these differences will be explicitly identified.

4.1.1 Hypotheses

In the two design experiments aimed at testing the effect of the guidelines, the following three hypotheses have been tested.

H1: Applying the guidelines will improve the quality of the analysis (experiment 1) and design (experiment 2) process. In other words, the participants with guidelines will perform better than those without guidelines.

H2: Applying the experimental guidelines will improve the quality of the analysis (experiment 1) and design (experiment 2) process with respect to team aspects as compared to the control guidelines. In other words, the participants with the experimental guidelines will perform better than those with the control guidelines.

H3: Participants with high quality processes will deliver high quality products; following H2, this implies that applying the experimental guidelines will improve the quality of the ID products.

The results can give more insight into the strong and/or weak aspects of the team training guidelines, and, consequently, the necessary improvements of the guidelines.

4.1.2 Participants

Participants were male military instructional designers from the Royal Netherlands Army and the Royal Netherlands Navy (both experiments) and the Royal Netherlands Air force (only experiment 1). We asked the participants for previous experience in the field of ID and/or training teams. All participants had experience as an instructor, but were novices in the field of ID; they were just about to finish, or had just finished, their military instructional design course. None had experience with training teams, although one participant had experience with conducting team building exercises (experiment 2). Following Chase and Simon (1983), the participants were neither experts nor naïve participants in instructional design and/or team training: they were novices having knowledge of instructional design and some experience in applying this knowledge. All participants volunteered to participate in the experiments. The number of participants in the first experiment was ten (N=10). In the second experiment the number of participants was eight (N=8); originally, ten participants were planned, but two participants cancelled just before the experiment and it was not possible to arrange substitutes. The number of participants is in line with previous studies on instructional design expertise (e.g. Goel & Pirolli, 1992; Greeno et al., 1990; Le Maistre, 1998; Limbach, De Jong & Pieters, 1998; Perez et al., 1995; Rowland, 1992). Table 4.1 shows the number of participants per military unit for the experiments 1 and 2.

Table 4.1

Number of participants per military unit for the experiments 1 and 2

	Military Unit			
	Royal Netherlands Army	Royal Netherlands Navy	Royal Netherlands Air force	Total
Experiment 1	3	4	3	10
Experiment 2	2	6	0	8
Total	5	10	3	18

4.1.3 Task and materials

Two sets of guidelines were used: guidelines supporting the analysis of team tasks (experiment 1) and guidelines supporting the design of team training scenarios (experiment 2). The guidelines are briefly described in sections 3.3.1 and 3.3.2, respectively. The experimental versions of the guidelines are described in more detailed in Appendices C and D; the differences between the control and the experimental versions are summarised in Appendices C.4 and D.4, respectively.

Further two fictitious, pc-based laboratory team tasks were used: the Fire Fighting Team Task and the Tactical Navy Decision-Making task. The advantage of these laboratory team tasks is that the participants' domain knowledge is being controlled for. The Fire Fighting Team Task (FFTT) (Rasker, 2002) is situated in a virtual city where different buildings are set on fire by an arsonist. The goal is to extinguish these fires in order to save as many lives as possible. Two team members (an observer and a dispatcher) can extinguish the fires by assigning fire-fighting units to a fire. The observer takes care of fire detection and identification of the buildings in the situation. Information on buildings must be exchanged with the dispatcher who determines the type of building, number, and time of the allocation of units. The observer and dispatcher work with different displays. They exchange information electronically through standardised electronic messages that do not require any typing. Subsequently, the system takes care of the transport of units and the extinction of fires. The number of units available is limited and more units are needed for large than for small building types. Several scenarios are developed that define when the fires take place and in which building. Pre-programmed algorithms determine the way fires develop in reaction to the deployment of units. Figures 4.1 and 4.2 present the displays of the observer and the dispatcher, respectively.

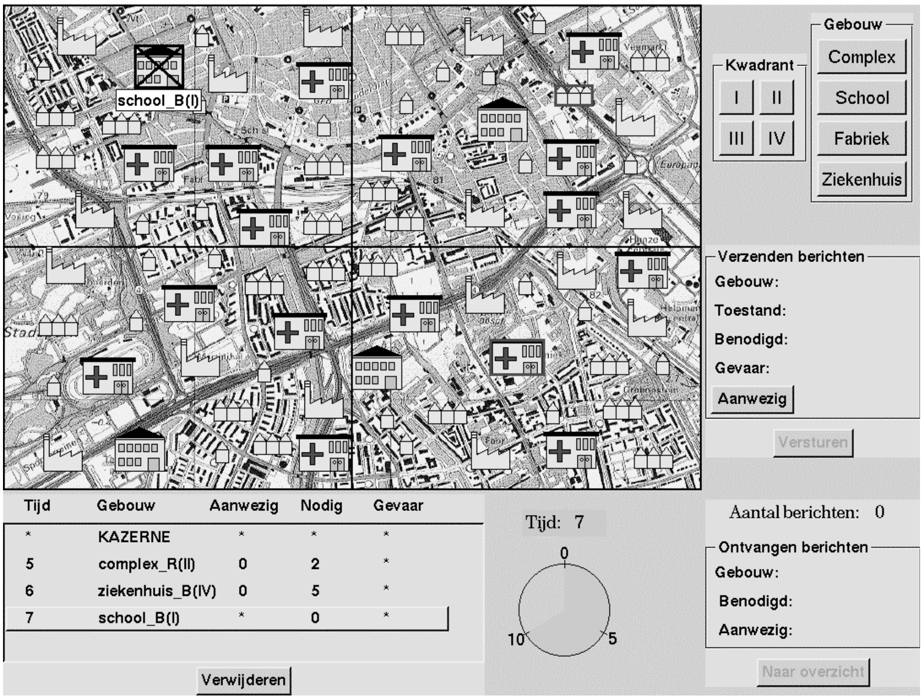

Figure 4.1. Screen display of the observer in the Fire Fighting Team Task (Rasker, 2002, p. 48).

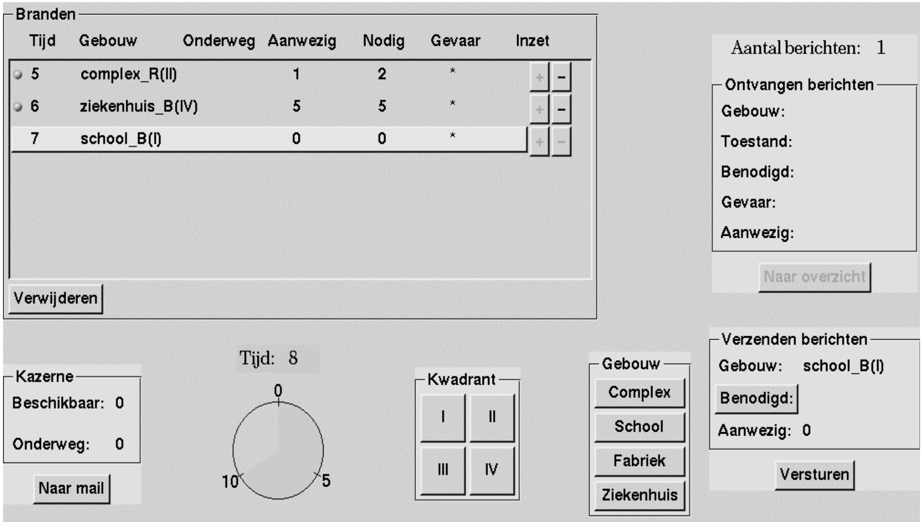

Figure 4.2. Screen display of the dispatcher in the Fire Fighting Team Task (Rasker, 2002, p. 49).

The Tactical Navy Decision-Making task (TANDEM: Weaver, Morgan & Hall, 1993) provides a low-fidelity simulation of a command and control environment, but with relatively high face validity to real-world combat information centres. The task was developed to investigate factors such as task interdependence, time pressure, task load and ambiguity and teamwork processes such as communication and co-ordination. TANDEM is a networked computer simulation and the task can be performed by a maximum of three team members. The team members have to detect and identify unknown targets and have to take appropriate actions. The team members are each sitting behind a radar screen, do not have visual contact with each other and can only communicate one-to-one through a microphone and headset. The team members performing the TANDEM task are required to make decisions regarding unknown targets represented on a simulated radar display by consulting the targets and integrating pieces of information that are distributed over team members. Based on this decision, targets are either cleared or shot. Figure 4.3 presents the display of every team member.

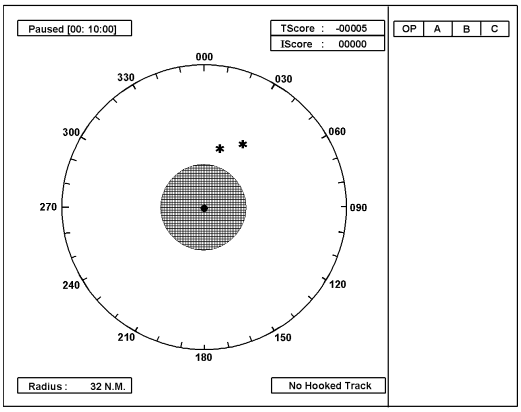

Figure 4.3. Screen display of the TANDEM team task (Weaver, Morgan & Hall, 1993, p. 15)

Both laboratory team tasks resemble the tasks to be performed in a Command Information Centre (CIC) team: in order to take adequate decisions, the team members have to co-operate, and exchange, interpret and integrate the information provided by each team member. This information, however, can be conflicting and/or ambiguous.

In experiment 1, the participants were asked to analyse the respective team task in order to formulate instructional objectives needed for training the team members. During the pre-test, all participants received the documentation illustrating the FFTT. During the post-test, all participants received documentation illustrating the TANDEM-task and were shown a TANDEM videotape. In experiment 2, the participants were asked to design training scenarios needed for training the team members. During the pre-test, all participants received documentation illustrating the FFTT and a set of instructional objectives (see Appendix E). During the post-test, all participants received documentation illustrating the TANDEM-task and a set of instructional objectives (see Appendix F). If participants needed more information in order to conduct the task analysis or to design the training scenarios (e.g., asking questions to subject matter experts, conducting interviews), they were instructed to ask the experimenter who played these various roles.

4.1.4 Design

For both experiments, the participants were randomly assigned to two conditions: the experimental (n=5 and n=4, respectively) and control condition (n=5 and n=4, respectively). In order to control for possible effects of where they were employed (Navy, Army and Air force) all participants were matched on military unit and experience with teambuilding. During the pre-test all participants had to analyse the task (experiment 1) or design an outline of a training program and a training scenario (experiment 2) of the FFTT. No guidelines or other supporting tools were used. During the post-test the participants did the same for TANDEM. This design is illustrated in Table 4.2.

Table 4.2

Design of the two experiments testing the effect of the guidelines

EXPERIMENT 1 (N=10) **EXPERIMENT 2 (N=8)**	**Pre-test**	**Post-test**
Laboratory team task	FFTT	TANDEM
Experimental condition (n=5 and n=4, respectively)	No guidelines	Experimental guidelines
Control condition (n=5 and n=4, respectively)	No guidelines	Control guidelines

A possible disadvantage is that one task would be more difficult to analyse than the other would. Due to practical constraints (size of the sample) it was not possible to check for this order effect. Analyses on both the FFTT (Rasker, 2002) and TANDEM (Van Berlo, 1998b) show that the TANDEM team task is more complex: the interdependency between the team members is larger, communication and information exchange is more natural and less standardised and the information has a higher degree of uncertainty. TANDEM was therefore more suitable to use during the post-test. Consequently, a crossed design did not seem to be necessary in this study.

4.1.5 Procedure

The pre-tests of experiment 1 were conducted during April and May 2000 and the post-tests two to three weeks later. The pre-tests of experiment 2 were conducted during March 2002 and the post-tests two to three weeks later. The pre-tests took place at the training centres the participants were employed while the post-tests took place at TNO Human Factors, Soesterberg, the Netherlands.

At the beginning of the pre-test, the researcher explained the aim and procedure of the study in a general introduction of about 10 minutes. The participants received the documentation containing the description (experiment 1) or the instructional objectives of FFTT (experiment 2) which they were instructed to read for at most 60 or 30 minutes, respectively. Next, the participants were asked to analyse the FFTT task (experiment 1) or to design an outline of a training program and a team training scenario for the FFTT team (experiment 2). This phase had a timeframe of at most three hours (experiment 1) and 2.5 hours (experiment 2), each interrupted by half an hour lunch break. This was followed by a 30 minutes period in which the participants had to complete a questionnaire referring to the analysis or design process (see Appendix G). Finally, the analysis or design process was briefly reflected upon during a discussion between researcher and each participant. Only topics marked by the researcher or raised by the participants have been discussed. This phase lasted for half an hour at most.

The procedure followed during the post-test was largely the same. One obvious difference is that before conducting the experimental task, the participants had to read the guidelines within one hour. During the first experiment the participants were also shown a video complementary to the description of TANDEM. The procedures for the pre- and post-tests of both experiments are summarised in Table 4.3.

Table 4.3

Procedure of the experiments testing the effect of the guidelines

Experiment	**Experiment 1**		**Experiment 2**	
Procedure	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**
General introduction	10 minutes	10 minutes	10 minutes	10 minutes
Read documentation of team task	60 minutes Description of FFTT	60 minutes Description and 20-minute video of TANDEM	30 minutes FFTT objectives	30 minutes TANDEM objectives
Read guidelines	Not applicable	1 hour (experimental or control)	Not applicable	1 hour (experimental or control)
Conduct experimental task: analyse task, design scenario	3 hours	3 hours	2.5 hours	2.5 hours
Fill out questionnaire	30 minutes	30 minutes	30 minutes	30 minutes
Interview	30 minutes	30 minutes	30 minutes	30 minutes

In section 3.3 it was argued that the guidelines have an analytical structure, comprising various steps and substeps. Although the guidelines support the participant in a step-by-step manner, the guidelines need to capture the dynamic nature of ID as well. This has, as already mentioned, led to several steps having overlap with, and shading off into, other steps and cross-references between steps. Further, opportunities to explicitly evaluate the (intermediate) results of the analysis and design process are frequently offered. As a result, the nature of the guidelines can be characterised as in between linear and iterative. The instructions given to the participants stressed that they had to follow the guidelines, but that they were allowed to deviate from it. In case the participants did not choose to follow the guidelines (e.g. skipping certain steps, following additional steps or changing the sequence of steps) they were instructed to explicitly indicate that they were deviating from the guidelines, why they were doing this and how they were proceeding with their tasks.

4.1.6 Data collection and data analysis

During conducting the team task analysis and designing the team training scenario, participants were allowed to take notes and they had to think-aloud in order to make explicit what they were doing and why certain choices have been made. They were stimulated to think-aloud continuously, rather than only during fixed time intervals. The risk of fixed time intervals is that this prompted and retrospective reflection will probably disturb the flow and quality of the design process, while continuously thinking aloud (concurrent verbalisation) only affects the speed of the task performance (Ericsson & Simon, 1980). During the verbalisation, no additional translation by the participant is required: the information is already in verbal code. Besides, the total task, rather than a subset, is the object of the verbalisation. It can therefore be concluded that the verbalisation is at level 1 (Ericsson & Simon, 1980). Stimulating the participants to verbalise the reasons behind their behaviour (the strategic knowledge) might influence their task performance positively as they will be more reflective in their actions. But it was assumed that this knowledge would normally be available to instructional design practitioners as well, implying that this information will probably not affect the task performance during these experiments (Ericsson & Simon, 1980). In order to obtain valid data, the probes were undirected, and did not contain any contextual information (Ericsson & Simon, 1980). Although think-aloud can have some side effects on the participants' performance (e.g. reducing the speed of task performance), this method yields valuable data to gain a deeper understanding of the processes the participants are involved in.

The processes the participants were engaged in were primarily depicted in the audio recordings; the notes were only analysed in case the verbal reports contained ambiguous or contradictory information. The audio recordings of every session have been transcribed into protocols. Every protocol was segmented into episodes and coded independently by two raters, one of who was blind to the experimental conditions of the participants. Every episode was coded according to a coding scheme. In first instance this coding schema was based on previous research (Greeno et al., 1990; Perez et al., 1995). In order to reach a sufficient level of agreement between the two raters, the coding results of two protocols were compared. The raters differed on some aspects in interpreting the coding scheme rather than that there was disagreement on the process the participants were involved in. The differences were discussed, the coding scheme was refined and all protocols were coded accordingly.

The coding scheme has several categories (see Appendix H for experiment 1 and Appendix I for experiment 2). The first three categories refer to the guidelines: 'Prepare', 'Conduct and evaluate', 'Present the results' (experiment 1) and 'Prepare', 'Design' and 'Evaluate' (experiment 2). Every category is divided in several subcategories capturing the essential aspects of the respective phases and steps in the guidelines. For instance, 'Prepare' the task analysis was subdivided in 'determine the goal of the analysis', 'determine the scope of the analysis', 'establish a project team', and 'develop an analysis and evaluation plan'. The step 'determine the goal of the analysis' was further divided in 'determine goal', determine condition' and 'match goal and condition'. Using subcategories, however, not always appeared to be useful. In the coding scheme of experiment 2, therefore, in two cases ('determine goal of design process' and 'establish project team') no further subdivision was made.

The category 'Prerequisite to analysis' deals with monitoring the progress by the participant. Examples are comments on what the participant has already done and what he should still do, asking clarifications about the experimental task and making remarks about the guidelines. The category 'Others' (experiment 1) is for miscellaneous remarks like for instance about training program design and the military course the participant is currently doing. The category 'New' is used for parts of the protocol that cannot be coded with the existing items of the coding scheme. Examples are remarks about the weather or the news of the day or making jokes. Because these two categories appeared to overlap, in the category scheme of experiment 2 these were combined into one category 'New'.

The categories 'Progressive Deepening' and 'Mental Simulation' cover two strategies relevant to design activities a participant can follow (Schraagen, 1992, 1994). Mental simulation refers to statements of the participant indicating that he is trying to imagine certain aspects of the task performance (e.g. saying "first do this, and then do that"). Based on this mental simulation the participant makes decisions on the task analysis or design process. Progressive deepening is a manifestation of the limited working memory and presence of cognitive load (Schraagen, 1992, 1994). The participant fills several slots, but cannot do this at once because that will result in a working memory overload. One might expect that a participant's task performance becomes more comprehensive as a result of applying progressive deepening. Applying progressive deepening enables the participant to postpone decisions to the moment he has a better picture of what is required. This strategy can provide valuable information, because it detects the problems participants encounter during a design task, in this case task analysis and specifying instructional objectives. Progressive deepening only leads to better design products if the participant is reasonably or well acquainted with the domain knowledge the instruction is designed for. Although in these experiments the participants were not familiar with the domain (FFTT and TANDEM), during the experiment they were handed over all relevant information: both on paper and by the experimenter when asked for by the participant.

After the experimental task the participants had to complete a questionnaire referring to the analysis or design process (pre- and post-test) and a questionnaire referring to the quality and usability of the guidelines (post-test only). The analysis or design process was reflected upon during a discussion between researcher and participant. Finally, the quality of both process and product (i.e. output of the analysis or design process) was assessed by two raters on a 5-point scale (1: very bad, 5: very good). The experts were instructed to base their assessments as much as possible on arguments. This assessment was on the level of major steps in the guidelines and not on the underlying substeps (see Appendix J) since it was assumed that not every participant would follow every detailed substep exactly as prescribed. As described in the previous section, they were actually allowed to deviate from the guidelines. But it was also assumed that on the level of the major steps no dramatic deviations would occur.

Summarising, the following combination of data has been collected:

a) Think-aloud protocols: these data are a representation of the process the participants were involved in. Protocols were collected during all sessions.
b) Analysis and design results: these data represent the result (output) of the task conducted by the participants.
c) Quality assessments: the quality of both process and product is assessed by two team training experts on a 5-point scale; this assessment is on the level of major steps in the guidelines (not the underlying substeps) and is based on arguments.

d) Questionnaire: after every session the participants completed a questionnaire referring to the analysis or design process (pre- and post-test) and a questionnaire referring to the quality and usability of the guidelines (post-test only).
e) Interview: after completion of the questionnaire an interview was conducted with each participant enabling him to reflect on the instructional design process.

Table 4.4 shows which data analysis activities were undertaken in order to test the hypotheses as described in section 4.1.1.

Table 4.4
Data analysis activities related to the hypotheses and additional questions

Hypothesis	Data analysis activities
Participants with guidelines (post-test) perform better than without guidelines (pre-test)	- Think-aloud protocols - Quality assessment of process and product
Participants with experimental guidelines perform better than participants with control guidelines	- Think-aloud protocols - Quality assessment of process and product
Participants with a high quality process yield better products	- Quality assessment of process and product
Additional questions	
Strong and weak aspects of guidelines	- Think-aloud protocols - Questionnaire - Interviews
Improvements to the guidelines	- Think-aloud protocols - Questionnaire - Interviews

4.2 Results of experiment 1: Analysis of team tasks

All participants had just finished the initial instructional design course in their organisation, or were recently assigned as an instructor/designer. None of the participants had previous experience in analysing team tasks. One participant had several years of experience as an instructor.

During the pre-test, the participants in the experimental group needed an average of 138 minutes (sd: 45 minutes) to conduct the analysis of the Fire Fighting Team Task; the participants of the control group needed an average of 86 minutes (sd: 43 minutes). There is

no explanation for this difference; all participants were randomly assigned to the conditions, so these differences seem to be accidental. In fact, the two participants needing most time to complete the task were in different conditions. During the post-test, the participants in the experimental group needed an average of 150 minutes (sd: 45) to conduct the analysis of the TANDEM task; the participants of the control group needed an average of 126 minutes (sd: 45). A reasonable explanation for this difference is that the guidelines for the participants in the experimental condition were more extensive and that the participants therefore needed more time to read and to follow these guidelines during the actual conduct of the team task analysis.
Analysis of time needed on a more individual level shows that all but two participants needed more time on the post-test than on the pre-test. Generally, participants using more time on the pre-test also needed more time on the post-test. This shows that both conditions contain both slow and fast participants. An exception is participant 2 in the experimental condition: during the pre-test he needed 142 minutes to complete the analysis, while on the post-test needing the least time of all participants, namely 63 minutes. Although he did complete the task analysis, looking into more detail at the protocol of the post-test revealed several signs of non-motivation. For example: repeatedly interrupting the experimenter when he was explaining something, making jokes about the TANDEM task, taking the conduct of the team task analysis not seriously, and making numerous remarks not related to the experimental session. Therefore, the results of this participant's post-test were not included in the qualitative data analysis. Due to a technical defect the audio tape of one participant's session (control condition) during the pre-test was blank. Consequently, the qualitative analysis was conducted on the data of four participants collected during the pre-test (control condition) which is still acceptable given the experiences of previous studies on ID expertise (see section 4.1.2).

The results show that the three hours available to analyse the FFTT or the TANDEM-task were not sufficient for every participant. Besides, not every participant made extensive notes. This resulted in a considerable variation of the final (paper-based) products the participants came up with. Therefore, no separate quality assessments of the products have been conducted.

Every protocol has been divided into segments that were scored independently by two raters. These raters knew about the research aims and can therefore not be regarded as blind. The level of agreement between the two raters is indicated using the coefficient kappa, K (Cohen, 1960). This coefficient takes into account the extent of accidental agreement and can be applied to dichotomous data at a nominal level (Heuvelmans &

Sanders, 1993). In this study, coefficient K is 0.74, which is interpreted as substantial agreement (Landis & Koch, 1977). Based on the number of scores in the protocols, on which the two raters agreed with each other, analyses of variance were conducted. The analysis shows the following significant differences of participants between pre and post-test. The experimental group increased on ‘establish a project team’ ($F=5.482$, $p=0.047$) and ‘describe individual task performance’ ($F=5.565$, $p=0.046$). The control group increased on ‘determine the goal of analysis’ ($F=5.772$, $p=0.047$), ‘establish a project team’ ($F=93.333$, $p=0.001$), ‘develop an analysis and evaluation plan’ ($F=13.144$, $p=0.008$), and ‘mental simulation’ ($F=7$, $p=0.033$). The results show further that all participants hardly ever applied the strategies of mental simulation and progressive deepening during both pre- and post-test. Overall, only 0.28% of all coded episodes reflects these strategies. The same holds true for evaluating the intermediate and/or final results: only 2.5% of all coded episodes reflect this activity.

The results of the analysis of variance are based on number of scores given, and do not necessarily reveal anything about the quality of the processes the participants were engaged in. Therefore, two team training experts rated the quality of the participants’ processes and their (intermediate/final) products on a 5-point scale. These experts knew about the research aims and can therefore not be regarded as blind. Kendall’s W (Coefficient of Concordance) was used as a measurement of the agreement between the two experts. This is a non-parametric measurement that can be used for ordinal data sets and computes the sum of ranks of each variable. For experiment 1, Kendall’s W is 0.56 which is interpreted as average agreement (Landis & Koch, 1977). Table 4.5 shows the average scores on every step of the team tasks analysis.

Table 4.5
Average scores of the quality of the analysis process

Steps of team task analysis	Experimental condition		Control condition	
	Pre-test (n=5)	Post-test (n=4)	Pre-test (n=4)	Post-test (n=5)
Determine goal of analysis	1.80	2.63	1.00	2.70
Determine scope of analysis	1.50	3.38	1.38	2.10
Establish project team	1.00	2.75	1.00	3.60
Develop analysis and evaluation plan	1.60	3.25	1.00	3.50
Present analysis and evaluation plan	1.00	2.50	1.00	1.70
Conduct system analysis	1.50	2.88	1.25	1.10
Analyse tasks conducted by the team	2.50	3.38	2.50	2.60
Determine knowledge, skills and attitudes	2.30	3.00	2.13	1.40
Formulate team instructional objectives	2.10	2.38	2.13	2.20
Evaluate (intermediate and final) results	1.20	1.75	1.75	2.40
Overall average score	1.65	2.78	1.51	2.33

On the pre-test, the overall average scores of both conditions did not significantly differ on a Mann-Whitney U-test, $U=928.00$, $p=0.559$. It can therefore be concluded that the random assignment of participants to conditions did not result in qualitatively different groups.

On the post-test, the participants of both conditions scored higher as compared to the pre-test. For the experimental condition, a Mann-Whitney U-test shows a significant improvement, $U=402.00$, $p<0.001$; for the control condition, a Mann-Whitney U-test shows a significant improvement as well, $U=563.50$, $p=0.000394$ (see Fig. 4.4).

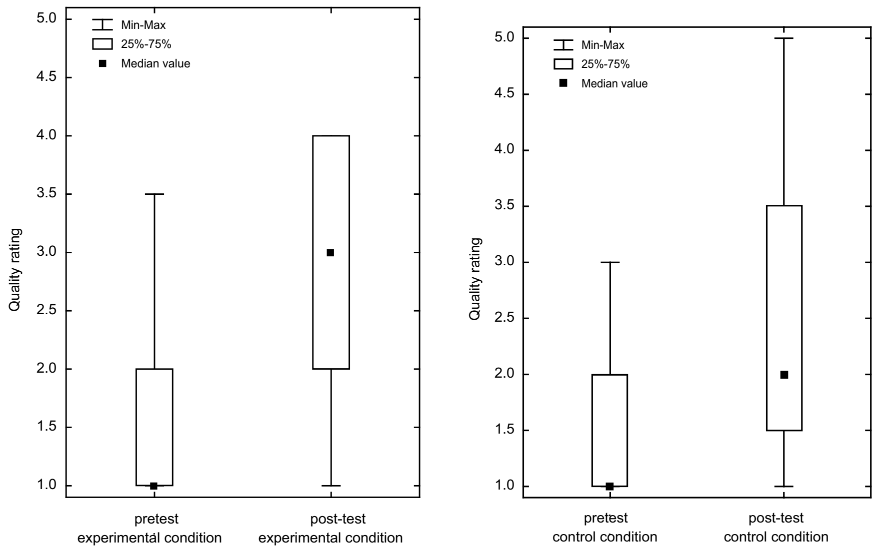

Figure 4.4. Quality differences between the pre-test and post-test of the experimental and control condition (experiment 1).

Comparing the overall scores on the post-test of both conditions shows that participants in the experimental condition have a higher overall score than the participants in the control condition; a Mann-Whitney U-test shows a significant difference, U=737.00, p=0.0327 (see Fig. 4.5).

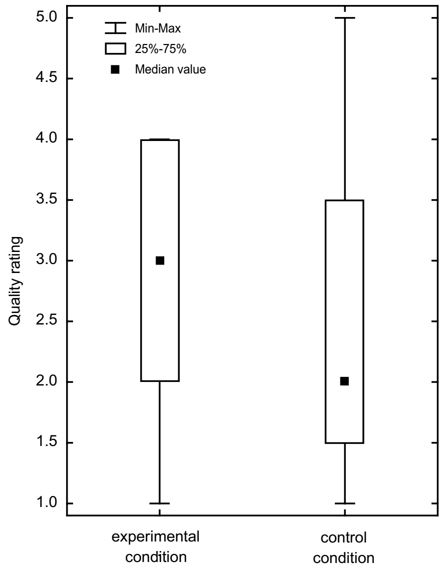

Figure 4.5. Overall quality differences on the post-test between experimental and control condition (experiment 1).

In order to test the effect of the guidelines on the quality of the analysis process, the average increase or decrease of the scores within subjects on the pre- and post-test is measured. Table 4.6 shows the average increase or decrease of the participants' scores.

Table 4.6

Average increase or decrease in the quality of the analysis process

Steps of team task analysis	Experimental condition (n=4) <–5, +5>	Control condition (n=4) <–5, +5>	Overall <–10,+10>
Determine goal of analysis	+ 0.83	+ 1.70	+ 2.53
Determine scope of analysis	+ 1.88	+ 0.72	+ 2.60
Establish project team	+ 1.75*	+ 2.60*	+ 4.35
Develop analysis and evaluation plan	+ 1.65*	+ 2.50*	+ 4.15
Present analysis and evaluation plan	+ 1.50*	+ 0.70	+ 2.20
Conduct system analysis	+ 1.38	– 0.15	+ 1.23
Analyse tasks conducted by the team	+ 0.88*	+ 0.10	+ 0.98
Determine knowledge, skills and attitudes	+ 1.13*	– 0.73	+ 0.40
Formulate team instructional goals	+ 0.28	+ 0.07	+ 0.35
Evaluate results	+ 0.55	+ 0.65	+ 1.20
Overall average increase or decrease	+ 11.83**	+ 8.16**	+ 19.99

* Significant (p<0.10)

** Significant (p<0.001)

Overall, comparing the pre- and post-test showed large differences between the participants, varying from +2 to +18 points. As already indicated, the average quality of the processes for both conditions increased (see Figure 4.1). This indicates that irrespective of the type of guidelines, the guidelines had a positive effect on the quality of the participants' performance. More specifically, a Wilcoxon test shows that participants in the experimental condition improve their performance on the following steps ($z=1.83$, $p<0.10$): 'establish project team', 'develop analysis and evaluation plan', 'present analysis and evaluation plan', 'analyse tasks conducted by the team', and 'determine prerequisite knowledge, skills and attitudes'. For the participants in the control condition, a Wilcoxon test shows a significant improvement ($z=1.83$, $p<0.10$) on the steps 'establish project team', and 'develop analysis and evaluation plan'.

A closer look at the specific team aspects of the task analysis ('conduct a system analysis', 'analyse the tasks conducted by the team', 'determine the prerequisite knowledge, skills and attitudes' and 'formulate the team instructional goals') shows a more differentiated view. On these aspects, the quality of the experimental group's analysis process increased with an average of +3.67 points, while the control group's quality of the process decreased with an average of –0.71 points.

In order to get a better understanding of the perceived difficulties and given support, self-reports were gathered by means of questionnaires and additional interviews (see Appendix G). A summary of these results will be presented next; a more detailed overview of the results can be found elsewhere (Van Berlo, 2002a). The illustrations represent the majority of answers given. On the pre-test the participants of both conditions revealed the same difficulties during the analysis process: gaining insight in the fire-fighting domain, lots of reading, time pressure, and that is was not entirely clear how detailed the instructional goals should be specified. Illustrations of answers given on the questions related to difficulties encountered during the task analysis are: "It was difficult to have an understanding of the subject matter", "There was no occasion to visit the workplace", "It was difficult to determine the attitudinal instructional objectives", "It was a lot of reading", "It was difficult to determine where to start", "The elements of the instructional objectives were not specific enough" and "There was a considerable time-pressure". More positive were some participants about identifying and describing the tasks and subtasks of the individual fire-fighting operators, and selecting the instructional goals. Illustrations of answers given on the questions related to what was perceived as easy parts of the task analysis are: "Defining the main tasks of the individual officers was easy", "It was easy to analyse the tasks of the individual officers", "Selecting the instructional objectives", and "Formulating the instructional objectives, because the FFTT domain was described very strictly". Illustrations of comments made during the additional interview are: "It was difficult to make a distinction between a task, subtask and instructional objective", "I learned a lot with respect to designing instruction for task domains that are not my expertise" and "Conducting the interviews with the subject-matter expert could be more structured".

On the post-test, the participants of both conditions more or less gave the same answers to the questions. Difficulties encountered during the task analysis were lack of time, formulating instructional goals, and making a TOSD. Illustrations of answers given on the questions related to difficulties encountered during the task analysis are: "It was difficult to get a grip on the tasks of the officers", "I did not get to the point of formulating instructional objectives", "Making a TOSD was difficult", "The systematic approach of the guidelines was difficult to follow because of the overlaps" and "It was difficult to formulate instructional objectives for practical sessions". Illustrations of answers given on the questions related to what was perceived as easy parts of the task analysis are: "Every part of the task analysis", "Determine prerequisite knowledge, skills and attitudes" and "Translation from task analysis to instructional objectives”. Illustrations of comments made during the additional interview are: “Making a TOSD is very complex”, “Conducting a systems analysis is difficult” (only experimental condition) and “It is difficult to indicate where phase I ends and phase II starts”.

According to the participants, information missing in the guidelines was both a checklist in order to indicate which steps have been followed and more examples of the steps. Weak aspects of the guidelines were considered to be the use of too much and too difficult text, and the exceeded emphasis on information resources. Strong aspects were considered to be the clarity and usability of the guidelines, and the example of the mission diagram. The participants suggested the following improvements:

- A checklist in order to indicate which steps have been followed
- More examples of the steps
- Less text resulting in less redundancy of information
- Less difficult words and terms
- Less (i.e. realistic) emphasis on information resources
- More support in making a Team Operational Sequence Diagram.

Finally, the participants were asked to rate on a 5-point scale whether they would apply the guidelines at their own job (‘1’ indicating certainly not, and ‘5’ indicating absolutely yes). The participants in the experimental condition had an average score of 4.2, while these in the control condition had an average score of 4.6. The ratings varied from ‘3’ to ‘5’ with an overall average score of 4.4 (see Table 4.7).

Table 4.7

Rating of the participants’ willingness to apply the analysis guidelines on their own job

Condition	Willingness to apply the guidelines at the own job					Average
	1	2	3	4	5	
Experimental			1	2	2	4.2
Control				2	3	4.6

4.3 Results of experiment 2: Designing of team training scenarios

The participants had all just finished the initial instructional design course in their organisation, or were recently assigned as a designer. None of the participants had previous experience in designing team training scenarios, and only one of them had several years of experience as an instructor of teambuilding exercises.

During the pre-test, the participants in the experimental group needed an average of 96 minutes (sd: 26 minutes) to design an outline of a training program and a training scenario for the Fire Fighting Team Task. The participants in the control group needed an average of 110 minutes (sd: 9 minutes). There is no explanation for this difference; all participants were randomly assigned to the conditions, so these differences seem to be accidental. In fact, the two participants needing most time to complete the task were in different conditions.

During the post-test, the participants in the experimental group needed an average of 119 minutes (sd: 20 minutes) to design an outline of a training program and a training scenario for the TANDEM team; the participants of the control group needed an average of 127 minutes (sd: 39 minutes). Analysis of time needed on a more individual level shows that all but two participants needed more time on the post-test than on the pre-test. Both conditions contained both slow and fast participants. An exception is participant 2 in the control condition: during the pre-test he needed 116 minutes to complete the analysis, while on the post-test needing the least time of all participants, namely 70 minutes. During the debrief this participant indicated that he did not spend sufficient time consulting the guidelines.

The results show that all participants managed to design a training program and a team training scenario for the FFTT or the TANDEM task within the 2.5 hours available. However, just as in the first experiment, not every participant made extensive notes. This resulted in a considerable variation of the final (paper-based) products the participants came up with. Therefore, no separate quality assessments of the products have been conducted.

Similar to the first experiment, every protocol has been divided into segments that were scored independently by two raters. These raters knew about the research aims and can therefore not be regarded as blind. The coefficient K, indicating the level of agreement between the two raters, is .71, which is interpreted as substantial agreement (Landis & Koch, 1977). Based on the number of scores in the protocols, on which the two raters agreed with each other, analyses of variance were conducted. The analyses showed no significant differences of the participants between the pre and post-test. Further, the participants hardly ever applied the strategies of mental simulation and progressive deepening during both pre- and post-test; the same holds true for evaluating the intermediate and/or final results.

Just as in the first experiment, two team training experts rated the quality of the participants' processes and their (intermediate/final) products on a 5-point scale. These experts knew about the research aims and can therefore not be regarded as blind. For experiment 2, Kendall's W is 0.46 which is interpreted as average agreement (Landis & Koch, 1977). Table 4.8 shows the average scores on every step of the design process.

Table 4.8

Average scores of the quality of the design process

Steps of designing team training scenarios	**Experimental condition**		**Control condition**	
	Pre test (n=4)	Post test (n=4)	Pre test (n=4)	Post test (n=4)
Determine goal of design	1.38	3.00	2.38	2.00
Establish project team	1.00	2.63	1.13	2.00
Determine conditions	1.50	1.75	3.63	1.88
Develop design and evaluation plan	1.13	1.75	1.63	1.38
Evaluate (team) instructional objectives	2.75	2.63	3.00	3.63
Specify learning trajectory	2.50	2.63	3.38	2.50
Specify context and environment	2.00	2.88	2.13	2.25
Determine important events and players	2.63	2.88	1.88	2.88
Combine events in coherent scenario	3.00	3.13	2.75	3.00
Determine ideal course of action	2.50	2.50	2.00	2.88
Determine prototypical mistakes of team (members)	1.38	1.50	1.00	2.00
Determine training strategies	2.88	3.00	2.38	2.63
Specify timing, modality and content of feedback	2.50	3.63	2.75	2.75
Evaluate (intermediate and final) results	1.88	1.75	3.38	2.38
Conduct try-out	1.88	2.00	1.25	3.13
Conduct pilot study	1.13	1.38	1.13	2.50
Overall average score	2.00	2.44	2.24	2.49

On the pre-test, the overall average scores of both conditions did not significantly differ on a Mann-Whitney U-test, $U=6.00$, $p=0.564$. It can therefore be concluded that the random assignment of participants to conditions did not result in qualitatively different groups. On the post-test, the participants of both conditions scored higher as compared to the pre-test; however, this increase is not significant. For the experimental condition, a Mann-Whitney U-test shows a non-significant improvement, U=3.00, p=0.149. For the control condition, a Mann-Whitney U-test shows a non-significant improvement as well, U=4.00, p=0.248 (see Fig. 4.6).

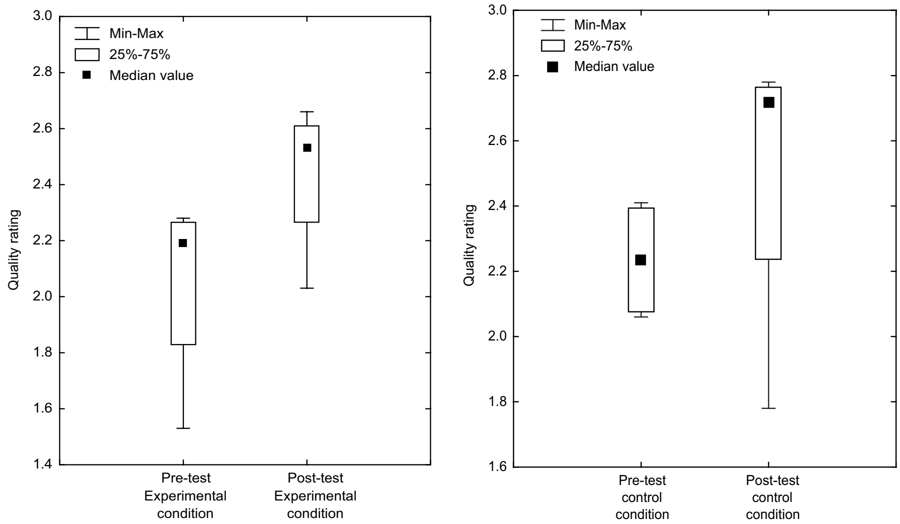

Figure 4.6. Quality differences between the pre-test and post-test of the experimental and control condition (experiment 2)

Comparing the overall scores on the post-test of both conditions shows that participants of both conditions do not differ significantly. A Mann-Whitney U-test shows a non-significant positive difference, U=4.00, p=0.248 (see Fig. 4.7).

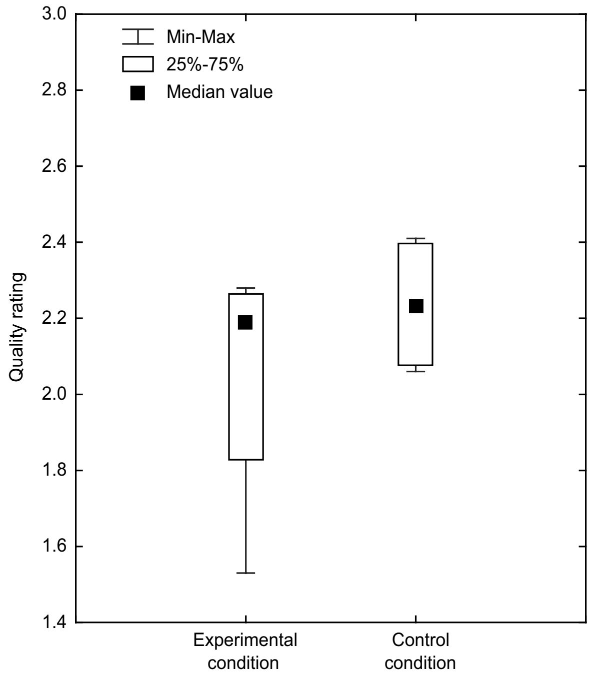

Figure 4.7. Overall quality differences on the post-test between experimental and control condition (experiment 2).

In order to test the effect of the guidelines on the quality of the design process, the average increase or decrease of the scores within subjects on the pre- and post-test is measured. Table 4.9 shows the average increase or decrease of the participants' scores.

Table 4.9

Average increase or decrease in the quality of the design process

Steps of team training design	Average increase/decrease		
	Experimental condition (n=4) <–5,+5>	**Control condition** (n=4) <–5,+5>	**Overall** <–10,+10>
Determine goal of design	+1.62	–0.38	+1.24
Establish project team	+1.63	+0.87	+2.50
Determine conditions	+0.25	–1.75	–1.50
Develop design and evaluation plan	+0.62	–0.25	+0.37
Evaluate (team) instructional objectives	–0.12	+0.63	+0.51
Specify learning trajectory	+0.13	–0.88	–0.75
Specify context and environment	+0.88	+0.12	+1.00
Determine important events and players	+0.25	+1.00	+1.25
Combine events in coherent scenario	+0.13	+0.25	+0.38
Determine ideal course of action	0.00	+0.88	+0.88
Determine prototypical mistakes of team (members)	+0.12	+1.00	+1.12
Determine training strategies	+0.12	+0.25	+0.37
Specify timing, modality and content of feedback	+1.13	0.00	+1.13
Evaluate (intermediates and final) results	–0.13	–1.00	–1.13
Conduct try-out	+0.12	+1.88	+2.00
Conduct pilot study	+0.25	+1.37	+1.62
Overall average increase or decrease	+7.00	+3.99	+10.99

Overall, comparing the pre- and post-test showed large differences between the participants, varying from –19 to +22 points. All participants increased their score, except for one participant. On average, the quality of the processes for both conditions increased, but this is non-significant (also see Fig. 4.6).

More specifically, Table 4.10 shows the results of Wilcoxon tests on every step of the team training design process. If less than three participants had a different average score on the pre-test and post-test, the Wilcoxon test could not be used, and a Mann-Whitney test was conducted.

Table 4.10

Mann-Whitney (M-W) and Wilcoxon tests on every step of the team training scenario design process

Condition	**Experimental**				**Control**			
Steps of team training design	**Pre (n=4)**	**Post (n=4)**	**Wilcoxon *p***	**M-W *P***	**Pre (n=4)**	**Post (n=4)**	**Wilcoxon *p***	**M-W *p***
Determine goal of design	1.38	3.00	0.0679*		2.38	2.00	–	0.5590
Establish project team	1.00	2.63	0.1088		1.13	2.00	0.1088	
Determine conditions	1.50	1.75	–	0.3496	3.63	1.88	0.0679*	
Develop design and evaluation plan	1.13	1.75	0.1088		1.63	1.38	0.4226	
Evaluate (team) instructional objectives	2.75	2.63	0.7893		3.00	3.63	0.1088	
Specify learning trajectory	2.50	2.63	1.0000		3.38	2.50	0.4652	
Specify context and environment	2.00	2.88	0.1441		2.13	2.25	1.0000	
Determine important events and players	2.63	2.88	0.3613		1.88	2.88	0.2851	
Combine events in coherent scenario	3.00	3.13	0.7150		2.75	3.00	0.5839	
Determine ideal course of action	2.50	2.50	0.7150		2.00	2.88	0.3613	
Determine prototypical mistakes of team (members)	1.38	1.50	1.0000		1.00	2.00	0.1088	
Determine training strategies	2.88	3.00	0.7892		2.38	2.63	–	0.6171
Specify timing, modality and content of feedback	2.50	3.63	0.0679*		2.75	2.75	1.0000	
Evaluate (intermediates and final) results	1.88	1.75	–	0.4539	3.38	2.38	0.0679*	
Conduct try-out	1.88	2.00	1.0000		1.25	3.13	0.1088	
Conduct pilot study	1.13	1.38	–	0.8501	1.13	2.50	0.1088	
Overall average in/decrease	2.00	2.44			2.24	2.49		

* significant ($p<0.10$)

The Wilcoxon test shows participants in the experimental condition to improve their performance on the following steps: 'determine goal of design' (z=1.83, p<0.10), and 'specify timing, modality and content of feedback' (z=1.84, p<0.10). On the steps no Wilcoxon test could be conducted, a Mann-Whitney test shows no significant increases or decreases in score. For the participants in the control condition, a Wilcoxon test shows a significant improvement (z=1.84, p<0.10) on the steps 'determine conditions', and 'evaluate the (intermediate and final) results'. On the steps no Wilcoxon test could be conducted, a Mann-Whitney test shows no significant increases or decreases. Together, all participants show an improvement on four steps. Only the participants in the experimental condition improve on one step specifically relating to team training, namely 'specify timing, modality and content of feedback'.

In order to get a better understanding of the perceived difficulties and given support, self-reports were gathered by means of the questionnaires and additional interviews (see Appendix G). A summary of these results will be presented next; a more detailed overview of the results can be found elsewhere (Van Berlo, 2003). The illustrations represent the majority of answers given. On the pre-test the participants of both conditions showed the same difficulties during the design process: gaining insight in the fire-fighting domain, time pressure and working with instructional goals not formulated by themselves. Illustrations of answers given on the questions related to difficulties encountered during the scenario design are: "I did not have a task analysis, documents or procedures, so the topic was not known to me", "It was difficult to put the instructional objectives in the right order", "I did all phases sub-optimally because of the time pressure" and "It was difficult to estimate the time required for training the instructional objectives". More positive were some participants about making a rough design of the overall training program. Illustrations of answers given on the questions related to what was perceived as easy parts of the scenario design are: "Making a training scheme was good", "Making practical exercises as many as possible was a good choice" and "A good sequence and combination of practical and theoretical instructional objectives". Illustrations of comments made during the additional interview are: "It is difficult to relate a fictitious task to the real world" and "Before designing a training program I have to know the facilities I can use".

On the post-test, the participants of both conditions more or less gave the same answers to the questions. Two participants (one in every condition) found the preparation phase difficult, and according to one participant the preparation phase could be excluded. Illustrations of answers given on the questions related to difficulties encountered during the scenario design are: "It was difficult to make a training session for operating the system and the communication procedures", "The preparation phase could have been better" and "It was a lot of work given the time available". Illustrations of answers given on the questions related to what was perceived as easy parts of the scenario design are: "The sequence of the various part of the training program is good", "Combining the theory and practice was done alright" and "Determining the instructional objectives and the related training methods". Illustrations of comments made during the additional interview are: "It was instructive", "The figures were very clarifying", "Phase II was too extensive and thus too unsystematic", "The TANDEM task was too easy because only three team members were involved" and "The guidelines are too abstract".

According to the participants, no information was considered missing in the guidelines, although documentation containing the results of the task analysis would have been regarded as helpful. Weak aspects of the guidelines were considered to be the extensiveness of the text and the use of difficult words. The extensiveness of the guidelines is, however, also regarded as a strong aspect, as well as the figures. The guidelines are considered useable as a reference guide. The participants suggested the following improvements:

- A checklist in order to indicate which steps have been followed
- More examples of the steps
- Less text resulting in less redundancy of information
- Less difficult words and terms

Finally, the participants were asked to rate on a 5-point scale whether they would apply the guidelines at their own job ('1' indicating certainly not, and '5' indicating absolutely yes). The participants in the experimental condition had an average score of 3.50, while the participants in the control condition had an average score of 3.75. The ratings varied from '1' to '5' (in both conditions) with an overall average score of 3.63 (see Table 4.11). The score of '1' in the experimental condition was given because on that particular participant's training school no teams were trained, and thus the guidelines had no added value to the regular guidelines. The score of '1' in the control condition was given because that participant did not see an added value of these guidelines to the regular guidelines.

Table 4.11

Rating of the participants' willingness to apply the design guidelines on their own job

Condition	Willingness to apply the guidelines at the own job					Average
	1	2	3	4	5	
Experimental	1			2	1	3.50
Control	1			1	2	3.75

4.4 Conclusions

The aim of the experiments described above was to test the following three hypotheses:

H1: Applying the (experimental or control) guidelines will improve the quality of the analysis (experiment 1) and design (experiment 2) process. With other words, the participants with guidelines will perform better then without guidelines.

H2: Applying the experimental guidelines will improve the quality of the analysis (experiment 1) and design (experiment 2) process with respect to team aspects as compared to the control guidelines. With other words, the participants with the experimental guidelines will perform better then the participants with the control guidelines.

H3: Participants with high quality processes will deliver high quality products; following H2, this implies that applying the experimental guidelines will improve the quality of the ID products.

A further aim was to identify the strong and/or weak aspects of the team training guidelines, as well as to improvements that can be made to the guidelines. The conclusions of both experiments are described below.

H1: Applying the (experimental or control) guidelines will improve the quality of the analysis (experiment 1) and design (experiment 2) process.

The results of the first experiment show that participants with experimental or control guidelines (post-test) are performing better than without guidelines (pre-test). The results show further that the participants in the experimental condition improved on all analysis steps; the same holds true for the participants in the control condition, except for two steps on which their quality decreased on the post-test. For experiment 1 it is therefore concluded that the first hypothesis can be confirmed.

The results of the second experiment show that participants with experimental or control guidelines (post-test) tend to perform better than without guidelines (pre-test): however, this overall improvement is not significant. Seven out of the eight participants improved their scores on the post-test but only a few improvements on the distinct steps are significant. For experiment 2 it is therefore concluded that the first hypothesis can only be partly confirmed.

H2: Applying the experimental guidelines will improve the quality of the analysis (experiment 1) and design (experiment 2) process with respect to team aspects as compared to the control guidelines.

The results of the first experiment show that the overall quality of the analysis process increases for all participants in both conditions. Especially on project management, as indicated by the subcategory 'develop an analysis and evaluation plan', both groups increased their scores. A closer look at the specific team aspects of the task analysis showed an increase of the experimental group on the respective steps, while the control group's quality of the process decreased. For experiment 1 it is therefore concluded that the second hypothesis can be confirmed.

The results of the second experiment show that the overall quality of the design process tends to increase for all participants in both conditions, although this is not significant. The participants in the experimental and control condition each improved on two steps. The participants in the experimental condition improved on just one team related aspect of the task. Although this is a rather complex step, for experiment 2 it is concluded that the second hypothesis can be rejected.

H3: Participants with high quality processes will deliver high quality products; following H2, this implies that applying the experimental guidelines will improve the quality of the ID products.

During both experiments, not every participant made extensive notes. This resulted in a considerable variation of the final products the participants came up with. Consequently, it was not possible to measure the differences between the products of the participants of both conditions, or to relate the quality of the processes to the quality of the separate products. For both experiments it was therefore not possible to reject or confirm the third hypothesis.

Identify the strong and/or weak aspects of the team training guidelines as well as the improvements that can be made to the guidelines.

Some participants of both experiments identified the following strong aspects of the guidelines: project management (making the analysis/design plan), clear and well structured steps and phases illustrated by the figures, usability of the guidelines and providing cues for identifying critical team task information (only experiment 1). This reflects the willingness to apply the guidelines. Nevertheless, the participants identified several points for improvement: including a checklist in order to indicate which steps have been followed, giving more examples of the steps, using less difficult words and terms, and using less text resulting in less redundancy of information. In the process of converting the prototype guidelines into a more definite version, these suggested improvements all seem valid. These improvements are, however, rather superficial remarks typical for novices. A second expert-evaluation, after the revision of the current guidelines based on the results of these experiments, might provide more in-depth information.

The next chapter will describe the third experiment aimed at testing the effect of an interactive workshop to provide for a more elaborate introduction of the guidelines. In the sixth and final chapter, the results and conclusions of all three experiments will be discussed.

5. TESTING THE EFFECT OF AN INTERACTIVE WORKSHOP

As described in the introduction of the previous chapter, the focus of the research shifted from determining and validating the contents of the guidelines towards supporting instructional designers how to use the guidelines. An important impetus for this was the comments of the participants of the experiment testing the effect of the guidelines. Many of these participants mentioned the brief introduction in working with the guidelines (one-hour reading) as problematic, especially given the detailed and difficult contents of the guidelines. In the line of this shifted focus, a third design experiment was conducted, testing the effect of an interactive workshop providing for a more elaborate introduction of the two sets of guidelines, including exercises to get hands-on experience with the guidelines (Baartman, 2003; Van Berlo & Baartman, 2004). First, the method will be explained (5.1), followed by the presentation of the results (5.2) and the conclusions (5.3).

5.1 Method

An experiment was conducted aimed at testing whether a more extensive introduction into the guidelines supporting the analysis of team tasks and the design of team training scenarios will lead to a better understanding of these guidelines. This section describes the hypotheses (5.1.1), the participants (5.1.2), the task and the materials (5.1.3), the design of the experiment (5.1.4), the procedure followed during the experiment (5.1.5) and the data collection and analysis (5.1.6). The method of this experiment was almost the same as for the previous two experiments; differences will be explicitly described.

5.1.1 Hypotheses

In this experiment aimed at testing the effect of an interactive workshop, the following two hypotheses have been tested.

H1: Attending the workshop will improve the quality of both the analysis and design process on the post-test as compared to the pre-test.

H2: The increase in the quality of both the analysis and design process will be higher after the workshop (this experiment) than after only reading the experimental guidelines (previous experiments).

5.1.2 Participants

In order to compare the results of this experiment with the results of the first and second experiment, a prerequisite was that the sample used in all experiments would be more or less the same. In all experiments, participants were male military novice instructional designers. In this third experiment the participants were six male instructional designers from the Royal Netherlands Navy (N=6). The participants were novices in the field of instructional design: they were in the final week of their Navy instructional design course. All participants had several years of experience as an instructor and two participants had some experience in training teams (1 year and 3 years). All participants volunteered to participate in the experiment. The instructor of the Navy instructional design course attended the workshop as well, but was no participant of the experiment.

5.1.3 Task and materials

A workshop has been given to provide for a more elaborate introduction into working with the guidelines. This experiment was primarily designed to test the effect of the workshop. During both the pre and the post-test, the participants therefore only used the experimental guidelines as described in section 3.3.1 and 3.3.2, and more detailed in Appendices C and D.

Further two fictitious, laboratory team tasks were used: the Fire Fighting Team Task and the Tactical Navy Decision-Making task (see section 4.1.3). During the pre-test, all participants received the documentation illustrating the FFTT and a set of instructional objectives (see Appendix E). During the post-test, all participants received documentation illustrating the TANDEM-task and a set of instructional objectives (see Appendix F). If participants needed more information in order to conduct the task analysis or to design the training scenarios (e.g., asking questions to subject matter experts, conducting interviews), they were instructed to ask the experimenter who played these various roles.

The workshop itself was divided in two parts. The topic of the morning session was the guidelines supporting the analysis of team task, in the afternoon session the subject was the guidelines supporting the design of team training scenarios. The structure of these two sessions will be briefly described next.
The morning session of the workshop consisted of three blocks of activities, in which the guidelines for team task analysis were explained and the participants were given some

practice in working with the guidelines. The goal of the first block was to give a broader picture of instructional design for team training and to present the rationale behind the guidelines. The second block consisted of an explanation of the guidelines supporting the analysis of team tasks. The Fire Fighting Team Task, used by the participants during the pre-test, was used as an example to clarify difficult parts of the guidelines. Special attention was paid to those parts the participants of the previous experiments had marked as difficult, or were observed by the experimenters as causing difficulties. Especially, the concept of a systems analysis was explained, a mission diagram was made, and a cognitive task analysis and Team Operational Sequence Diagram (TOSD) were presented and explained. Finally, the participants were given the opportunity to practise working with the guidelines by analysing the tasks of a familiar team they knew from previous experiences. The two experimenters provided help when necessary, but the exercises were completed individually.

During the afternoon session, the guidelines supporting the design of team training scenarios were clarified using the method of co-learning (Kagan, 1992; Kagan & Kagan, 1994) because within this method specific attention is paid to teaching small-group skills. Just like the morning session, the afternoon session of the workshop was divided into three blocks. First, the concept of co-learning was explained to the participants, including a small introductory exercise. The second block started with another short co-learning exercise: Team Word Webbing (Kagan, 1992). This is an exercise meant to enable learners to generate, question, combine, categorise, evaluate and apply information. It was used to focus the participants' attention to the guidelines (they have used during the pre-test). The main part of the second block consisted of an explanation of the guidelines supporting the design of team training scenarios, again illustrated by the FFTT. This explanation was meant to give the participants a better understanding of the structure of the guidelines and was focussed mainly on the parts of the guidelines that had not come up during the process of making the Team Word Web. The last block of the workshop consisted of practising with the guidelines supporting the design of team training scenarios. Again, the participants were asked to work on a familiar team. Different from the morning session, this time the participants worked together in dyads.

5.1.4 Design

This experiment was conducted as a follow up of the previous two experiments. Therefore, the design had to take into account the characteristics of the three experiments together. Figure 5.1 depicts the design of all three experiments. In this section the design of the third experiment will be described, in relation to the other two experiments.

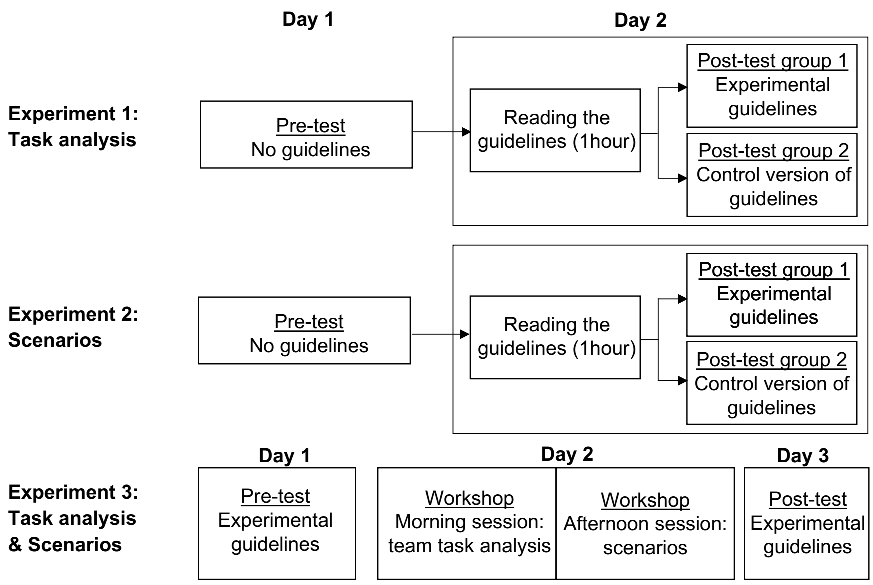

Figure 5.1. The design of all three experiments.

The design of the first two experiments is described in the previous chapter. The third experiment was primarily designed to test the effect of the workshop. During both the pre and the post-test, the participants therefore only used the experimental guidelines: no control group was used.

5.1.5 Procedure

The experiment consisted of three different parts that took place on three separate days (see the bottom row of Fig. 5.1). First a pre-test was administered (day 1), followed by the workshop given a week afterwards (day 2) and finally a post-test was conducted (day 3), that took place 5 to 18 days after the workshop. All sessions were conducted during March and April 2003 at the Maritime Training School (SMVBO) in Den Helder, the Netherlands.

Pre-test (day 1)

Following the procedure of the first two experiments, all participants had to analyse the Fire Fighting Team Task and design a team training scenario based on the learning objectives. In a general introduction of about 10 minutes the researcher explained the aim and procedure of the study. This was followed by a half an hour period during which the participants were instructed to read the description of the FFTT, and a 1.5 hour period during which the participants could read both sets of guidelines (team task analysis and team training scenario design). Next, the participants had to apply the task analysis guidelines on the FFTT task. The participants were instructed to start with the second phase of the analysis process and skip the first, preparatory, phase (see section 3.3.1). On a separate sheet, the participants were given the outcomes of this preparatory phase. The underlying assumption is that the results on the first phase do not impact the results on the second phase. Ideally, a canonical correlation analysis is required to test this assumption, but the data do not meet the requirements (i.e. sufficient number of cases and a normal distribution) to conduct this analysis. A non-parametric correlation shows that the assumption is valid for experiment 1 (gamma = -.0285, $z = -0.36$, $p=.7225$), but not valid for experiment 2 (gamma = .381, $z=5.16$, $p =.0000$). Nevertheless it was decided to skip the first phase because otherwise the total pre-test would take too long and become too mentally fatiguing for the participants. In total, participants had to perform both tasks within three hours, interrupted by a 15 minutes break.

After 1.5 hour of analysis, the FFTT instructional objectives were handed out, and the participants had to start with the second task, designing an outline of a team training program and a team training scenario. All participants received the same set of FFTT instructional objectives formulated by the experimenter. This ensured that all participants used the same learning objectives as a basis to design the training scenario.

This was followed by a 30 minutes period in which the participants had to complete a questionnaire referring to the analysis and design process (see Appendix G). Finally, the analysis and design process was reflected upon during a discussion between researcher and each participant. This phase lasted for half an hour at most.

Workshop (day 2)

The one-day workshop consisted of two parts. During the morning session, the guidelines supporting the analysis of team tasks were addressed; the afternoon session involved the explanation of the guidelines supporting the design of team training scenarios. A more detailed overview of the workshop is described in section 5.1.3. At the end of the workshop, a questionnaire was filled out by both the participants (anonymously) and the instructor referring to the structure and topics of the workshop (Appendix K).

Post-test (day 3)

The procedure of the post-test was exactly the same as that of the pre-test. The only difference is that the participants had to apply the guidelines on the TANDEM task.

The procedure for this experiment is summarised in Table 5.1.

Table 5.1

Procedure of the experiment testing the effect of an interactive workshop

Procedure	**Pre-test (day 1)**	**Workshop (day 2)**	**Post-test (day 3)**
General introduction	10 minutes	See section 5.1.3 for a detailed description	10 minutes
Read documentation of team task	30 minutes Description of FFTT		30 minutes Description of TANDEM
Read guidelines	1.5 hour		1.5 hour
Conduct experimental task: analyse task	1.5 hour		1.5 hour
Conduct experimental task: design scenario	1.5 hour		1.5 hour
Fill out questionnaire	30 minutes		30 minutes
Interview	30 minutes		30 minutes

5.1.6 Data collection and data analysis

The data collection and data analysis were the same as in the previous two experiments: this is already clarified in section 4.1.6. The coding scheme of this experiment is a combination of the coding schemes used during the previous two experiments, with the exception that the preparatory phases were not coded (see Appendix L). Further, the categories 'Progressive Deepening' and 'Mental Simulation' were left out, because the participants of the previous two experiments hardly ever applied these strategies. The final difference with the other two experiments is that within this experiment it was identified to what extent the participants have actually followed the respective guidelines. This might give insight into the aspects that are easy or hard to conduct, and thus into the understandability of the guidelines.

5.2 Results

The time available (1.5 hour per session) seemed sufficient to complete the tasks: only one participant had to be asked to speed up finishing the task ten minutes before the end of the session. On the pre-test, the participants needed an average time of 56 minutes (sd. 19 minutes) to complete the team task analysis and an average time of 59 minutes (sd. 14 minutes) to design a team training scenario. On the post-test, the participants needed an average time of 38 and 53 minutes respectively (sd. 16 and 18 minutes). For the task analysis, the participants needed less time on the post-test than on the pre-test: a Wilcoxon test showed that this difference is significant ($z=-2.2$, $p<.05$). Observations of the experimenters indicated that during the post-test most participants explicitly focussed on the elements of the guidelines practised during the workshop and tended to neglect the other steps described in the guidelines.

Due to a technical defect, the audio-tape of one participant's session (post-test) was blank. Therefore, all analyses were conducted using six participants for the measurement of the pre-test and five participants for the post-test. Every protocol has been divided into segments that were scored independently by two raters. These experts knew about the research aims and can therefore not be regarded as blind. Kendall's W (Coefficient of Concordance) was used as a measurement of the agreement between the two experts. This is a non-parametric measurement that can be used for ordinal data sets and computes the sum of ranks of each variable. In this study, Kendall's W is 0.86 for the team task analysis and 0.88 for the design of team training scenarios. This is interpreted as a good agreement (Landis & Koch, 1977). Table 5.2 shows the average scores (and standard deviations) given by the experts on every step of the analysis process for both the pre-test and the post-test.

Table 5.2

Average scores of the quality of the analysis process (SD between brackets)

Step in analysis process	**Pre-test (n = 6)**	**Post-test (n = 5)**	**Increase / decrease**
Conduct systems analysis	1.58 (0.74)	1.50 (1.12)	-0.08
Identify individual tasks	3.42 (0.66)	3.20 (1.15)	-0.22
Identify team tasks	2.58 (1.07)	2.20 (0.67)	-0.38
Make Team Operational Sequence Diagram	1.25 (0.61)	1.90 (1.08)	0.65
Conduct Hierarchical Task Analysis	1.33 (0.61)	1.30 (0.45)	-0.03
Analyse knowledge, skills and attitudes for individual tasks	3.33 (0.61)	1.70 (0.45)	-1.63*
Analyse knowledge, skills and attitudes for team tasks	1.92 (0.66)	1.20 (0.27)	-0.72
Formulate individual instructional objectives	2.50 (0.89)	2.50 (0.61)	0
Formulate team instructional objectives	1.75 (0.61)	1.60 (0.22)	-0.15
Evaluate (intermediate and final) results	2.08 (0.86)	2.30 (1.04)	0.22
Overall average score	*2.17 (1.01)*	*1.94 (0.92)***	*-0.23*

* significant (p<.05)

** significant (p=.06)

The average increase or decrease of scores (within subjects) on the post-test compared to the pre-test was evaluated using Wilcoxon tests. A comparison of the overall scores of the analysis process shows a decrease of performance for the team task analysis (z=-1.87, p=.06). The median values of the pre-test and the post-test are 2 and 1.5 respectively. This overall difference is depicted in Figure 5.2.

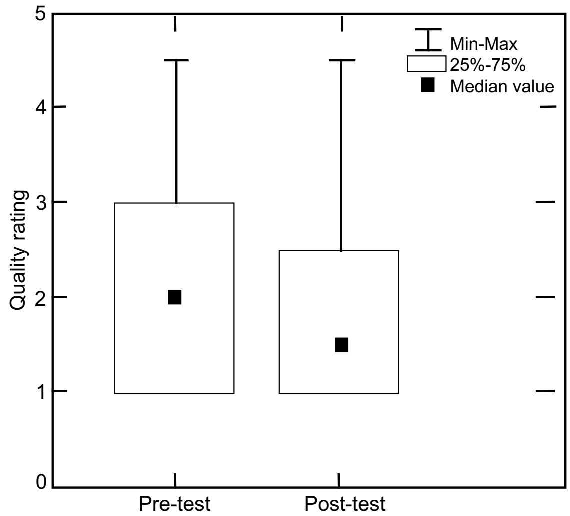

Figure 5.2. Quality differences of the analysis process between the pre-test and the post-test.

As can be seen in Table 5.2, only the steps 'Make Team Operational Sequence Diagram' and 'Evaluate results (intermediate and final)' show an increase in the performance of the participants. A Wilcoxon test shows that the increase in performance for the steps 'Make TOSD' ($z = -1.60$, $p=.11$) and 'Evaluate (intermediate and final) results' ($z = -1.63$, $p=.10$) was not significant, but a trend in the positive direction can be observed. The self-reports supported the positive trend for the step 'Make TOSD'. In the questionnaire filled out after the post-test, and during the additional interview, many participants indicated that they thought it was very useful to make a TOSD. Looking at the decrease in performance of the other steps of the analysis process, only a significant effect was found for the step 'Analyse knowledge, skills and attitudes for individual tasks' ($z = -2.04$, $p<.05$). No significant effects were found for the other steps of the analysis process.

Table 5.3 shows the average increase or decrease in scores (and standard deviations) given by the experts on every step of the design process for both the pre-test and the post-test.

Table 5.3

Average increase or decrease in scores of the quality of the design process (SD between brackets)

Steps in design process	**Pre-test (n = 6)**	**Post-test (n = 5)**	**Increase / decrease**
Review instructional objectives	2.58 (0.97)	3.10 (1.39)	0.52
Make outline of entire training trajectory	3.08 (0.49)	3.40 (0.65)	0.32
Specify context and conditions	1.83 (0.61)	1.80 (0.84)	-0.08
Determine key events and participants	2.50 (0.89)	2.70 (0.84)	0.20
Combine events into coherent scenario	3.17 (1.25)	1.90 (1.08)	-1.27
Determine ideal course for scenario	3.00 (1.58)	2.50 (1.17)	-0.50
Determine prototypical mistakes and errors	1.67 (0.41)	2.30 (1.20)	0.63
Determine training strategies	2.58 (0.74)	2.60 (0.55)	0.02
Specify measurement of performance	2.33 (1.03)	2.20 (1.15)	-0.13
Specify timing, modality and content of feedback	2.00 (0.95)	1.90 (0.89)	-0.10
Evaluate (final and intermediate) results	2.00 (1.00)	2.70 (1.35)	0.70
Overall average increase or decrease	*2.33 (1.03)*	*2.40 (1.05)*	*0.07*

The results for the design of team training scenarios show a slightly different pattern. As can be seen in Table 5.3, almost half of the steps of the participants' design process show an increase in performance. One step shows a strong indication of an improvement of the performance, however not significant, namely 'Evaluate (intermediate and final) results' ($z= -1.63$, $p=0.10$). An indication of decrease of performance was found for the step 'Combine events into coherent scenario' ($z = -1.63$, $p=0.10$). A Wilcoxon test shows that none of the other differences between the pre-test and the post-test were significant ($p>.29$).

The average increase or decrease of scores (within subjects) on the post-test compared to the pre-test was evaluated using Wilcoxon tests. A comparison of the overall scores of the design process shows a slight, however non-significant increase ($z= -0.79$, $p=.43$). For both the pre and the post-test the median value is 2.5. This overall difference is depicted in Figure 5.3.

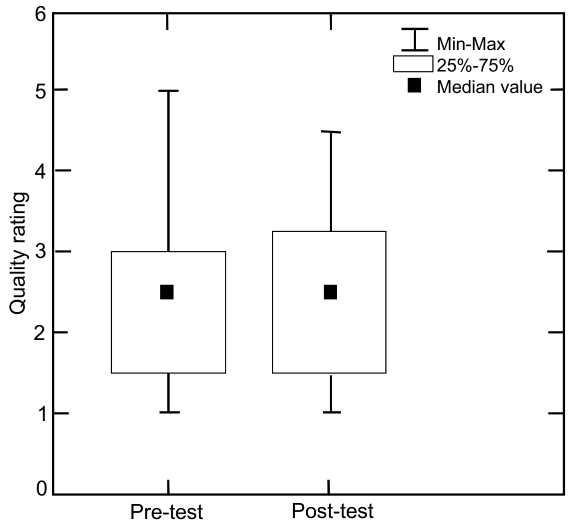

Figure 5.3. Quality differences of the design process between the pre-test and the post-test.

Figure 5.4 shows the relation between the time needed to complete the task and the mean performance of the participants, assessed by the experts. Previous research on instructional design shows that the performance on a task increases when participants spend more time on-task (e.g. Verstegen, Barnard & Pilot, 2003). In this study, Spearman's rho was computed as a measure of the correlation between the mean scores and the time they needed to complete the task. Only a small non-significant correlation (rho=.34, p=.139) was found, indicating that the decrease in performance on the post-test cannot be explained by the shorter time used on this test.

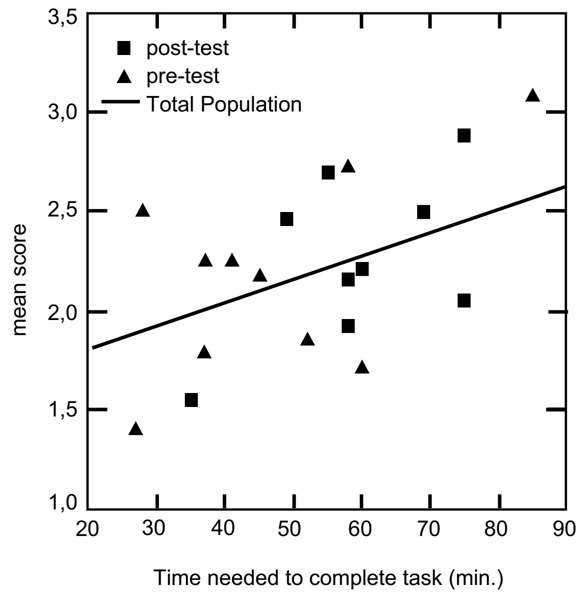

Figure 5.4. Relation between the time needed and the quality of the process.

The mean scores of the individual participants on the pre-test and the post-test are depicted in Table 5.4. For the team task analysis, all participants performed better on the pre-test than on the post-test. For the design of team training scenarios, three participants improved their performance on the post-test compared to the pre-test, while the performance of the other two decreased. A Wilcoxon test shows that the differences in performance between the post-test and the pre-test were not significant for any of the participants ($p>.32$).

Table 5.4

Mean scores of the individual participants on the pre-test and post-test

Participant	**Mean scores Task Analysis**		**Mean scores Scenario Design**	
	Pre-test	Post-test	Pre-test	Post-test
1	2.70	2.50	2.88	2.25
2	2.15	1.85	1.92	2.17
3	2.05	1.70	2.04	3.08
4	2.50	2.25	2.46	2.71
5	1.55	1.40	2.21	1.79
6	2.1	*Missing*	2.46	*Missing*

Two participants (numbers 3 and 5) had several years of experience in training teams (1 and 3 years). Observing Table 5.4 shows that this experience apparently did not influence their performance on any of the tests, compared to the other participants.

The post-test was conducted 5 to 18 days after the workshop. Figure 5.5 depicts the increase or decrease in the participants' performance as a function of the delay between the workshop and the post-test. It shows that the participants tended to perform worse on the post-test (scenario design) when the delay between the workshop and the post-test increased.

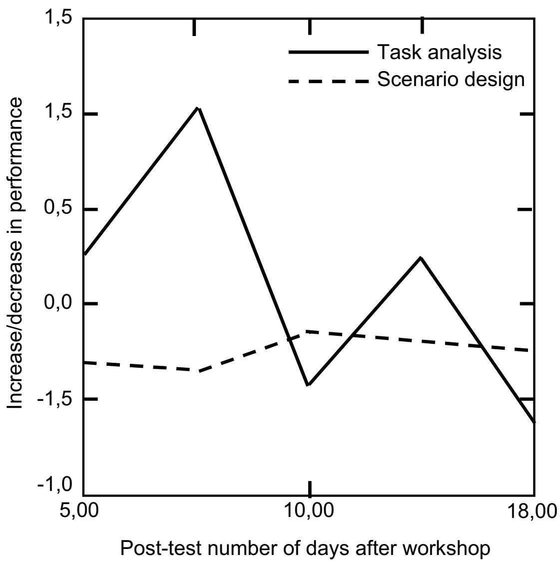

Figure 5.5. Performance as a function of the delay between the workshop and the post-test.

In order to get a better understanding of the perceived difficulties and given support, self-reports were gathered by means of the questionnaires and additional interviews. A summary of these results will be presented next; a more detailed overview of the results can be found elsewhere (Van Berlo & Baartman, 2004). The illustrations represent the majority of answers given. On the pre-test some participants showed the following difficulties during the analysis and design process: conducting a systems analysis, making a TOSD, formulating instructional objectives, and determining the ideal course of action of a scenario. Illustrations of answers given on the questions related to difficulties encountered during the task analysis are: "Conducting a systems analysis and making a TOSD were difficult", "In fact, I skipped the formulation of instructional objectives" and "Nothing, I guess everything was good". Illustrations of answers given on the questions related to difficulties encountered during the scenario design are: “It was difficult to specify the context of the scenario and the ideal course of action”, “The required level of detail of the scenario, because that depends on the skill of the instructor” and “Nothing, there were no difficulties”. More positive were some participants about determining the knowledge, skills and attitudes, formulating the instructional objectives, making an outline of the training scenario and determining training strategies. Illustrations of answers given on the questions related to what was perceived as easy parts of the task analysis are: “Everything”, “Formulating the instructional objectives was difficult” and “I spent too little time to this phase because I regarded the scenario design as more important”. Illustrations of answers given on the questions related to what was perceived as easy parts of the scenario design are: “The gradual increase of the difficulty was good”, “Everything” and “Steps 1, 4, 6, 7 and 8 of Figure 3 were conducted well”. Illustrations of comments made during the additional interviews are: “Many unfamiliar words”, “I rather use the Navy-guidelines because I am now making my final assignment of the ID course”, “The figures are nice overviews, but a summarising text would be welcome as well”, “It is not possible to make an ideal scenario because the trainees’ behaviour can not be predicted” and “I would like to use the guidelines, but my training school does not train teams”.

On the post-test some participants showed the following difficulties during the analysis and design process: formulating instructional objectives that are adequately detailed, determining training strategies and specifying feedback. Illustrations of answers given on the questions related to difficulties encountered during the task analysis are: “Capturing the time pressure in a task analysis is difficult”, “The instructional objectives needed to be more detailed than I use to do at my training school” and “The TANDEM task itself was difficult”. Illustrations of answers given on the questions related to difficulties encountered during the scenario design are: “Determining the training strategies and specifying the feedback are difficult”, “I do not want to specify the scenario in detail, because otherwise the instructor will be restricted” and “I am not used to implement system failures in order to evoke particular behaviour of the trainees”. More positive were some participants about conducting a system analysis and making a TOSD, formulating the instructional objectives, and defining the contents and structure of a scenario. Illustrations of answers given on the questions related to what was perceived as easy parts of the task analysis are: “My task analysis matches with the instructional objectives just handed out”, “Conducting a system analysis and making a TOSD went alright” and “I succeeded in formulating instructional objectives for the team”. Illustrations of answers given on the questions related to what was perceived as easy parts of the scenario design are: “The relation with the task analysis”, “Specifying the context and structure of the scenario went alright” and “Everything”.

Illustrations of comments made during the additional interviews are: “Making a TOSD works just fine”, “The guidelines are complementary to the Navy guidelines” and “The FFTT and TANDEM tasks offered too little opportunities for free communication, so guidelines referring to how to facilitate group processes remained indistinct”.

According to the participants, no information was really missing in the guidelines. Weak aspects of the guidelines were considered to be too much and too difficult text, unnecessary repetition of some items, and the lack of a clear structure making it difficult to find the desired information. Strong aspects were considered to be the useful and clear figures, the clarity of the guidelines, and making the TOSD. Several participants suggested as an improvement to summarise the different steps of the guidelines on one or two pages, together with a checklist in order to indicate which steps have been followed: the more extensive version of the guidelines may then be used as a reference book.

Further, the participants were asked to rate on a 5-point scale whether they would apply the guidelines at their own job (‘1’ indicating certainly not, and ‘5’ indicating absolutely yes). After the pre-test, the participants had an average score of 2.0 (with scores ranging between ‘1’ and 3), while after the post-test the average score was 2.8 (with scores ranging between ‘2’ and ‘4’); these results are summarised in Table 5.5. The reasons for hesitating to use the guidelines were (a) the availability of the mandatory Navy guidelines they were trained in during their Navy ID-course, and (b) no assignment to design team training programs, what was actually the reason for one participant not to give a rating after the post-test.

Table 5.5

Rating of the participants’ willingness to apply the analysis and design guidelines on their own job

	Willingness to apply the guidelines at the own job					Average
	1	2	3	4	5	
Pre-test	2	2	2			2.0
Post-test		2	2	1		2.8

At the end of the workshop, all participants were requested to fill out a questionnaire containing a number of questions about their experiences during the workshop (see Appendix K). This is an evaluation at the level of reactions (Kirkpatrick, 1994). According to Kirkpatrick (1994) every program should at least be evaluated at this level to provide for the improvement of a training program. In addition, the participants' reactions have important consequences for learning (level two evaluation). Although a positive reaction does not guarantee learning, a negative reaction almost certainly reduces its possibility. An overview of all answers and comments is presented in Appendix M; a summary of these results is presented in Table 5.6.

Table 5.6

Mean scores and standard deviations on questionnaire filled out after the workshop

Questions about the morning session of the workshop (team task analysis)	**Mean**	**SD**
The structure of the guidelines has become clearer to me	4.0	0.58
I better understand the meaning of the different steps described in the guidelines	4.5	0.50
A workshop is a good way to learn how to work with the guidelines	4.2	0.69
When I would have to design team training systems, I would like to use the guidelines	3.0	0.58
Questions about the afternoon session of the workshop (team training scenarios)	**Mean**	**SD**
The structure of the guidelines has become clearer to me	4.0	0.58
I better understand the meaning of the different steps described in the guidelines	4.5	0.50
A workshop is a good way to learn how to work with the guidelines	4.2	0.37
When I would have to design team training systems, I would like to use the guidelines	3.0	0.58

The average scores of the first three questions did not differ for the morning session and the afternoon session of the workshop. The participants indicated that they had a better understanding of the respective guidelines after the sessions. The participants were equally satisfied about both parts of the workshop, as is shown by the first two questions (M=4 and 4.5 for both sessions), and considered a workshop a good way to learn how to work with both sets of guidelines (M=4.2 for both sessions). However, according to all participants, a one-day workshop was too short to get familiarised to the guidelines, let alone to get sufficient hands-on experience.

In order to gain extra insight in the extent to which the participants have actually followed the respective guidelines, an additional data analysis was conducted within this experiment. The protocols of the pre-test have been studied and three assumptions were formulated regarding strategies frequently employed by the participants. The three assumptions and an indication of the possible results are discussed below.

In the process of team task analysis and scenario design, all transitions of steps are allowed, the process being iterative. The only sequence that is not allowed in the model is to skip a step when going through the process for the first time. For example 1-2-3-1-3 is allowed, but 1-3-1-2-3 is not allowed, because step number 2 was skipped when going through the

process for the first time. In order to get an idea whether the participants were working according to this model, the transitions that represent confirmations and deviations of the model were counted. No attention was paid to transitions outside the model, for example numbers 16 to 19 and N (see coding scheme in Appendix L). A number of sub-steps in the coding scheme was considered as one category in the counting process, because no a priori reason were found why one of the sub-steps should be executed before the other. In total, 219 allowed transitions and 37 not allowed transitions were counted, indicating that the participants were following the model to a reasonable extent.
During the pre-test, some participants had difficulties with conducting the systems analysis and the team task analysis (TOSD and HTA). During the concluding interviews, some participants indicated that they wanted to proceed immediately to the determination of knowledge, skills and attitudes and the formulation of learning objectives. Leaving irrelevant codes (numbers 16-19 and N) out of the counting process, numbers 2 (systems analysis) and 3.2, 3.3 and 3.4 (team task analysis) were counted 35 times on a total of 109 codes. This indicates that the participants did pay attention to the systems analysis and the team task analysis.
Like many novice instructional designers (Verstegen, Barnard & Pilot, 2003), the participants tended to spend only short time performing the team task analysis as a whole and tended to proceed to the design of the scenario immediately. Again the irrelevant codes were skipped. Comments referring to evaluation (number 15) were skipped because this might apply both to the team task analysis and the scenario design. In total, 49 out of 132 fragments within the task analysis process were coded as referring to the design of the scenario. This indicates that participants indeed already tended to divert their attention to the scenario design during the task analysis process, and seem to be more solution-oriented than problem-oriented. These results may give some insight into the working strategies employed during the think-aloud sessions, but can only serve as an indication. More and independent expert raters are needed to really test the assumptions.

Finally, a comparison has been made between the current experiment and the two previous experiments. In Table 5.7, the mean scores of the participants of the three experiments are depicted. Of the first two experiments, only the scores of the participants in the experimental group of the post-test are displayed, because these groups of participants used the experimental guidelines as well as the participants of the third experiment.

Table 5.7
Mean scores of the subjects participating in all three experiments

Exp. 1 Post-test Task analysis (n=5)	**Exp. 2 Post-test Scenario design (n=4)**	**Exp. 3 Pre-test Task analysis (N=6)**	**Exp. 3 Post-test Task analysis (N=6)**	**Exp. 3 Pre-test Scenario design (N=6)**	**Exp. 3 Post-test Scenario design (N=5)**
2.75	2.66	2.70	2.50	2.88	2.25
2.45	2.50	2.15	1.85	1.92	2.17
2.60	2.03	2.05	1.70	2.04	3.08
3.35	2.56	2.50	2.25	2.45	2.71
1.35		1.55	1.40	2.21	1.79
		2.10		2.46	
M = 2.5 (sd. = 0.65)	M = 2.44 (sd. = 0.24)	M = 2.18 (sd. = 0.36)	M = 1.94 (sd. = 0.39)	M = 2.33 (sd. = 0.32)	M = 2.4 (sd. = 0.45)

In order to test the effect of the interactive workshop as compared to only reading the guidelines, the following analysis were conducted. The results of the participants on the post-tests of the first and second experiment were compared with the results on the pre-test of the third experiment (see Figure 5.1). All participants in these samples used the experimental guidelines to guide their analysis and design process after reading these guidelines. The only difference between the groups is the fact that in the first two experiments, the participants performed the task for the second time (on the TANDEM-task), while in the third experiment it was the first time the participants had to perform such a task (on the FFTT-team). Mann-Whitney U-tests show that neither for the analysing team task ($p=.39$) nor for designing team training scenarios ($p=.27$) a significant difference was found between the first and second experiment on the one hand and the third experiment on the other. It can therefore be concluded that these groups are comparable. In order to test the additional effect of the workshop above just reading the guidelines, a comparison was made between the post-test of the third experiment (workshop) and the post-test of the previous two experiments (reading only). Again, no significant results were found for the team task analysis ($p=.18$) nor for the team training scenario design ($p=1.00$). For the team task analysis, the participants in the post-test of the first experiment ($M=2.5$) scored even better than the participants in the third experiment ($M=1.94$).

5.3 Conclusions

The aim of this experiment was to test the following two hypotheses:

H1: Attending the workshop will improve the quality of both the analysis and design process on the post-test as compared to the pre-test.

H2: The increase in the quality of both the analysis and design process will be higher after the workshop (this experiment) than after only reading the experimental guidelines (previous experiments).

The conclusions of the third experiment are described below.

H1: Attending the workshop will improve the quality of both the analysis and design process on the post-test as compared to the pre-test.

A comparison between pre-test and post-test of the overall scores of the analysis process and the design process shows a significant decrease of performance for the team task analysis and a non-significant increase for the design of team training scenarios. With respect to the task analysis, only two steps show a non-significant increase in the performance of the participants. Although not significant, a trend in the positive direction can be observed, which is supported by the self-reports. A significant decrease in performance was found for one step. With respect to the scenario design, almost half of the steps show an increase in performance. Although not significant, a trend in the positive direction can be observed for two steps, as well as a trend towards a decrease of performance for another step. It is therefore concluded that the first hypothesis can be rejected: only some steps show a (trend towards) significant improvement and no overall improvement could be established.

H2: The increase in the quality of both the analysis and design process will be higher after the workshop (this experiment) than after only reading the experimental guidelines (previous experiments).

Comparing the results on the pre-test of this experiment with the results on the post-tests of the previous two experiments shows no differences between the participants. It can therefore be concluded that these groups are comparable. A comparison between the post-test of the third experiment (workshop) and the post-tests of the previous experiments (reading only) showed no significant results as well. Apparently, the workshop did not have any additional positive significant effects above just reading the guidelines, although the self-reports do reveal positive aspects. Nevertheless, based on these empirical results it is concluded that the second hypothesis can be rejected.

6. DISCUSSION

According to Lowyck and Elen (1993, p. 220), instructional design is “a discipline that links descriptive research outcomes with instructional practice by: (1) identifying design parameters, (2) instrumenting these parameters and (3) prescribing processes for instructional development in order to optimise learning and instruction.” The research described in this doctoral dissertation is in line with this definition since the guidelines that were developed are based on theories of instructional design and team performance, and are empirically tested leading to an understanding why the guidelines did (not) work in the given circumstances. Further, the research aimed at the empirical validation of prescriptions, rules and procedures to enable more intentional and precise decision-making in concrete design situations.

Instructional design is an iterative, complex and ill-structured process (Elen, 1995) encompassing several phases each comprising several steps. In every phase several actors can be identified, like for instance instructional designers, instructors, subject-matter experts, students, managers and evaluators. In order to keep control over this complex field, the focus of this research is on only one of the identified actors, namely the instructional designers. Further, guidelines were chosen as the specific kind of support during the process of ID for team training. These restrictions have of course implications for the generalisability of the results, though this research can generate new insights and hypotheses for ID research. At the beginning of the research, the focus was on defining the contents of the guidelines: which steps and substeps, in which order and to what level of detail. In line with this focus, two design experiments were carried out to validate the guidelines. The purpose of the first experiment was to determine the effect of the guidelines supporting the analysis of team tasks and the purpose of the second experiment to determine the effect of the guidelines supporting the design of team training scenarios. Later on during the research, the focus shifted from the content of the guidelines towards supporting the instructional designers how to use the guidelines. In line with this focus, a third design experiment was conducted, testing the effect of an interactive workshop providing for a more elaborate introduction of the two sets of guidelines. The empirical validation of the guidelines is an essential step. Empirical research is needed in order to formulate theoretically sound and validated design specifications. Because of the practical nature of ID, this research needs ecological validity. This ecological validity was achieved, as much as possible, in a naturalistic environment and by conducting design experiments. This research concentrated on how instructional designers can be supported in analysing team tasks and designing team training scenarios, on validating the quality of this support and on how these results contribute to developing an Instructional Design model for training teams. These three issues will be discussed in more detail next.

6.1 Support for instructional designers

An adequate analysis of a design problem is of paramount importance, but various solutions are possible and can be equally adequate. This means that support for the instructional designer is supposed to be not only procedural of nature, but strategic as well; meaningful considerations and illustrative examples need to support the designer in choosing the most adequate solution. Support can be provided in various different formats. In this research, the support is provided in the form of guidelines. Several reasons underlie this choice. This research is conducted as part of a project for the military. Therefore, the supporting tools need to be suited for military instructional designers. In general, military personnel are used to work with procedures, guidelines and specific work instructions. That includes the military instructional designers. Moreover, as indicated in the introduction, ID for team training is a relatively immature area of expertise. With respect to ID for team training, the military instructional designers can be regarded as novices. An additional complicating factor within the military organisations of the Netherlands is that military personnel, including ID practitioners, has to switch jobs after three years. As a result, there is hardly any opportunity to construct a solid ID knowledge base and to grow from novice towards professional: a process that takes many years (Chi, Glaser & Farr, 1988). In order to be useful within this context, ID support needs to be as concrete as possible. Indeed, the intention of guidelines is to closely and concretely corresponding to the way people work. In this way we tried to deal with the tension between new and more constructivist paradigms of learning, the characteristics of ID, the need for systematically designing instruction and the best way to support ID practitioners, also taking into account the characteristics of the military organisation they are employed at. The guidelines that have been developed have an analytical structure, comprising various steps and substeps. This has the risk in it of causing cognitive overload to the instructional designers. On the other hand, the guidelines need to support the novice instructional designer in a stepwise manner, at the same time capturing the dynamic nature of ID. This has led to several steps having overlap with, and shading off into, other steps and cross-references between steps. Further, opportunities to explicitly evaluate the (intermediate) results of the analysis and design process are frequently offered. As a result, the nature of the guidelines can be characterised as in between linear and iterative. It can be argued, however, if this kind of support was the most adequate. The guidelines were formulated to reflect the strategies of expert instructional designers, in order to support the novices as much as possible. The results showed that this worked out only partly. For instance, the participants hardly ever applied the strategies of progressive deepening and mental simulation. It seems doubtful whether guidelines can support novice instructional designers to apply these strategies, since acquiring these skills requires several years of experience (Schraagen, 1994). This is in line with Perez et al. (1995) contending that although novices may have enough knowledge about instructional design principles and models because they had finished several courses on the topic, they still lack the strategic knowledge that is necessary to translate theory into practice. A complicating factor within the military organisations of the Netherlands is that military personnel, including ID practitioners, has to switch jobs after three years. As a result, there is hardly any opportunity to construct a solid ID knowledge base and to grow from novice towards professional. Only recently the discussion has started to offer personnel the opportunity to develop a career within the domain of ID.

Guidelines are a form of support appreciated by the participants although they made some critical remarks. The volume of the guidelines was perceived as too large. The various figures were regarded as useful because of these summarised the contents of the guidelines, but most participants nevertheless indicated the need for a separate checklist, so that the full version of the guidelines could be consulted if more detail was required. The interactive workshop showed that the participants appreciated the more hands-on practice, based on several cases. Although no significant results were obtained, the data showed a positive trend on the topics explicitly encountered during this workshop. This may lead to the conclusion that a more layered approach will be more effective in supporting the instructional designer for team training. Possibly, an instructional designer is best supported by first attending a practical and interactive workshop, followed by applying a checklist as a job-aid, using a more detailed and elaborate description of the guidelines as a (paper-based or electronic and hyperlinked) reference document, and by consulting an expert colleague. Because of the ill-structured nature of the ID process, the support needs to be case-based, with various practical and worked examples illustrating the steps to be taken and decisions to be made. Adding process-oriented information (illustrating why and how experts use information) can further enhance transfer performance for complex cognitive skills with multiple possible solution paths (Van Gog, Paas & Van Merriënboer, 2004), as is the case for ID. This is in line with Wilson and Cole (1992, p. 76) stating that "(a) the procedural prescriptions often go far beyond our knowledge base about learning and instructional processes and are often at odds with that knowledge; and (b) instructional designers tend to follow models in a principled-based, heuristic manner in spite of detailed procedural specifications". Further research can be aimed at specifying these layers and their interrelationships and testing the effectiveness of this support.

One of the reasons to use guidelines as support for the instructional designers, was that the intention of guidelines is to closely and concretely correspond to the way people work. It can be argued if the way people work needs to be changed. However, this was not the purpose of this research. Nevertheless, the results of the empirical validations may offer more insight into the way the military ID practitioners work, if this is the most optimal way, and if the support that is offered is the most adequate. Firstly, within the military organisations of the Netherlands, courses in Instructional Design are almost exclusively focused on training individuals. It seems that with respect to conducting a task analysis, determining the prerequisite knowledge, skills and attitudes, and formulating instructional objectives, the underlying assumption is that combining all information with respect to the individual team members will lead to well-defined team training programs and systems. The results of this study indicate that broadening the individual focus of the instructional design courses with an explicit team dimension may be beneficial. In the first and second experiment the manipulation was fairly minimal and the time available to get acquainted with the guidelines was restricted to only one hour. Nevertheless, the results showed a positive effect of the team task analysis guidelines. A more general improvement with respect to current instructional design courses may be the inclusion of project management aspects, in this research operationalised as developing an analysis/design and evaluation plan).
Secondly, in their (military) organisations, instructional designers go through several phases in the instructional design process. During the first and second design experiments, the participants followed only one phase (task analysis and scenario design). One of the observations of the second experiment was that the participants seemed to find it hard to design training scenarios based on instructional objectives they did not formulate themselves. At the beginning of the experimental session, they first reformulated these objectives in a format they felt comfortable with. During this process, the participants asked questions related to the domain (FFTT or TANDEM). The experimenter, however, provided no additional domain knowledge. It seemed that the participants were conducting a kind of task analysis in order to get a grip on the domain (additional to the documentation), enabling them to reformulate the instructional objectives and proceed with the instructional design. This finding would support the current practice in the military organisations to appoint a complete instructional design assignment (including analysis, design and development) to the same instructional designer(s).

One of the problems the participants were facing, was the lack of domain knowledge. Although the participants were provided with all relevant information both on paper and by the experimenter when asked for, there still remained a lack of specific domain knowledge. In real-life, the ID practitioner would form a design-team, or consult several subject-matter experts or other agents (e.g. books, reports or documents). Nevertheless it raises the problem of content-free design: to what extent is it possible to design instruction without sufficient domain knowledge, although the designer might be an expert instructional designer? According to Dijkstra (2001, p. 284) "the design phase is an especially difficult and challenging phase. The instructional designer will typically first imagine a design space for the solution. This includes the content subject matter, how that content will be structured into situations, objects, examples and problems, and what is known about how to learn such content. The designer will also typically imagine an outline (…) and the strategy to be used". This may imply that content-free instructional design is not possible. This is line with the precondition for developing training scenarios, stated by Beard, Salas and Prince (1995), that the instructional designer has domain specific knowledge. On the other hand, much effort is put into the definition of templates. A template is a kind of standardised instructional component (Merrill, 2001) with predefined pedagogical and instructional features. Templates partly solve the context problem because the context-sensitive information need not be in the template but only in the instantiation of this template: they offer the developer the opportunity to specify the context-sensitive information (Van Merriënboer & Boot, 2005). But nevertheless, this context specific information still appears to be relevant.

In this section we will next look more into detail to what the results imply for the content of the support: the guidelines and the workshop. The results of the first experiment showed significant effects of the experimental guidelines supporting the analysis of team tasks. The second experiment, however, showed only positive but non-significant trends of the experimental guidelines supporting the design of team training scenarios. Three possible explanations for this effect, which may be interrelated, can account for this. A first explanation is that designing scenarios is a much more creative process than conducting a task analysis. A task analysis can be better structured and supported providing step-by-step instructions. Designing scenarios is a more iterative and ill-structured process with many factors to be taken into account, like the characteristics of the trainees, the learning environment, the use of technologies and the instructional strategies. Moreover, there is not just one single optimal solution for a design problem. Therefore, the problem space is relatively large, and the final outcomes of a design phase can vary considerably, depending on specific conditions and the designer's considerations. A second is that, contrary to the control guidelines, the experimental guidelines supporting the analysis of team tasks contained steps that were new compared with not only the control version of the guidelines, but also with the military ID-guidelines the participants were trained in. These steps described conducting a system analysis, analysing the tasks conducted by the team and determining the prerequisite knowledge, skills and attitudes required by at least two team members. More specifically, making a mission diagram and a Team Operational Sequence Diagram were explained and described. The guidelines supporting the design of team training scenarios may not be perceived as new to such an extent as the guidelines supporting the analysis of team tasks. This relates to a third explanation for achieving significant results in the first experiment, but not in the second, namely the degree of the manipulation. The experimental guidelines supporting the analysis of team tasks explicitly contained other steps than the control version of the guidelines. The experimental guidelines supporting the design of team training scenarios, however, resembled the control version of the guidelines to a high degree, maybe causing the non-significant effects.

An interactive workshop was developed to provide for more hands-on experience with the guidelines and more detailed instructions on difficult parts of both sets of the experimental guidelines. On these sets of guidelines, only some steps showed a (trend towards) significant improvement and no overall improvement could be established. A comparison between the post-tests of the third experiment and of the first two experiments showed no significant overall results as well, implying that the workshop did not have any additional positive effect compared with just reading the guidelines. However, the participants made several positive statements about content and structure of the workshop. Besides, the participants' performance improved on the steps specifically targeted on during the workshop. Three possible explanations for this effect will be discussed next: (a) the workshop itself, (b) the relation with the Navy ID-course, and (c) the experimental design.
(a) The questionnaire filled out after the workshop showed a positive evaluation by all participants at the reaction level (Kirkpatrick, 1994). Although a positive reaction does not guarantee learning, a negative reaction almost certainly reduces the possibility for learning (level two evaluation). The only negative point mentioned was the fact that only one day was too short to learn how to work with the guidelines. Another effect caused by this lack of time was that the workshop-leaders did not intend to explicitly address all steps of the guidelines. The explanation and practice of the team task analysis guidelines were primarily focussed on only two steps that showed most difficulties during a previous experiment: (a) conducting a systems analysis and (b) making a Team Operational Sequence Diagram (TOSD). These steps were extensively described and the participants could practise these using a familiar team. The results revealed an improvement on making a TOSD, while

almost all other steps of the guidelines showed a (slight) decrease in performance. This indicates that the workshop did have a positive effect, but only on a step that was extensively discussed and practised.

(b) Just as in the first and second experiment, the participants in the workshop were novices in the field of instructional design. They were in the final stage of a training program on instructional design within the Royal Netherlands Navy, in which they learned to work with specific Navy instructional design guidelines. These Navy guidelines are aimed at developing training programs for individual operators (resembling the control guidelines used in this research), as opposed to the experimental guidelines, which primarily focus on training teams. Although the Navy and experimental guidelines differed in focus, they overlapped to some degree. In the period after the workshop, the participants extensively used the Navy-guidelines while working on a final assignment to prove their mastery of these guidelines. As a result, a recency effect may have occurred, causing this new learning to have at least partly overruled the knowledge about the experimental guidelines (Green, Prepscius & Levy, 2000). This effect can also be observed in the participants' improvement in applying some steps of the experimental guidelines, while they did not improve on other steps. The participants' performance on the team task analysis showed an increase on a step not described ('making a TOSD') or not stressed ('conduct evaluations') in the Navy-guidelines. This effect might indicate that the participants remembered only those parts of the experimental guidelines and the workshop showing the least overlap with the Navy-guidelines.

(c) The final aspect explaining the lack of overall positive effects of the workshop is the fact that the participants were not asked to re-read the guidelines at the start of the post-test. All participants have read the guidelines at the start of the pre-test, immediately followed by conducting the team task analysis and designing the training scenario. The post-test was conducted 5 to 18 days after the workshop, and the participants were working with the Navy-guidelines in the mean time. It appeared that the participants tended to perform worse on the post-test (scenario design) when the delay between the workshop and the post-test increased. This might be caused by the fact that the participants tended to forget the information about the guidelines when the delay increased, and, consequently, because of the higher interference with the own Navy-guidelines.

In this section we will finally take a closer look at the participants' view on the effectiveness and usability of the supporting guidelines. This study obtained several non-significant results. These seem to be only partly attributable to the research design and methodology. The self-reports, however, suggested that the participants' conceptions of the instructional interventions (guidelines and workshop) determine how and to what extend these interventions are used. The learners' conceptions about the relationship between instructional interventions and learning, is referred to as instructional knowledge (Luyten, Lowyck & Tuerlinckx, 2001; Elen & Lowyck, 1998). Students' perception of the instructional environment is assumed to be the starting point for further learning processes, activities and results (Boekaerts & Simons, 1993). Understanding students' perceptions of the instructional environment and how this process can be influenced is relevant for optimising instruction through ID (Lowyck & Elen, 1994, referred to by Luyten, Lowyck & Tuerlinckx, 2001). "Indeed, discrepancies between interpretations by designers or teachers, on the one hand, and by learners, on the other hand, commonly lead to a mismatch and sub-optimal use, (…). Interventions are often neglected, or used in a way that deviates form that which is intended" (Elen & Lowyck, 2000, p. 422). Throughout all ID phases, a variety of values, beliefs and preferences play an important role (Utsi, Canters & Lowyck, 2001). This is also true for the design, development and implementation of support provided to ID practitioners. In line with Elen and Lowyck (2000), further research can be aimed at analysing how (military) ID practitioners think about supporting ID, how this knowledge influences their information-processing during ID and how this affects the use of support given.

6.2 Methodology of validating the support

This research not only focussed on how instructional designers can be supported, but also on validating the quality of this support. In this section we will discuss the methodology that was followed in this research. Many of the data were gathered by audio taping the participants while they were thinking aloud. Although thinking aloud can have some side effects on the participants’ performance (e.g. reducing the speed of task performance), this method yields valuable data to gain a deeper understanding of the processes the participants are involved in. Stimulating the participants to verbalise reasons behind their behaviour (strategic knowledge) might influence their task performance positively as they will be more reflective in their actions. But it was assumed that this knowledge would normally be available to instructional design practitioners as well. It can be questioned if this assumption is correct. The participants of the design experiments were novices in ID, and not real practitioners. Thinking aloud may have induced a cognitive load, negatively impacting the quality of the ID processes the participants were engaged in. In order to verify this assumption, we should have measured the cognitive load (Paas, Renkl & Sweller, 2004), but we have not done this. Nevertheless, thinking aloud seemed the only available method in order to get a deeper understanding of what and why the participants were doing during their experimental ID tasks. The implication may be that for further research, participants need to have some practical ID experience in order to be able to think-aloud without negatively influencing the quality of the task performance.

The design experiments were conducted in a naturalistic environment while at the same time achieving for experimental control. This had implications for the position of the participants and the experimenter in the design experiment. During all design experiments the participants could ask questions to subject matter experts, conduct interviews, and ask for clarification of the guidelines: in all these cases the experimenter played these various roles. Some participants found this rather unusual, certainly at the beginning. For the experimenter it was difficult to keep control over all the answers provided to the participants. On the one hand not too much information could be presented in order to prevent taking over the thinking of the participants, and on the other, providing too little information had the risk of participants getting stuck into the analysis or design process. Future research may be aimed at testing the applicability of the guidelines in design situations that completely resemble the participants' natural work environment. During the design experiments, the participants used the guidelines individually. In real-life, this will not always be the case. For relatively easy training programs, the instructional designer will individually conduct the task analysis, formulate the learning objectives and develop the training program; he will then hand over the program to the instructor. For team training programs, the instructional design will hardly ever be an individual, but rather a team effort. Within this research the experimenter played several roles to simulate the working in an instructional design team, in order to gain experimental control. Further research may be aimed at how to actually support this instructional design teamwork (Zagers, 2001), and how this impacts the quality of the design processes of every team member.

The support developed and validated in this research is based on literature and field studies, as well as on our own experiences with ID problems. Future research may follow a more bottom-up and cognitive approach. It may be aimed at design teams, rather than individuals, consisting of ID practitioners with several years of experience in designing team training and who are able to critically reflect on both support provided and the ID processes they are involved in. Analysing the ID process of such a design team, also specifically taking into account the values, beliefs and preferences these ID practitioners hold, may lead to valuable recommendations for supporting ID for team training. Offering training, or other kinds of support, based on a cognitive task analysis is regarded as an effective and efficient way of preparing personnel to conduct their jobs (Clark & Estes, 1996; Reynolds & Brannick, 2002; Schaafstal, Schraagen & Van Berlo, 2000) and this may be applied to instructional designers as well.

A final remark concerning the methodology used to validate the developed support is that during the first and second design experiment, the participants received the guidelines at the start of the post-tests and not some days before. Several participants asked why this was not possible so they could better prepare for the design experiments. With respect to the required experimental control, however, this could not be realised. Participants were sometimes employed at the same military organisation and the same training school. Sending guidelines to the participants of both experimental conditions had the risk of participants communicating the intended experimental different versions of the guidelines with each other. In addition, a more extensive introduction might have resulted in experimental sessions that were too long and strenuous for the participants. That seemed not desirable, because most participants found the post-tests already mentally fatiguing. On the other hand, actually applying the guidelines on a laboratory team task after just one hour of reading appeared to be difficult and strenuous for the participants as well.

6.3 An Instructional Design model for training teams

The final issue this research concentrated on was how the results of the three design experiments contribute to developing an Instructional Design model for training teams. As described in section 1.2, ID models consist of several components (Elen, 1995): design parameters (variables of the learners and of the instructional environment), design procedures, design/development processes, the descriptive knowledge base and the referent system. Applied to this research (see section 3.3), the learners are adult military personnel that have to perform in operational teams; they have a more or less technological background, and generally prefer practice-oriented rather than theoretical instruction. The instructional environment can vary from a classroom in which a role-play is conducted to a high-fidelity training simulator or to a real-life environment in which a field exercise is carried out. The design procedures are the prescriptive guidelines as described in sections 3.3.1 and 3.3.2 (and Appendices C and D, respectively). The design/development processes are the specific steps to be taken while designing/developing specific instances of instruction; although practical considerations and decisions are called upon, this parameter has not been specifically elaborated in detail because the intention was to develop general applicable supporting guidelines. The descriptive knowledge base, i.e. the theoretical background of the model, is based upon a mild constructivist view on learning (chapter 1) and on the learning and performance of teams (chapter 2). With respect to the referent system, the model can be applied to military teams that have to learn to perform all aspects of the team task performance (both task- and teamwork). These components need to be elaborated more profoundly. The design/development process can be improved by enhancing the quality of layered support, including many worked examples illustrating decision-making in specific contexts and situations. Relating this to the 4C/ID model (Van Merriënboer, 1997), this means that the third level of the model needs to be improved. As already described in section 1.2, the 4C/ID model consists of four layers. In the first layer, the complex cognitive skills are decomposed into a hierarchy of recurrent and nonrecurrent constituent skills. In the second layer, the constituent skills, their relationships and the underlying knowledge structure are analysed. In the third layer, the instructional methods are selected and specified. In the fourth layer, a detailed blueprint for the learning environment is designed, and the learning environment is developed. Especially the selection and specification of instructional methods can be improved: sequencing learning tasks from simple to complex, developing and offering both supportive and procedural information and determining the characteristics of part-task practice. This may also affects the way of decomposing the team skills into their constituent skills.

Another component of an Instructional Design model for training teams that needs to be further developed, is the descriptive knowledge base. Theories about team learning, instructional strategies and how this relates to the actual performance of teams are not entirely clear yet and have hardly been tested empirically (Salas, Bowers & Cannon-Bowers, 1995; Salas & Cannon-Bowers, 1997). The content of the descriptive knowledge base is influenced by four interrelated categories of research (Elen, 1995): learning research (how people learn), instructional research (effectiveness of instructional methods, procedures, interventions or tactics), instrumental research (constructing and validating instruments) and descriptive research (on how practitioners design and develop instruction). This resembles more or less the three Worlds of ID as described by Van Merriënboer and Kirschner (2001, p. 432). "The World of Knowledge stresses the analysis of tasks and content in learning goals and prescribes optimal instructional methods for particular learning goals. The World of Learning stresses the characteristics of particular learning processes and yields guidelines for the synthesis of learning support systems, in particular, learning systems. Finally, the World of Work takes a holistic viewpoint and stresses real-life, professional task performance and instructional strategies that may help to deal with the complexity of whole-task performance." Bridges are needed over the troubled waters between these three worlds (Van Merriënboer & Kirschner, 2001). Optimising the design/development processes, specifically targeted to technology-supported learning environments to train military teams, may lead to clearly defined Instructional Design Anchor Points (IDAPs): educational tools or approaches that can be studied to generate design guidelines (Elen, 2004) and these may be the bridges that are wanted for. The effectivity of various training strategies and methods of performance measurement and feedback that are prescribed need to be investigated in several different cases and the transfer of training needs to be determined. These research findings and practical experiences will give more insight into the form, content and applicability of an ID model for the training of teams. In that case, the research would be both replicative and synthetical. “It is replicative because the generalisability of particular theories and outcomes over specific situations is investigated. It is synthetical because specific theories and disciplines offer detailed explanations of limited aspects of the learning and instructional process, while instructional design takes into consideration all aspects of the learning and instructional process” (Lowyck & Elen, 1993, p. 221). This research may can contribute to building a grand Theory of Instructional Design (Duchastel, 1998). Including an ID model for training teams, comprising validated team training and team learning components, within such a Theory of ID would be a challenging research effort.

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APPENDICES

APPENDIX A: INTERVIEW QUESTIONS OF THE FIELD STUDY

Introduction

1. To what extent does designing instruction for individual operators differ from designing instruction for teams?
2. Is there a need for a methodology specifically aimed at developing team training?
3. The literature is not very specific on this topic.
4. The purpose of this field study is to gain insight into the way team training is being designed within the military. That is why I have chosen your organisation.
5. It could be that some questions are being asked that seem rather strange for you, and that can not be answered. That is alright. I am just interested in your organisation's specific way of handling team training.

Background information

6. Could you tell something about your own professional background?
7. How many training developers and instructors/trainers are working in this organisation?
8. How many teams (trainees) a year are being trained?
9. What kinds of training are being developed/executed?

Organisation and premises

10. How is the organisation of developing team training organised (one person, development team, other persons)? How is the co-ordination between these persons organised?
11. Is a team training program being executed by only one instructor/trainer, or more? If the latter case is true, how is the co-ordination between the instructors being organised?
12. What (general) principles for instructional systems development are being applied?
13. Is the development process being supported by some methodology handbook, prescriptions, and/or software tools?

Analysis

14. How is the training need established?
15. How are team tasks being analysed?
16. How are instructional objectives being derived?

Design and execution

17. How is the structure of the training program (learning trajectory) established? This relates to the structure of the team training on the one hand, and the relationship between team training, individualised training and the operational practice on the other hand.
18. How are training scenarios being developed?
19. Are there certain team characteristics which influence how to instruct a team (e.g. the way of communication, kind of leadership, mutual personal relations)? If so, which are these, how are these identified, and how does this adapt the instruction?
20. To what extend is instruction being differentiated towards the individual team members, and how is this accomplished?
21. How is checked for the involvement of all team members during the execution of the training program?
22. How do you monitor the learning process of the team and the individual team members?
23. How do you decide when to intervene in the training process?

Performance measurement and feedback

24. Is the performance of the team assessed during the training? If so, at what moments?
25. How is the team performance being measured? To what extend is there a distinction between the process and product of the team performance?
26. Is the individual team member's performance being measured? To what extend is there a distinction between the process and product of the individual team member's performance?
27. Is feedback being provided towards the team as a whole, towards the individual team members, or both to the team and its individual members?
28. How is the feedback being provided?
29. Is a debrief at the end of a team training being organised? If so, how is this done?

Instructional activities and training devices

30. Which instructional activities are being employed during the team training?
31. Which training devices are being applied during the team training?
32. How are the requirements for (technologically advanced) training devices being specified? Who's responsibility is this?

Evaluation and maintenance

33. Is the effectiveness of the training program established? If so, how is this being done?

34. Is there a feedback loop from the operational practice back to the training program? If so, how does this work?
35. Are sufficient resources available in order to maintain training programs, scenarios and training devices?
36. In what way are changing instructional needs being encountered?

Concluding remarks

37. Are there specific aspects (bottlenecks, positive points) regarding the development of team training systems that have not been discussed yet?
38. Do you have any remarks and/or questions with respect to this interview?

APPENDIX B: PARTICIPATING ORGANISATIONS IN FIELD STUDY

Royal Netherlands Army:
- Staff 1 (GE/NL) Corps
- Staff 11 Air Mobile Brigade
- School battalion 11 Air Mobile Brigade
- 13 Mechanised Brigade

Royal Netherlands Military Police:
- Staff Royal Netherlands Military Police

Royal Netherlands Air Force:
- Directorate Personnel Royal Netherlands Air force
- Department of Military Leadership and Training
- Group Guided Weapons De Peel

Royal Netherlands Navy:
- Operational School
- School for Nuclear, Biological, Chemical and Damage control
- School for Management and Education

Civil Organisation:
- KLM Royal Dutch Airlines

APPENDIX C: GUIDELINES SUPPORTING THE ANALYSIS OF TEAM TASKS

Conducting a task analysis is an iterative process; in subsequent steps the required information is gathered and analysed into more detail, resulting in the specification of the instructional objectives that will guide the design of a training program. Supporting guidelines need to have a balance between completeness and detail on the one hand, and applicability and usability on the other. Because of the specific characteristics of team tasks (especially with regard to the communication and co-ordination demands) and the characteristics of team performance, results from research on individual-level tasks only partly generalise to the team level.

In this chapter the guidelines supporting the analysis of team tasks are presented. Analysing team tasks comprises three phases: (I) Prepare, (II) Conduct and evaluate, and (III) Present. Every phase consists of several steps.

<u>Phase I: Prepare</u>

1) Determine the goal of the analysis
2) Determine the scope of the analysis
3) Establish a project team
4) Make up an analysis and evaluation plan
5) Present the analysis and evaluation plan

<u>Phase II: Conduct and evaluate</u>

1) Orientate on the domain
2) Conduct a system analysis
3) Analyse the tasks conducted by a team
4) Determine the prerequisite knowledge, skills and attitudes
5) Formulate the instructional objectives
6) Evaluate the results

<u>Phase III: Present</u>

1) Make up a final analysis report
2) Present the final analysis report

During the entire process of conducting the team task analysis evaluations are performed on a regular basis. Although the primary sequence of the phases is ‘prepare’ → ‘conduct and evaluate' → 'present', based on the results of the evaluations the task analyst can decide to go through previously followed phases and/or steps. The phases and steps will be described next.

C.1 Phase I: Prepare

Phase I - Prepare a team task analysis, consists of six steps: (1) determine the goal of the analysis, (2) determine the scope of the analysis, (3) establish a project team, (4) make up an analysis and evaluation plan, (5) present the analysis and evaluation plan, and (6) evaluate the results. The steps one through four are followed in an iterative way: in first instance a linear sequence is followed, but the results can determine the analysts to return to a previous step, in order to check the results or to look for more detail information. Even a reconsideration of the original goal of the analysis is possible. After completion of the definitive analysis and evaluation plan, it is presented to the management of the organisation. These steps are depicted in Figure C.1, and are described into more detail next.

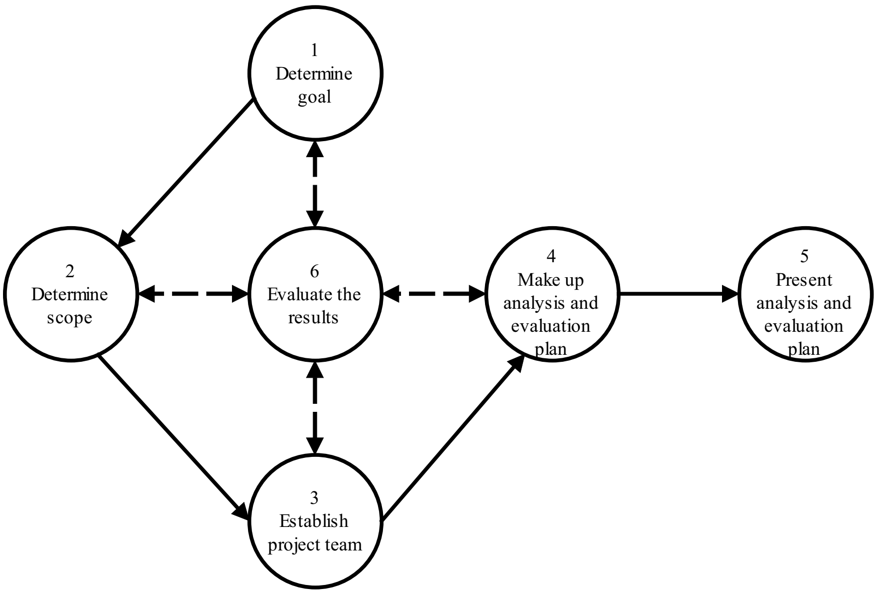

Figure C.1 Prepare a team task analysis.

1. <u>Determine the goal of the analysis</u>

1.1 As soon as management orders to conduct a team task analysis, the goal of the analysis needs to be determined. The goals of the analysis can be various: developing a new team training program, redesigning an existing team training program, formulating the specifications of a training simulator, or determining to what extent the team tasks can be performed by less personnel. The latter goal relates to the organisation of the work and not to training; these guidelines primarily support the analysis of team tasks within the context of instructional design. The goal of the analysis provides an initial view on the expertise required within the project team.

1.2 Determine to what extent the conditions under which the analysis should be conducted, are already given. Possible conditions are time, money, tools and personnel.

1.3 Determine to what extent the goal can be achieved within the current conditions. If it is already clear that this can not be achieved, this needs to be reported to the management immediately. Making up the analysis and evaluation plan (step 4) will give more insight into this aspect.

2 <u>Determine the scope of the analysis</u>

2.1 Determine the scope of the to be analysed domain: will the analysis focus on all tasks performed by all team members, on the tasks performed by some team members, or on the tasks performed by individual team members?

2.2 Describe the to-be-trained team. Indicate:

a) The number and names/roles of the team members forming the team (and thereby explicating the persons that are not a member of the team).

b) The physical location of the team members (all in the same room, all at the same location, or distributed). This is especially important with respect to the features of communication within the team.

2.3 Determine the super-ordinate system of which the team is a part. For instance: ‘cockpit crew’ is part of the system ‘squadron’, ‘tank’ is part of the system ‘tank platoon’, ‘Patriot crew’ is part of the system ‘fire platoon’.

2.4 Describe briefly which other systems and teams are related to the particular team.

3. Establish a project team

Establishing a project team is strongly related to the next step, making an analysis and evaluation plan. Given the goal and scope of the analysis an initial project team can already be formed. However, depending on the specific activities to be carried out during the analysis, it can be determined more specifically who will be part of the project team. The steps 3 and 4 of this first phase should be followed iteratively depending on the information that comes available.

3.1 Form, based on the goal and scope of the analysis, an initial project team. The following expertise needs to be included at least: project management, the particular military domain and (team) task analysis.

3.2 Make an analysis and evaluation plan to conduct the team task analysis (see step 4).

3.3 Determine, based on the analysis and evaluation plan, the expertise required to be included in the project team to successfully conduct the analysis. Several forms of expertise can be identified:

- Project management: the division of tasks and responsibilities within the project team, monitoring the process, co-ordinating the actions of the project team members.
- Military domain: sufficient knowledge of the domain is needed in order to assess the collected information.
- Analysis techniques: especially experience in interviewing is an important skill, as well as documenting the results.
- Instructional design: the task analysis is the first step in (re)designing a team training program.
- Weapon system: this is especially relevant when the training will prepare for operating a new weapon system with which relatively little operational experience has been gained.
- Instructional technology: this is especially relevant when technologically advanced training media are implemented, for instance computer-based training, simulators and virtual reality.

3.4 Find the right people to match the required expertise. Different kinds of expertise can be combined in one person. The teaming of the project team is of course dependent on the availability of the persons during the planned period of analysis.

3.5 Form the definitive project team.

4. Make up an analysis and evaluation plan

As already indicated, this step is followed iteratively with the previous step. The analysis and evaluation plan should be a blueprint based on which the analysis can be conducted and evaluated. Conducting and evaluating the team task analysis consists of the next steps: orientate on the domain, conduct a system analysis, analyse the tasks performed by the team, determine the prerequisite knowledge, skills and attitudes required for adequate task behaviour, formulate the instructional objectives, and evaluate the results. These steps will be elaborated on in Phase II. This section concentrates on making up the analysis and evaluation plan.

4.1 Determine which information resources need to be analysed, the methods of the information gathering and the way of documenting the data. In order to obtain results as reliable as possible, it is important to apply various methods of information gathering and to analyse various information resources.

4.1.1 Select the possible resources of information. The information resources can be documents, people, or real-life practice.

(a) Documents (both written and audio-visual):
- Reports of (field) exercises
- Policy documents / doctrine
- Descriptions of functions and tasks
- Technical manuals
- Combat prescriptions
- Training documents
- Movies and documentaries

(b) People:
- Subject-matter experts
- Members of an operational team (novices as well as experts)
- Instructors / trainers
- Policy makers

- Members of the super-ordinate system

Some people can of course have various roles, for example subject-matter experts and instructors.

(c) Practice (performing the task by the team)
  - Operational environment
  - Training environment (e.g. simulator)

Depending on the available expertise within the project team and/or the specific conditions (time, money, tools and personnel), the project team can supplement these information resources.

Depending on the specific phase of the team task analysis process, different information resources can be useful. A distinction can be made between orientation on the one hand, and the other steps of conducting the analysis on the other.

Orientation

During the orientation on the domain there is much more freedom in choosing resources and data gathering can be less strict. Because of the purpose, during the orientation on the domain the most adequate means of information gathering is a documentary study. Possibly an unstructured interview with one or two subject-matter experts can be conducted. In this case, however, it is required to explicitly indicate that the purpose of the interview is an orientation on the domain and that the analyst has no in-depth knowledge of the domain yet. An observation in the operational practice is only advised if ample time is available. The only purpose of an observation is to get some ‘feeling’ for the team and the team functioning. The disadvantage of an observation during the orientation is that it is not immediately obvious what to observe during the team task performance.

Other steps

During the actual conduct of the team task analysis and the evaluation of the results, much stricter methods need to be applied in order to verify and validate the information. It is of course allowed to consult the same resources during both the orientation and the other steps.

4.1.2 After the orientation on the domain, in most cases the subject-matter experts (SME's) will be the most important resources of information. In the process of selecting SME's it is important that people of various levels of expertise will be consulted in order to gain insight in all aspects of the team task performance.

4.1.2.1 Determine to what extent there are strategic variations of the task performance. Do this by studying relevant documents, attending exercises and conducting orienting interviews with team members and instructors.

4.1.2.2 In case of relatively few strategic variations of the task performance, one or two experts (and novices) for every position within the team will be sufficient as information resources. If the strategic variation is relatively large, at least three to four experts and novices for every position are required.

4.1.2.3 Select the SME team members (experts and novices) from various teams in order to control for different ways of task performance by different teams. Especially persons who have executed various roles within similar teams, or persons who executed the same role in several teams, can provide valuable information.

- Ask some highly experienced persons how many years it takes to become an expert in the particular field.
- Use this number as criterion and ask commanders for persons with at least that number of years experience, and who are, according to the commander, true experts.
- Select only those SME's who want to participate voluntarily.
- Select an equal number of persons with less years of experience to gain insight in the problems that novices encounter during the team task performance.

4.1.2.4 In case of new designed or just implemented (weapon) systems it is hard to select experts. Because especially instructors are highly committed to the current systems, in these cases it is advised not to select instructors as experts. Alternatives can be policy makers, future users and representatives of the industry.

4.1.3 Determine for every identified information resource the method of information gathering and documenting the data. Please note that it is not the intention of these guidelines to present an exhausting overview of all possible methods of information gathering and registration: depending on the available expertise within the project team and/or the specific situation, the project team members can supplement this overview. The following methods of information gathering can be distinguished:

(a) Document study
(b) Structured interview (with one or two interviewers). In case the interview is conducted by a dyad, there needs to be clarity concerning the roles (e.g. who has the lead, who makes the notes), the structure and goal of the interview, and the rules with respect to making comments and posing questions (e.g. interrupting each other). An interview can also be conducted based on ‘critical incidents’.
(c) Unstructured interview: this method can only be applied during the orientation on the domain.
(d) Questionnaire/checklist (for example: ‘what is easy/difficult’, ‘what is/is not a problem’).
(e) Observation, listening in on the team (e.g. in the operational environment or in a simulator). An additional possibility is presenting controlled stimuli, for instance: what happens if one team member drops out. An important issue here is the physical position of the analyst: within the team, on the sideline, or in a separate room (invisible for the team). The disadvantage of an observation is that it is time-consuming.
(f) Group-based brainstorm sessions
(g) Conducting (parts of) the tasks by the analyst (only if this does not take to much time).

If the information resources are team members (within the category ‘people’), then it is important that various team members of various teams will be consulted in order to obtain reliable information.

The relation between information resources, the methods of information gathering and documenting the data, is depicted in Table C.1.

Table C.1

Relation between information resources, methods of information gathering, and registration of information

<table>
<tr><th colspan="6">Information resource</th></tr>
<tr><td colspan="2">Documents</td><td colspan="2">People</td><td colspan="2">Practice</td></tr>
<tr><th>Method</th><th>Documentation</th><th>Method</th><th>Documentation</th><th>Method</th><th>Documentation</th></tr>
<tr><td rowspan="4">Document study</td><td rowspan="4">Summary
Description</td><td>Structured interview</td><td>Report</td><td>Observation, listening in</td><td>Report
Video-tape
Audio-tape
Protocol</td></tr>
<tr><td>Unstructured interview</td><td>Report</td><td>Participating observation</td><td>Report (of own experiences)</td></tr>
<tr><td>Questionnaire/ checklist</td><td>Report</td><td rowspan="2">Self performing</td><td rowspan="2">Report (of own experiences)
Video tape
Audio tape</td></tr>
<tr><td>Brainstorm sessions</td><td>Report</td></tr>
</table>

4.1.4 Determining the information resources and the methods of analysis and registration, requires the previously identified working conditions to be taken into account (see step 1.2). The following, and partly overlapping considerations play a role during this process:

(a) Experience: has the method already been applied successfully? Is the method reliable, i.e. does the method come up with identical results after repetitive applications?

(b) Availability: can the method be applied immediately, or should it be adapted to the specific situation? How much training is required in order to apply the method adequately?

(c) Generalisability: to what extent is the method appropriate for various kinds of team tasks?

(d) Acceptance: is the method suitable for both the analysts and the respondents and the management as well?

(e) Number of respondents: how many respondents and information resources are required to obtain reliable information?

(f) Time: how much time does it take to gather the information and to make up a final report of the results?

(g) Costs: what are the costs of the materials, the required training, the personnel involved?

The decision whether or not a method is suitable, is dependent on the specific situation. Especially 'time' and 'costs' will probably be decisive.

4.2 Make a division of tasks and activities between the members of the project team. This division of work can best be made based on the distinguished steps of phase II (see Table C.2).

Table C.2

Division of work between the members of the project team

Steps in conducting the analysis	Team member 1	Team member 2	Team member 3	Team member X
Orientate on domain				
Conduct system analysis				
Analyse team tasks				
Determine prerequisite knowledge, skills and attitudes				
Formulate instructional objectives				
Evaluate results				

4.3 Determine the way the (intermediate and final) results will be evaluated. This will (partly) depend on the available time and personnel. Possibilities are:

- Present intermediate results to the management on a regular basis
- Group discussions with the members of the project team
- Cross checking the information using other sources of information (excluding the superior of an interviewed person)
- Discussing the results with the interviewed and/or observed persons: this is polite, it ensures that the information is presented correctly, and it can generate new information.

During the orientation the group discussions and cross checking the information are especially recommended; during the other steps of Phase II all of the above-mentioned alternatives can be considered.

4.4 Evaluate the analysis and evaluation plan

4.4.1 Discuss the analysis and evaluation plan with all members of the project team. It is important to reach agreement within the project team.

4.4.2 Make up the final analysis and evaluation plan. This contains all information gathered in the previous steps, including the dates on which the (intermediate and final) results need to be delivered.

5. Present the analysis and evaluation plan

5.1 Present the analysis and evaluation plan to the management of the organisation / department, and have them committed to the plan.

C.2 Phase II: Conduct and evaluate

The input of Phase II – Conduct and evaluate, is the output of the first phase, namely the analysis and evaluation plan. Conducting and evaluating a team task analysis is an iterative, rather than a linear, process. During the conduct of the analysis the project team continuously needs to monitor which information has been collected, the quality of the information, if additional information is required, and if additional information resources need to be analysed. Based on these (intermediate) evaluations it is decided if the conduct of the team task analysis needs to be adjusted. Conducting and evaluating the analysis form therefore an integrated process comprising the following six steps: (1) orientate on the domain, (2) conduct a system analysis, (3) analyse the tasks that are performed by the team, (4) determine the prerequisite knowledge, skills and attitudes required for adequate task behaviour, (5) formulate the instructional objectives, and (6) evaluate the results. These steps are depicted in Figure C.2 and will be described in more detail next.

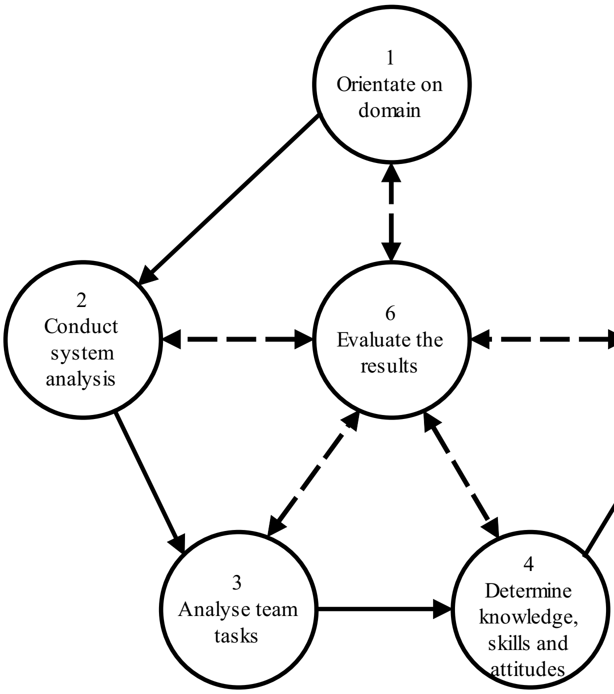

Figure C.2 Conduct and evaluate a team task analysis.

1. <u>Orientate on the domain</u>

1.1 The purpose of this first step is to get acquainted with the domain: what kind of team is analysed, what kind of tasks does the team perform, which ‘language’ is spoken, what does the task environment look like, what are characteristics of the task performance, et cetera. This step does not result in a detailed and complete picture of the team and the task, but is rather to be considered as a first familiarisation with the domain. It is also a kind of preparation in order to conduct interviews with subject-matter experts: it would be very annoying to them if they need to continuously explain elementary concepts to a naive interviewer. It is also a preparation in order to be able to observe the team performing the task. During this ‘phase of the surprise’ it is recommended to the instructional designer not to fill in the knowledge gaps, even when many aspects of the team functioning are not perfectly clear yet.

1.2 Given the purpose of this step, conducting a document study is one of the most appropriate methods of information gathering (see Phase I, step 4.1.3). Possibly an unstructured interview with one or two subject-matter experts can be conducted. In this case it is essential to explicitly indicate that the purpose of the interview is an orientation on the domain. Conducting an observation in the operational practice is only recommended if sufficient time is available. The only purpose of the observation is to get some kind of 'feeling' for the team and its functioning. The disadvantage of an observation during the orientation is that it is not immediately obvious where to look at during the team task performance.

2. <u>Conduct a systems analysis</u>

Conducting a systems analysis is an iterative process leading to more detailed information.

2.1 Determine which super-ordinate system the team is part of. The super-ordinate system is the higher level unit of which the to be analysed team is part of. This can be organisational or hierarchical but also functional. For instance: 'cockpit crew' is part of the system 'squadron', 'tank' is part of the system 'tank platoon', 'Patriot crew' is part of the system 'fire platoon' (see Phase I, step 2.3). Indicate which other relevant teams and subsystems, apart from the to-be-analysed team, make part of the super-ordinate system.

2.2 Determine the mission(s) of the super-ordinate system. A mission is an assignment the system as a whole needs to accomplish.

2.3 Determine the functions the system needs to fulfil in order to accomplish the mission(s). A function is a characteristic feature of the system (i.e. the combination of humans and technology) requisite for the mission accomplishment. For instance, the functions of a mobile weapon system, like a tank, are: mobility, co-ordination, sustainability, target acquisition and target elimination. The functions of a frigate are floating, mobility and combating. It is important to note that this definition of a function differs from the more common definition: a combination of tasks performed by an employee in a specific organisation. The tasks performed by an individual employee will as such not be covered by these guidelines; the analysis of tasks performed by a team of employees will be further described next.

2.4 Determine the relations between the team and the other subsystems within the super-ordinate system. These relations can involve orders, communication channels (mediated or face-to-face), information transfer between subsystems, transfer of materials, dependencies between the conduct of tasks, et cetera. Depict these relations graphically, for instance by indicating every category of relation with a unique colour (e.g. red for information, green for materials, blue for hierarchical relations), or by giving every relation a number and describing the relations in a table.

2.5 Describe the environment in which the team has to operate. It is important in this step to describe only the aspects that are relevant to the conduct of the team tasks. A distinction can be made between the physical environment, the tactical environment and the presence of stressors:

(a) Physical environment: e.g. terrain, climate, day/night, weather, room/location
(b) Tactical environment: e.g. type of enemy, combination with own troops
(c) Presence of stressors: e.g. time pressure, combat strain, and ambiguous information.

2.6 Determine which phases the mission is comprised of and for each phase which tasks and activities are conducted by the various subsystems (including the to-be-analysed team). It is important to check whether these tasks and activities cover all of the system's functions (see step 2.3). A useful method to present this information is a 'mission diagram' (see last page of this Appendix for an example). For every mission, a mission diagram presents the phases of execution, the sequence of the tasks being performed by the subsystems, and the conditions of the behaviour.

2.7 Check the results on completeness, correctness and consistency by discussing the results within the project team, cross checking the information resources, discussing the results with the interviewed and/or observed persons, et cetera.

3. <u>Analyse the tasks that are performed by the team</u>

In this step, the tasks performed by the team are analysed into more detail. Because many characterising features of the team performance are not directly observable (the team processes), a behavioural analysis is conducted complemented by a cognitive task analysis. The behavioural analysis is conducted by dividing the team tasks into subtasks by applying the Hierarchical Task Analysis (HTA) method. An

HTA is a description of the task at various levels: it provides insight into the way (sub)tasks are divided into (sub) subtasks and the sequence in which the (sub) tasks should or could be performed. An HTA produces a description of the context in which the task is conducted and the requirements posed on the performance, identifies the problematic and difficult task elements, and the subtasks that require complex cognitive skills. Next, the team tasks are analysed into more detail in order to gain insight in the cognitive aspects of the team behaviour: this can be done by using Team Operational Sequence Diagrams (TOSD's). A TOSD is a description of the team task at one level and gives a better time order of the tasks than an HTA does: a TOSD is therefore more suited for team tasks conducted in a rather fixed sequence. The format of a TOSD is already presented in Figure 3.1. Although first the HTA method is applied, followed by producing a TOSD, probably several iterations are needed to obtain all relevant information. Depending on the specific domain certain information can be obtained by either an HTA or by using a TOSD: the point is, however, that at the end all relevant information has been gathered.
The steps to analyse the tasks performed by the team will be described into more detail next.

3.1 Construct, for every mission of the team, an overview of the tasks that are performed by the team. See the mission diagram of step 2.6. Select from this diagram only the tasks that are conducted by the respective team, thereby excluding the tasks conducted by other teams, subsystems and/or operators within the same super-ordinate system.

3.2 Describe the relations between the members of the team. These relations can involve orders, communication channels (mediated or face-to-face), information exchange between team members, transfer of materials, dependencies between the conduct of tasks, et cetera. These relations can be depicted schematically, for instance by indicating every kind of relation with a unique colour (e.g. red for information, green for materials, blue for hierarchical relations), or by giving every relation a number and describing the relations in a table.

3.3 Conduct a behavioural team tasks analysis by applying the HTA-method.

(a) Take a prototypical mission as starting point. In this way the team tasks are placed in a specific context, and is the relevance of the events and actions clearly indicated. Deviating situations will be identified in the next step (step 3.4.b).

(b) Divide every team task into subtasks, until the level is reached on which the team members conduct strictly individual tasks and no adjustments and co-ordination with other team members is required. Present the results in a tree diagram.

(c) Let several project team members conduct the HTA independently and discuss the results on a regular basis.

(d) Check the results together with experienced task performers or instructors and iteratively improve the results based on these discussions.

(e) Select the (sub) tasks that are indicated as problematic/difficult to conduct by experienced and/or novice teams.

(f) Repeat this step for all prototypical missions.

3.4 Conduct a cognitive task analysis in order to gain insight in the cognitive aspects of the team behaviour. Especially the specific interactions between the team members should be made explicitly clear.

(a) Indicate, at least with respect to the problematic / difficult tasks (see step 3.3.e), which events trigger the behaviour of the team members, the way these situations are assessed and describe the most appropriate reaction(s) of the team on these events. Present the results by means of Team Operational Sequence Diagrams.

(b) Describe the special, non-routine events (emergency situations) that can happen during the team task performance, the way these situations are assessed and the most adequate reaction(s) of the team in this particular situation. Integrate this information within the TOSD's.

(c) Describe for every event (including the emergency situations) the requirements posed to the team performance (this needs to be in accordance with previously identified criteria of good team task performance).

(d) Identify the critical behaviours (including cognitive actions like making a decision, and the 'tricks of the trade' like a clever application of procedures) that are characterising for effective team task performance. For instance:

- In which sequence do team members have to take actions?
- Who is communicating with whom? What is the content of the communication? At what moments do team members communicate? What is the nature of the communication?
- To what extent do team members monitor each other's task performance, and give each other feedback (for this influences the workload)? What

knowledge concerning the fellow team members' task performance is required?

- Within what time frame do the tasks have to be conducted?

(e) Identify the errors and mistakes novice team members are most likely to make.

(f) An adequate method to follow these steps is to conduct a structured interview based on the following outline (see Table C.3):

Table C.3

Format of structured interview (Klein Associates Inc., 1997)

Examples	**Cues/strategies**	**Why difficult?**
What exactly is it about in this situation?	• Given this situation, how does the team know this? • On which cues and strategies does the team rely?	In which respect is this difficult for novice teams?

4. <u>Determine the prerequisite knowledge, skills and attitudes</u>

The prerequisite knowledge, skills and attitudes required for an adequate performance of the team tasks, can be described at two levels: (1) the team level, for tasks that are conducted by two or more team members and (2) the individual level, for tasks that are conducted by one team member, although within the context of the team task performance. Team members are not explicitly trained on these latter issues, but during the conduct of the team training program the feedback can be linked to the individual task performance: what effect does the action of an individual team member have on the performance of the team as a whole? The knowledge, skills and attitudes are further categorised based on a model describing the characteristic features of team performance.

4.1 Determine for every team task the prerequisite knowledge, skills and attitudes that at least two team members have in common. These are related to the following, partly overlapping categories:

(a) Shared mental models of the:

- Task and the sequence of tasks
- Environment
- Problems with the task performance / knowledge of specific errors
- Materials and tools

- Team and the team members
- Interactions between the team members

(b) Adaptability, flexibility, mutual re-ordering of tasks

(c) Monitoring of the task performance and providing feedback, including correction of team members' errors

(d) Co-ordination
- Organisation and integration of tasks
- Synchronise/adjust the tasks to each other
- Shared utilisation of materials and other resources
- Applying 'time management' principles

(e) Communication
- Information exchange (correct information at the right moment to the correct person, also with respect to monitoring and giving feedback)
- Discussing the team's strategy

(f) Team decision-making
- Assessing the situation
- Finding a solution
- Planning the actions
- Implementation of the solution

4.2 Determine the prerequisite knowledge, skills and attitudes required for adequate performance of individual tasks within the context of the team task.

(a) Determine for every team task the critical actions or subtasks an individual team member has to perform. These actions are especially related to:
- Handling of the equipment
- Monitoring of the own task performance (self-correction)
- Leadership / team management, for example:
  - Immediately providing feedback
  - Structuring and co-ordinating the team in order to work together
  - Preparing for critical situations (crises)
  - Encouraging personal involvement in achieving the team goals

(b) Determine the prerequisite knowledge, skills and attitudes for adequately performing these individual tasks.

5. Formulate the instructional objectives

In this step the instructional objectives are formulated. This is based on the prerequisite knowledge, skills and attitudes on the one hand and the knowledge, skills and attitudes the target group already masters on the other.

5.1 Evaluate the results of the analysis process. Determine whether the identified prerequisite knowledge, skills and attitudes are specified at a sufficiently deep level in order to formulate instructional objectives aimed at mastering the team task competencies. If this is not the case, the team task needs to be analysed more profoundly.

5.2 Determine to what extent the team members already possess the prerequisite knowledge, skills and attitudes: these do not have to be operationalised into instructional objectives.

5.3 Formulate, based on the discrepancy between the results of step 5.1 and step 5.2, the instructional objectives aimed at mastering the team task.

5.4 Divide the instructional objectives at the team level into instructional objectives aimed at performing the tasks and actions by individual team members (see step 4.2). In this way it is possible to provide the team members with accurate and individualised feedback, enabling them to gain insight into the relations between their own task performance and the task performance of the team as a whole.

6. Evaluate the results

6.1 Assess whether the quality of the instructional objectives is sufficient to serve as input for designing team training programs and team training scenarios. If this is not the case, clearer instructional objectives need to be formulated: if this is not possible, the prerequisite knowledge, skills and attitudes have not been specified adequately and the team task needs to be analysed more profoundly (see step 6.2).

6.2 If additional information is required in order to formulate clear instructional objectives, the results of the task analysis need to be checked, corrected and supplemented.

6.2.1 Check all results of the task analysis on consistency, completeness and correctness. Consider consulting subject-matter experts who are not part of the project team.

6.2.2 Make up an inventory of issues that need to be complemented or corrected. Discuss these issues in a plenary session with all project team members, and determine whether complementary analyses are required or that the available data contain the required information.

6.2.3 Conduct the necessary additional analyses and integrate the information in the final result of the team task analysis process. Assess again whether it is possible to formulate adequate instructional objectives (see step 5).

C.3 Phase III: Present the results

In Phase III - Present the results, a report of the final results of the team task analysis process is made up and reported to the management. It is important that the management commits itself to these results. This commitment guarantees that the team task analysis, as input for the next phase in the instructional design process (i.e. designing team training scenarios), will not be brought up for discussion anymore. In other words, in this phase the instructional objectives for the team training program are definitively established.

1. Make up a final report

1.1 Make up a final report of the work and activities the project team has conducted and the results of the team task analysis.

1.2 Indicate, as far as possible, which relevant information should be given to the design team responsible for designing the team training scenarios. Examples are: indicated time frame of the new training program, use of specific instructional technologies, current training tools, availability of subject-matter experts, et cetera.

2. Present the final report

2.1 Present the final report to (representatives of) the management of the organisation and have them committed to the results.

C.4 Differences between experimental and control guidelines

The participants of the experimental condition in experiment 1 used a Dutch version of these guidelines (see chapter 4), as well as all participants of experiment 3 (see chapter 5). The participants of the control condition in experiment 1 used the same Dutch version of the guidelines, however excluding all team related aspects. More specifically, the following differences between the experimental and control versions of the guidelines were made (see Table C.4). First of all, the control version of the guidelines supports the analysis of tasks and not particularly team tasks. The word 'team' is omitted as much as possible, except when the guidelines refer to the establishment of the project team that conducts the task analysis. Next, the steps in Phase II – Conduct and evaluate, are not the same. In the control version of the guidelines the steps 'conduct a systems analysis', 'analyse the tasks conducted by the team' and 'determine the prerequisite knowledge, skills and attitudes' are left out. Instead, the step 'analyse the tasks conducted by the team members' is described; this step does not support conducting a system analysis, making a mission diagram nor making a TOSD, but does support conducting a HTA and analysing the cognitive aspects of the task performance. These steps are also implemented in Phase I – Prepare, step 4.2 on 'making a division of tasks and activities between the members of the project team'. Further, the step 'determine for every team task the prerequisite knowledge, skills and attitudes that at least two team members have in common' as described in the experimental version of the guidelines (Phase II – Conduct and evaluate, step 4.1), has been left out in the control version of the guidelines. Finally, formulating the instructional objectives is only aimed at the tasks performed by individual team members.

Table C.4

Differences between experimental and control versions of the guidelines supporting the analysis of team tasks

Phases and steps	**Version of guidelines**	
	Experimental	**Control**
Phase I - Prepare	No differences	
Phase II – Conduct and evaluate		
Step 2: Conduct a systems analysis	Included	Excluded
Step 3: Analyse the tasks conducted by the team	Of both team and individual team members	Only of individual team members
Step 4: Determine the prerequisite knowledge, skills and attitudes	Of both team and individual team members	Only of individual team members
Step 5: Formulate the instructional objectives	For both team and individual team members	Only for individual team members
Phase III – Present the results	No differences	

EXAMPLE OF MISSION DIAGRAM

Figure C.3 depicts an example of a mission diagram, as is prescribed in the guidelines supporting the analysis of team tasks (see Phase 2, step 2.6). This example (Van Rooij and Van Berlo, 1996) deals with a mission of a tank platoon, viz. 'Take the offensive, aimed at the conquest of territory'.

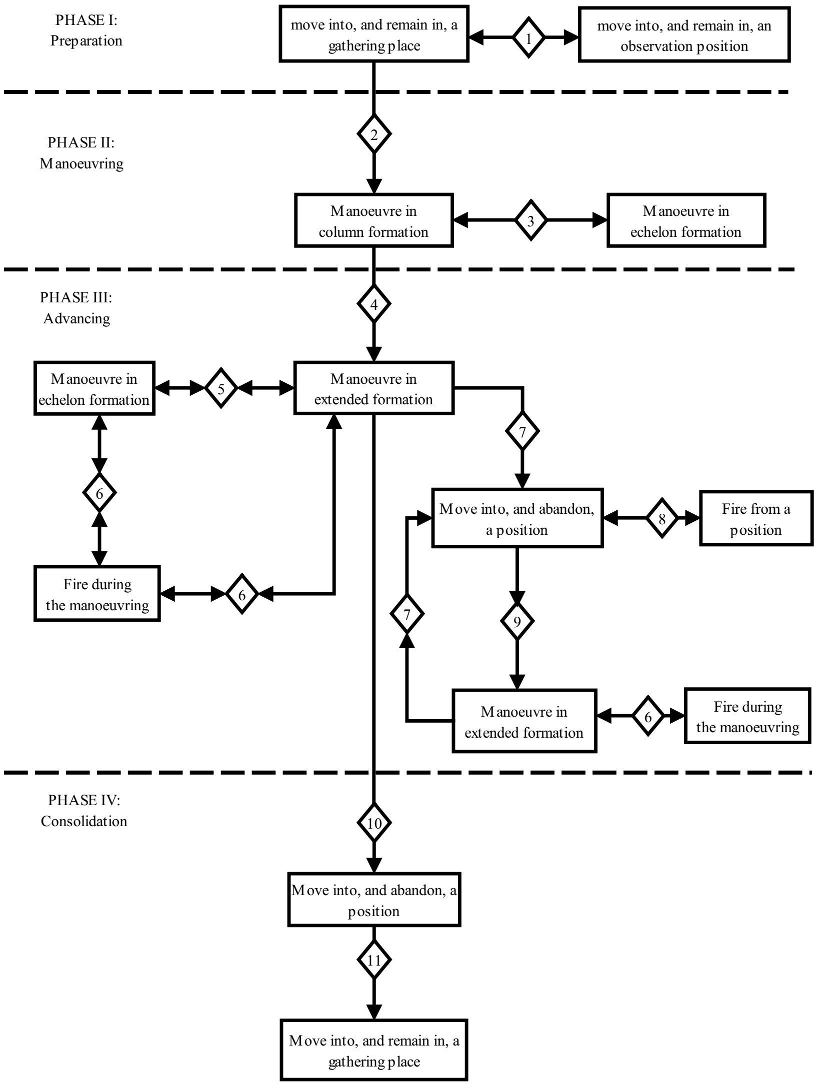

Figure C.3 Example of a mission diagram.

Constructing a mission-diagram involves creating a graphical representation, as well as a brief description of the phases, the tasks the super-ordinate system performs (rectangles) and the transition points (diamonds). Without the intention to present a complete description, some aspects of the mission-diagram on the previous page will be exemplified below.

Phase I: Preparation

A gathering place is an area in which the tanks (as part of the platoon) are assembled before the actual combat operation will be performed. In the gathering place the preliminary measures are undertaken by means of performing the functional checks of the weapon systems, and to reconnoitre.

<u>Move into, and remain in, an observation position:</u>

An observation position is taken with the purpose to observe the entire platoon sector and to open fire (when required) in this sector. Important findings are reported to the platoon commander. The location of the observation position is determined by the platoon commander and is taken during the settling of the gathering place. The crew of an observation position can also perform as an anti-chemical warfare observation unit. If there are insufficient sight-covered positions available, an observation unit (outside of the tank) has to be taken.

Phase II: Manoeuvring

Starting from the gathering place the tank manoeuvres, as part of the platoon, towards the battlefield. In this phase, speed is of utmost importance and therefore the platoon manoeuvres in column formation.

Transition point 2: move into, and remain in a gathering place → manoeuvre in column formation

- The following actions must be undertaken by the tank crew concerning the preparation of the manoeuvre: (1) the tank is combat-ready up to the position 'action', (2) the tank crew is informed about the goal of the manoeuvre, (3) the tank is camouflaged, (4) the tank sector is identified and divided, (5) the combat-sight (battle-visor) has been put on, (6) the calculator-input has been provided for, (7) the tank's position in the platoon formation (including the colour) has been identified.
- The column formation is always taken in cases of reduced sight (e.g. rain, fog, snow) and certain characteristics of the physical environment (e.g. village, valley, forest).

Transition point 3: manoeuvre in column formation → manoeuvre in echelon formation

- During the manoeuvring phase the platoon usually manoeuvres in column formation. Only in cases of flank threats, an echelon formation (to the left or to the right) is taken.

Phase III: Advancing

As soon as enemy territory has been entered, the phase of advancing starts. There is a high probability of enemy contact. While advancing the enemy the platoon can fire both during the manoeuvring and from a position.

<u>Manoeuvre in extended formation</u>

A manoeuvre is a tactical movement of a tank (within a platoon) in a combat-ready condition/state. The route to be followed is an ordered route, and enemy contact should be expected at all times. At this moment critical aspects of the behaviour are: (1) avoiding, as much as possible, dust and tracks, (2) using the covering possibilities of the terrain, (3) approaching the enemy with front armour-plating.

<u>Fire from a position</u>

A (fire) position is a position from which the tank can fire, in front, at the enemy. This position is preferably, but not necessarily, prepared in advance. Usually a fire position is a trunk-covered position, but it can also be a turret-covered, sight-covered, or entrenched position. Whenever possible a turret-covered position must be taken; in this case the tank commander observes the terrain and enemy using the periscope. After an agreed-upon sign by the platoon commander and the ‘free fire’ command the trunk-covered position is taken. The gunner fires at the first distinguished target. The elimination of targets happens, as much as possible, in accordance with the target-priority. Potential targets in the sector of the co-ordinate tank can also be fired at. A critical aspect of the task performance is the rules concerning opening fire.

Transition point 6: manoeuvre in extended formation → fire during the manoeuvring

- In case of enemy-contact the enemy will be fired at immediately; this is ordered by the tank commander.
- In case the own tank is fired at, the tank immediately responds by firing back: this is ordered by the tank commander.
- If the platoon-order contains the statement ‘fire at my command’, the enemy will be fired at only on the platoon commander’s command.

Transition point 9: move into, and abandon, a position → manoeuvre in extended formation

- In case the tank is under heavy enemy's fire, the tank commander determines to abandon the position and to move to the reserve fire position.
- In case the advancing occurs by moving ('jumping') from one position to another, the tank abandons a position and moves to the next one on the platoon commander's order.

Phase IV: Consolidation

During the consolidation the target location is occupied. The tank takes a position within the platoon's position, and remains for the next order.

<u>Move into, and remain in, a gathering place</u>

After abandoning the last position all tanks gather in the platoon's gathering place. This place offers an opportunity to reorganise, re-supply, take care of the wounded, carry out repairs, et cetera.

Transition point 10: manoeuvre in extended formation → move into, and abandon, a position

- This position is taken at the command of the platoon commander. It must remain possible to fire from this position.

APPENDIX D: GUIDELINES SUPPORTING THE DESIGN OF TEAM TRAINING SCENARIOS

In this appendix a framework and guidelines supporting the design of team training scenarios are presented. The framework is presented in Figure D.1. The output of the team task analysis (i.e. the instructional objectives) is the input for designing the team training scenarios. Designing scenarios is an iterative process. This is indicated by the circular relationship between 'design' and 'evaluate': the products of the design process should be evaluated regularly. Designing scenarios evolves from a general structure (training mission) to a detailed version of the training scenario (script/blueprint). Within the cycle 'design' - 'evaluate' a problem space emerges comprising the elements 'content', 'training strategies', 'performance measurement and feedback', 'role of the instructor/observer' and 'training media'. By getting involved in this problem space, the instructional designer progresses from a general training mission to a detailed script/blueprint of the training scenario.

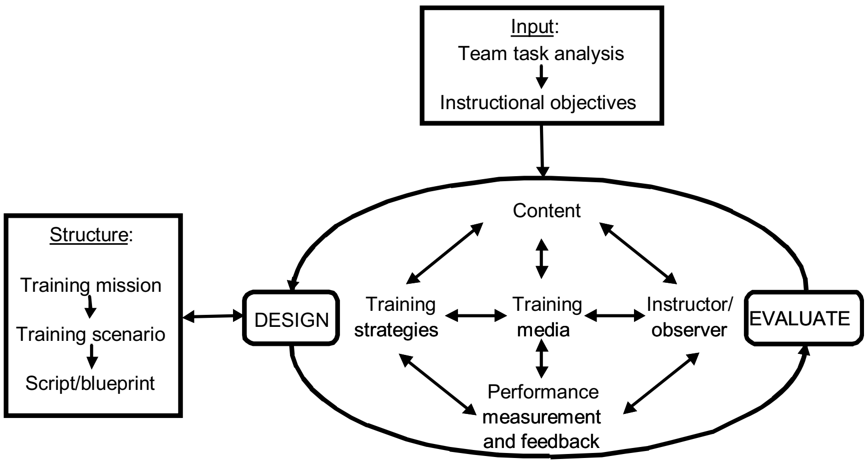

Figure D.1 Framework for designing team training scenarios.

The intention of the guidelines is to provide support in designing scenarios in which team task skills are trained irrespective of the specific learning environment: field exercises, computer-based training, (distributed) simulator-based training, instrumented battlefield exercises, et cetera. The major difference between these learning environments is level of control over the training situation and the trainees' learning process, implying a varying level of detail in executing the respective guidelines. The guidelines consist of three phases: (I) prepare, (II) design, and (III) evaluate; every phase contains several steps.

Phase I: Prepare

1) Determine the goal of the design process
2) Establish a project team
3) Determine the conditions
4) Make up a design plan

Phase II: Design

1) Review the instructional objectives
2) Specify the context and conditions
3) Determine the key events and participants
4) Combine the events into a coherent scenario
5) Determine the ideal course of action for each scenario
6) Determine the prototypical mistakes and errors
7) Determine the training strategies
8) Specify the timing, modality and content of feedback
9) Evaluate the results

Phase III: Evaluate

1) Make an evaluation plan
2) Conduct formative evaluations
3) Conduct a try-out
4) Conduct a pilot-study

During the entire process of designing team training scenarios evaluations are conducted on a regular basis. In this way the project team can closely monitor the whole process. Although the primary sequence of the phases is 'prepare' $\rightarrow$ 'design' $\rightarrow$ 'evaluate', based on the results of the evaluations the designers can decide to go through previously followed phases and/or steps. The guidelines are described next.

D.1 Phase I: Prepare

Phase I - Prepare, consists of four steps: (1) determine the goal of the design process, (2) establish a project team, (3) determine the conditions, (4) make up a design and evaluation plan and (5) evaluate (intermediate) results. The results of (intermediate) evaluations can cause the design team to return to previous steps, including a reconsideration of the goal of the design process. These steps are depicted in Figure D.2 and will be described next.

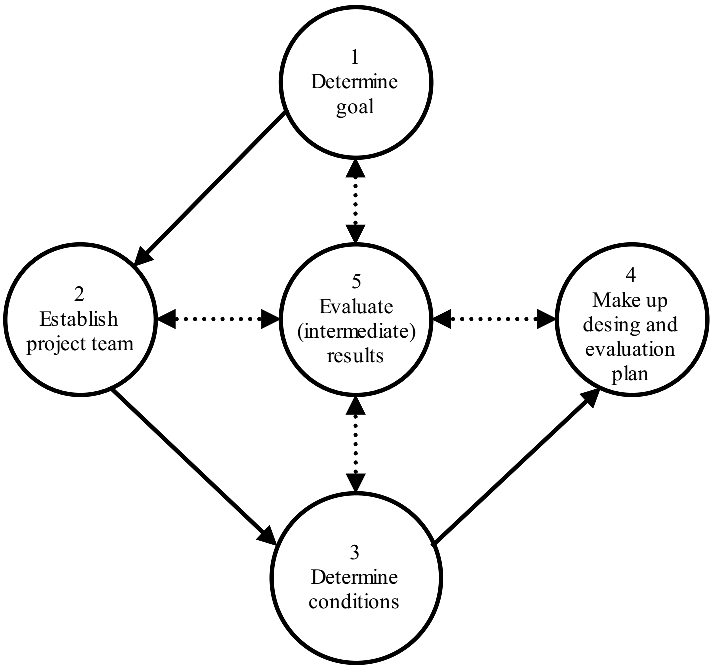

Figure D.2 Prepare the design process

1. <u>Determine the goal of the design process</u>

1.1 As soon as it is ordered to design team training scenarios, it is important to determine the goal of the design process. Will the design process focus on all identified instructional objectives, or a subset? Will the training scenarios be implemented in one specific learning environment, or in various learning environments? The goal of the design process determines largely the working conditions of the project team and the required expertise.

2. <u>Establish a project team</u>

2.1 Establish a project team responsible for designing the team training scenarios. Because designing team training scenarios is a complex and multidisciplinary process, various fields of expertise need to be included within the project team, for instance: instructional design, military subject-matter, software development and group dynamics. Different kinds of expertise can of course be united in one person.

3. Determine the conditions

3.1 Determine the conditions for the design process, based on its goal (see step 1). Examples are the:

- Instructional objectives
- Time, personnel and money available
- Available team training time
- Learning environments (e.g. simulator, networked simulators or exercise terrain)
- Characteristics of the learning environments (e.g. technical possibilities and/or restrictions, terrain features and availability of material).

3.2 In first instance, however, the design of a training scenario should not be affected by the (technical) restrictions of a learning environment. Ideally, the design is based only on the instructional objectives. During the design process, minor modifications may be implemented to adjust to the specific learning environment, thereby not violating the essence of the instructional objectives. If more dramatic modifications are required, then it can be concluded that the available learning environment is not adequate for designing training scenarios that meet these instructional objectives.
The same holds true for the available training time. If the design process results in training scenarios that exceed the available training time, only minor modifications can be implemented to meet this restriction. Otherwise the project team should report to the management that the available training time, given the instructional objectives, is not sufficient for adequate team training.

4. Make up a design and evaluation plan

4.1 Assign the various tasks to the different members of the project team.

4.2 Determine which products need to be delivered on what dates.

4.3 Determine the way the (intermediate and final) products will be evaluated. Evaluation of the products is an important activity. Therefore, evaluation is an integrated and essential part of these guidelines. In order to stimulate regular evaluations, an evaluation plan can be made up as part of the design plan. This evaluation plan contains information regarding the:

- Moment of evaluation
- Method of evaluation
- Persons involved
- Method of data collection
- Way the data will be used

The experts of the project team, or colleagues can best evaluate the first drafts. The quality of rather final products can be assessed using (representatives of) the target group. Final products can be evaluated in try-out sessions using the actual trainees and instructors. This will be elaborated on in Phase III.

4.4 Discuss the design and evaluation plan with all members of the project team until everyone has agreed upon it.

4.5 Make up the final version of the design and evaluation plan including the deliverables, dates and required expertise (i.e. the project team members).

4.6 Present the design and evaluation plan to the management of the organisation and have them committed to it.

D.2 Phase II: Design

Phase II – Design, consists of nine iterative steps and is depicted in Figure D.3. The results of (intermediate) evaluations can cause the design team to return to previous steps or even back to phase I. This implies that the design of team training scenarios progresses from a preliminary design, via refinements to a detailed design: the design of scenarios follows an incremental development process. The following steps are identified: (1) review the instructional objectives, (2) specify the context and conditions, (3) determine the key events and participants, (4) combine the events into a coherent scenario, (5) determine the ideal course of action for each scenario, (6) determine for each event in a specific scenario the prototypical mistakes and errors trainees make, (7) determine the most adequate training strategies, (8) specify the timing, modality and content of feedback (especially for the mistakes) and (9) evaluate the results.

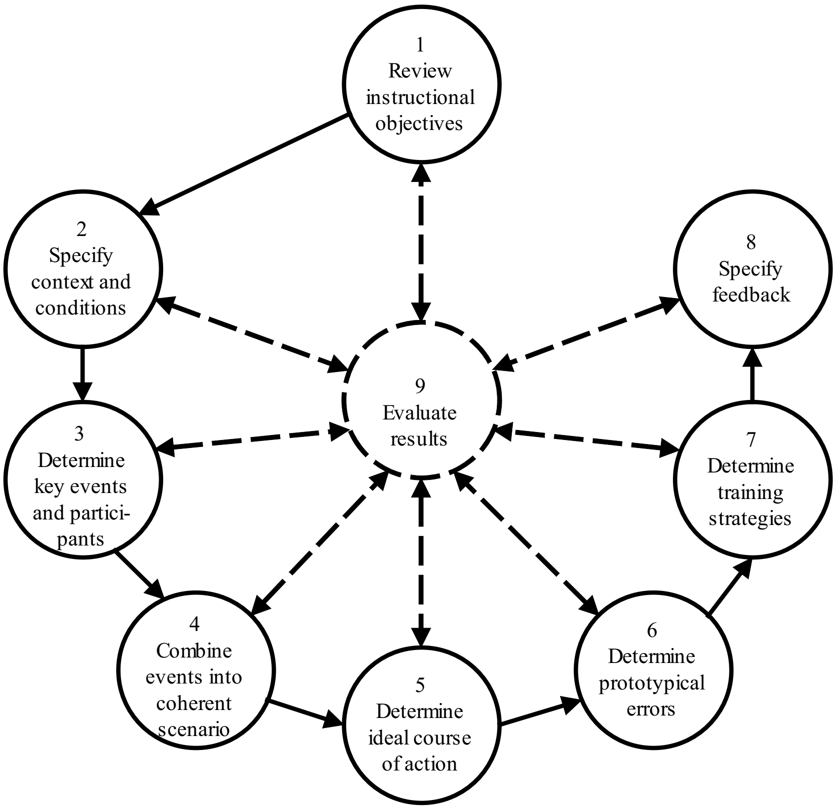

Figure D.3 Design a team training scenario

1. Review the instructional objectives

1.1 Review the quality of the instructional objectives because these are the starting points of the design process. The objectives define the required behaviour of the team as a whole. The results of the analysis phase, in which prototypical team performance has been identified and analysed, provide valuable information with respect to designing training scenarios.

2. Specify the context and conditions

Context is defined as the mission/warfare area in which the team has to conduct the tasks. The conditions under which the team has to perform the tasks can vary considerably, like for instance: time pressure, uncertain information, environmental conditions (both physically and tactically), materials and tools and the political situation. Based on the instructional objectives the events are identified and described that are supposed to trigger the team behaviour as described in the instructional objectives. Combining these events into a coherent scenario happens in three, progressively more specific steps: determining the training mission, developing the training scenario and developing the script/blueprint.

2.1 Always use a standard format when designing scenarios. A similar structure promotes the exchange of various parts of different scenarios. The structure of a scenario is threefold: introduction, execution, and evaluation.

(a) In the introduction phase the trainees are explained about the instructional objectives, the role of the instructor/observer and the rules of the game. This introduction has an instructional purpose: it prepares the trainees to participate in the team training.

(b) The phase of the execution includes all essential elements of the real life mission, including an operational briefing, the actual execution and the operational debriefing. In the operational briefing topics like the tactical situation, the environmental conditions and the rules of engagement are reported. The way this operational briefing is conducted should resemble the reality as close as possible. Let the team members make all necessary preparations as they would do in real life situations (e.g. ask for take-off information, adjusting the equipment). After the mission accomplishment an operational debriefing needs to be conducted. Just as the operational briefing, this operational debriefing resembles the reality as close as possible.

(c) After the execution, an evaluation, or after action review (AAR), is conducted. The AAR focuses on the learning process of the team and the improvements that should be made. It is important that the AAR is based on the instructional objectives.

2.2 The context of the training task is called the 'training mission'. This training mission is derived from an operational mission. Important aspects are description of the physical and tactical environment and all other participants in the scenario.

2.3 The conduct of the training mission is described in the 'training scenario'. In the training scenario all events (both within the own system and from its environment) are described in terms of immediate cause, required actions, supposed reactions and the moment when an event is supposed to occur. In this step are described the:

- Key events that will illustrate the problem and will trigger the target behaviour
- Key actors in each event, the tasks they will perform and the actions they will take
- Equipment and (weapon)systems that will be employed, or that will be affected by the events
- Events in terms of locations, movements and other behaviour (e.g. electronic warfare)

2.4 The deepest level of detail is the 'script/blueprint'. In a blueprint the roles of all participants are specified, the actions they should perform, and for each participant and each object the position within the battle area. Especially in the case of (large) field exercises this step is important because it takes a lot of time to restart an exercise. Also if technologically advanced training media are used (like computer-based training or simulators) it is important to specify what should happen and what is supposed to appear on the display. In this step the following aspects need to be described:

- Historical and political context
- Situation of own troops in terms of force, organisation, locations, manoeuvres and intentions
- Situation of enemy troops in terms of force, organisation, locations, manoeuvres and intentions
- Of all units/teams the names and manner of representation (simulated, role players or trainees)
- Of all (weapon) systems the type, features, maintenance status, amount of fuel and ammunition and operational status
- Orders (intention of the commander)
- Maps and overlays
- Scenario event timeline to oversee all events constituting the scenario

2.5 Evaluate the results on completeness, correctness and consistency.

3. Determine the key events and participants

In the instructional objectives it is delineated which competencies should be trained and which level of difficulty is required. Only when all objectives are defined the content of the scenario can be determined.

- Determine the key events that are supposed to trigger the target behaviour
- Identify the key actors in each event, the tasks they perform and the actions they take
- Identify the equipment and (weapon)systems that will be employed, or that will be affected by the events
- Describe the events in terms of locations, movements and other behaviour.

The following guidelines may support this step.

3.1 The primary focus of a team training scenario is on the team task competencies required for effective team performance. Although feedback can be presented to individual team members as well, it is not the intention to fully train team members on their individual tasks: every trainee should already master their individual tasks before participating in the team training program.

3.2 Design the scenario in such a way that the required team task competencies can really be practised. For instance, if the instructional objectives stress communication, the trainees need to have plenty of opportunities to communicate with each other. If the emphasis is on target detection and identification, the scenario must evoke this kind of behaviour. Therefore it is important that the instructional objectives clearly specify the actions of the team and its members.

3.3 During the execution of the scenario, several kinds of problems can be introduced. Problems can relate to tactics (e.g. new orders, ambiguous information, increased time pressure), the environment (e.g. deteriorating weather, more enemies than expected), the equipment (e.g. partly malfunctioning navigation system) and personnel (e.g. exhausted, stressed or wounded). These problems need to be sufficiently challenging and representative for real-life stressors. The number and kinds of problems and stressors, as well as the level of difficulty are supposed to be adapted to the proficiency level of the trainees. Pitfalls to deliberately fail the trainees are of course not allowed.

3.4 Define the team members' roles within a scenario in accordance with the instructional objectives. The training scenario and the various roles should be consistent, and thus feasible and comprehensible to the trainees. In first instance these roles can be scripted and rather detailed: this more or less coerces the trainees to behave in an effective way. Otherwise there is the risk that trainees choose for an easy way or fall into old habits, and, as a result, do not really learn anything. Besides, clearly defined roles guarantee that all team members are actively involved in the training scenario. In the course of training, as the proficiency level of the trainees is increasing, the roles can be described in less detail.

3.5 Define the roles of the role players. The behaviour of the role players needs to elicit the team's reactions and needs to be an adequate reaction on the team's behaviour. The role players should behave in a prescribed and standardised manner and definitely according to the applicable rules of the game. Make sure the role players know their roles by heart.

3.6 Define the role of the instructor. The instructor can have multiple roles during the course of the training, like for instance briefing the trainees and letting them familiarise with the training equipment, giving instruction to the trainees, playing roles in the scenario, monitoring and observing the team's performance, giving feedback and conducting the AAR. Depending on the size of the team and the particular tasks to be trained, it is advised to use several instructors, each having their own roles. In this case a supervisor can co-ordinate their activities. The following guidelines may support this step.

3.6.1 Make sure that an instructor has knowledge and skills with respect to the particular military tasks (the subject matter), group facilitation, teaching and training and use of simulation technologies (in case of computer- or simulator-based training). If this is not the case the instructor needs training on these aspects.

3.6.2 The role and tasks of every instructor needs to be clearly defined and described, and should be an integral component of the training scenario. It must be clear when and how he is supposed to intervene in the scenario, give feedback, play a role, initiate an event (e.g. an engine fault), implement a training strategy, et cetera. In this way it is prevented that the progress and effectivity of a training scenario is hampered by an instructor not exactly knowing what to do and when.

3.6.3 Providing the instructor with supporting tools to monitor and measure the team members' performance. Indicate the critical events in the scenario the team should react upon: in this way the instructor is already prepared to observe critical team behaviour. This will decrease the workload of the instructor, so that he can better concentrate on issues that are difficult to anticipate on (e.g. determining the exact moment and content of the feedback).

3.6.4 Make sure that every instructor knows the scenario by heart. Especially with complex training scenarios, in which several instructors/observers have to co-operate, an additional train-the-trainer course can be useful.

3.7 Evaluate the results on completeness, correctness and consistency.

4. <u>Combine the events into a coherent scenario</u>

This includes defining a political-historical context and designing orders, maps and overlays. Start designing relatively easy scenarios, later more difficult scenarios can be designed.

4.1 Indicate in a timeline the relations between the various events in the scenario. In this way a clear overview of all relevant events in the scenario is created.

4.2 The degree of realism of the learning environment can be enhanced by various measures, especially when these have detrimental effects on the task performance. Examples are implementing distractions (e.g. irrelevant communication and background noise), wearing uniforms, gloves, headsets and/or helmets, communicating with other personnel (e.g. air traffic control; these can be simulated by role players) and checking and examining orders, maps and documents, as well as the equipment.

4.3 Evaluate the results on completeness, correctness and consistency.

5. Determine the ideal course of action for each scenario

5.1 Using a timeline with all events has the advantage that it is relatively easy to indicate the ideal behaviour of the team and its members. This can relate to both internal actions (e.g. discussion, collaborative decision making, determining the strategy) and external actions directed to the external world (e.g. giving orders, present a situation report, ask for additional information). In case a scenario consists of many events, it is advised to make descriptions of the ideal behaviour only for the important, critical and/or difficult events.

5.2 Evaluate the results on completeness, correctness and consistency. Use in this case the results of the team task analysis.

6. Determine the prototypical mistakes and errors

6.1 Determine for each event in a specific scenario what the most likely typical mistakes and errors are that a team and its members will make. If a scenario consists of many events, restrict this to the in step 5.1 indicated important, critical and/or difficult events. The advantage of already indicating this beforehand is focusing the attention of the training staff during the conduct of the scenario. It supports the performance measurement and helps in noticing if actions and/or decisions do not occur, or if incorrect actions and/or decisions are made. In this way, valuable information is gathered for the evaluation of the training scenario. Besides, the descriptions of the prototypical mistakes and errors can help in determining the most adequate training strategy.

6.2 Evaluate the results on completeness, correctness and consistency. Use in this case the results of the team task analysis.

7. Determine the most adequate training strategies

A model delineating the execution of team training scenarios is depicted in Figure D.4. At the on-set of the execution of a training scenario, the instructional objectives can be presented to the trainees: in this way the importance and relevance of the objectives can be made clear, which increases the trainees' willingness to learn. After an optional pre-discussion of the scenario, the trainees engage into the execution of the training scenario. In order to enhance the trainees' learning, the instructor can apply several training strategies and didactical methods. During the execution of the scenario, the team's performance is measured and feedback provided. The feedback can be provided both during and after the execution of the scenario. Because it is simply not possible to practice all tasks under all conditions, reflecting on the task performance is an elementary part of the after action review (AAR). Guided by the instructor the team members reflect on the team's performance, discuss which actions have been conducted, why certain choices and decisions have been made and which improvements can be made. In this way, a critical function in the team's learning process can be realised: reflecting on the own behaviour in order to gain a deeper understanding of the characteristics of effective team performance. The reflection is primarily aimed at the instructional objectives and the execution of the training scenario. After the reflection the team can execute the next scenario, or repeat (parts of) the same scenario.

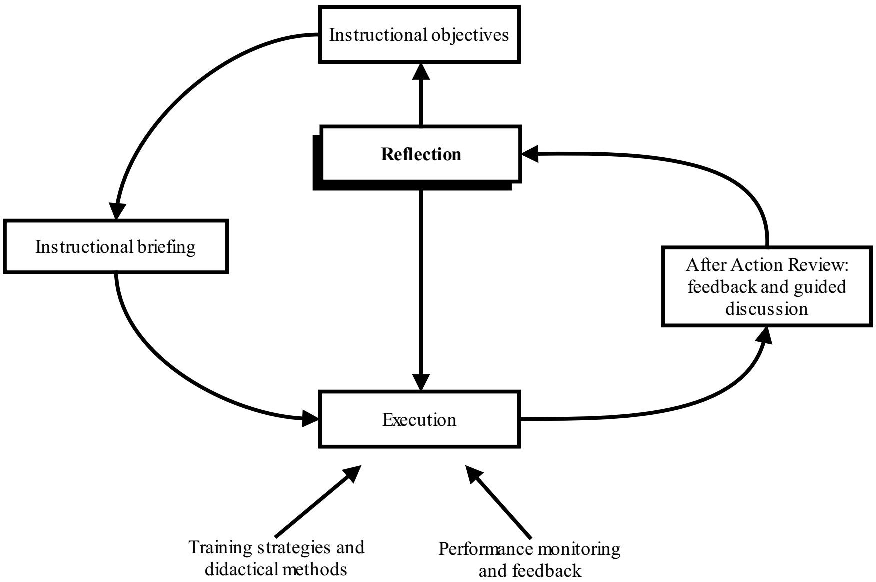

Figure D.4 Model for the execution of team training scenarios.

In order to make sure the trainees will achieve the instructional objectives, several training strategies can be implemented. Irrespective of the specific strategies to be implemented, it is important to take the current team members' proficiency level into account. In many cases trainees will already have some operational experience, maybe even in a rather similar team. Depending on the varying levels of prior knowledge and skills, the following guidelines may support this step.

7.1 Start with relatively easy scenarios and progressively introduce more difficult scenarios. The level of difficulty can be varied by manipulating the environmental aspects (e.g. number of enemies, weather conditions, and political context) or aspects related to the own weapon system (e.g. amount of ammunition, hit by enemy fire, number of human losses or conflicting orders from higher commander).

7.2 The importance and relevance of the to-be-trained behaviour, as described in the instructional objectives, should be clear to the trainees. Goal acceptance is an important condition for an adequate performance and the willingness to learn. The criteria to obtain the instructional objectives need to be clear and plausible to the trainees.

7.3 In a guided pre-discussion of the training scenario the relevant events, the required behaviour, the anticipated reactions, and the rationale behind the outcomes may be discussed. In this way the trainees are better prepared for engaging in the scenario, and this increases the probability that they will master the instructional objectives. During the course of the training this support can diminish.

7.4 Provide the team members with plenty of opportunities to demonstrate the target behaviour. This can be done within one scenario, but also in several consecutive scenarios. In this case, the behaviour can be observed more than once and in various conditions, so in the end a more profound picture emerges concerning the team's proficiency emerges and the extent to which the instructional objectives are achieved.

7.5 Provide for sufficient means of supporting the trainees in their learning processes ('scaffolding') for instance giving guidance, replay the scenario and giving on-line feedback. In course of time this support can decrease, along with the trainees' increasing proficiency level ('fading').

7.6 In order to prevent team members from learning merely tricks rather than a deep understanding of the how and why of the competencies, unexpected deviations from the scenario's routine course of action can be presented. For instance, enemy targets appear just before the F-16 is intending to land rather than after the take-off. These deviations should of course represent valid instructional objectives.

7.7 Improve the construction of shared mental models: knowledge about the relations between the tasks of the individual team members has a positive effect on the team task performance. An effective method to acquire these shared mental models is cross training. During cross training the team members receive instruction in the tasks of their team members and it is indicated how these tasks relate to the own task performance and to the team's task performance. It depends on the specific team, the specific tasks to be trained, and the specific training context how cross training can be implemented. This can vary from only reading about the other tasks to practising the execution of these tasks. Besides, the cross training can be aimed at the tasks of all, or some, team members.

7.8 Make use of various didactical methods like role-playing, demonstration, group discussion, guided practice exercises, switching between learning environments, et cetera. The implementation of the various methods needs to be in accordance with the instructional objectives and the level of the trainees' proficiency. The variation in didactical methods during the course of the training program should happen in a structured manner, resulting from an analysis of each method's weak and strong features.

7.9 Team training is primarily focused on the combination of team task and teamwork competencies, and not exclusively on the social and communication competencies to function as a team (i.e. teambuilding). This implies that the training does not necessarily have to be conducted with the intact team: role-players can fulfil the positions of the other team members. An advantage of role-players (or simulated team members) is that the trainee can co-operate with good performing 'team members' not hindering their own performance.

7.10 Avoid presenting problems that are too easy or too difficult. Otherwise there are not sufficient relevant 'learning points' for a team. In training scenarios that are not adjusted to the team's proficiency level, not enough learning points will occur. The advantages and disadvantages of various ways to conduct the training task can be discussed during the AAR.

7.11 If a team member is actively engaged in the scenario, the probability of successfully achieving the instructional objectives is increased. Team members are supposed to have various opportunities to conduct actions and to practice the competencies. It is therefore important to engage all team members in the execution of a training scenario in a meaningful manner (and not having them to participate as rather passive role-players).

7.12 Design the scenarios in such a way that they fit into a more encompassing training program. For instance, in case of multiple learning environments (e.g. training simulator, exercise terrain) various scenarios may be presented each using the advantages of the particular learning environment. In this way, the total training program covers all aspects of the particular training task in a structured and effective manner.

7.13 Evaluate the results on completeness, correctness and consistency.

8. Specify the timing, modality and content of feedback

The performance of the team can be registered by the instructor/observer or, when training technologies are used, measured by the computer. The same holds true for providing feedback. Besides, feedback can be given on-line (during the exercise or training) or off-line (when the scenario or training has ended). During the after action review (AAR) the team discusses the execution of the training scenario, guided by the instructor. Feedback is an essential aspect in the team's learning process and here the instructor plays an important role. The guidelines dealing with this issue are divided into three subcategories: performance measurement, feedback and after action review.

Performance measurement

8.1 A team develops over time. Therefore, the team's behaviour should be measured regularly in order to assess the time-to-time changes in team performance and the underlying processes. Several observations and several scenarios are needed to get a reliable picture of the team's proficiency.

8.2 The quality of the team's performance is indicated based on measures of both process and product. It is not only important whether the team has accomplished the task (product) but also how this has been done (process). Relevant process information concerns the communication between team members (e.g. quality, timing and direction of communication), decision-making (e.g. quality and timing), and co-ordination between team members (e.g. adjusting the actions to each other and monitoring each other's task performance).

8.3 In order to measure the team's performance (i.e. the degree to which an objective has been reached) in a reliable way, the criteria to obtain the instructional objectives need to be clear to the instructor. Examples of tools supporting the instructor in monitoring and assessing the team members' performance are a list of clearly defined instructional objectives and a timeline delineating all relevant actions, a behavioural observation checklist, video recordings, audio recordings and Team Operational Sequence Diagrams. While the team is involved in the scenario, the instructor can take notes regarding specific characteristics of the team task performance as described in the instructional objectives. These notes can be used during the AAR and might even facilitate on-the-job coaching.

8.4 The results need to be presented in such a way that these are easily accessible for the instructor when conducting the AAR. The format of the data recordings should facilitate statistical data analysis. In case technologically advanced training media are used, this can be discussed with the software developer.

Feedback

8.5 The relations between the actions of the team and the resulting outcomes need to be clearly visible and sensible to the trainees. This is especially the case if the training takes place in a virtual environment. But of course this also holds true for the reactions of role-players.

8.6 The feedback to the team members needs to be as realistic as possible. In some cases however, from an instructional point of view artificial or augmented feedback (e.g. on-line feedback by the instructor) can be the most effective. In general the feedback will shift during the course of the training from artificial and augmented to more realistic.

8.7 Feedback is to be provided at the right time. A choice has to be made between on-line and postponed feedback. Feedback on actions inherent to the execution of the training task needs to be provided immediately in order not to disturb the dynamics of the scenario. Feedback concerning the instructional objectives can be postponed to the end of the scenario: during the AAR the various actions and decisions can be discussed in more detail. In case of serious problems, the scenario can be paused in order to discuss the problems before continuing or restarting it.

8.8 Feedback is supposed to be specifically aimed at the team's behaviour rather than being general of nature. The more specific the feedback, the more it will benefit the team members' learning process. All relevant aspects of the team task performance should be commented on; no feedback has the risk in it that the task performance will not improve or even decrease.

8.9 Feedback needs to include specific cues and suggestions for improving the task performance and the underlying processes. Knowledge of results by itself is not effective. Explicit cues for improvement will give team members insight in the processes that lead to effective team performance.

8.10 The performance of both the individual team member and the team as a whole are supposed to be measured and assessed. In first instance, the feedback will concentrate on the individual level. This will gradually shift to the team level. The feedback on individual task performance should always be related to the performance of the team. Feedback on an individual's task performance does not necessarily need to be given only to the particular team member. If this is presented in the presence of the other team members, they can learn of it as well. The relations between the individual's and the team's task performance can first be indicated by the instructor; gradually this can be done more and more by the team members themselves.

8.11 The feedback should always take into account the actual proficiency level of the competencies and the underlying knowledge, skills and attitudes within a team. The content, the moment and level of reality of the feedback will therefore change during the course of the training program.

After action review (AAR)

8.12 Because it is probably not possible to train all aspects of the team task performance under all conditions, the after action review needs to stress the processes underlying effective team performance. This focus on the team processes will increase the probability that the team will perform well in operational situations not explicitly encountered during the training. Reflecting on the own behaviour is an essential condition for learning and is therefore an integral part of the team training program. During the AAR and guided by the instructor, the team discusses the training scenario.

8.13 The guided discussion during the AAR needs to be about both ineffective behaviour and adequately performed actions. During the learning process, it is also important to know for the team members what went good. The actions should not be reviewed in isolation, but within their context: this means that the immediate cause, the execution itself and the result are supposed to be reviewed.

8.14 An AAR has the following structure:

(a) Present a brief and general overview of the training scenario's onset: what were the instructional objectives, which task was it about, what was the goal of the team, in which environment(s) did the team perform and what were the behaviours of the other participants.

(b) Present a brief summary of the execution of the training scenario. The tasks and actions can be sequenced chronologically or thematically (by the instructional objectives).

(c) Provide ample opportunities for reflection on critical task behaviours. The most appropriate form is a guided discussion. Let the team members reflect on their behaviour, discuss the positive aspects and the points for improvement, and discuss the advantages and disadvantages of decisions, actions and/or the alternatives.

(d) Give a summary of the team task that needs to be improved and give suggestions how to achieve this.

8.15 Make an evaluation report of the training scenarios and give this to the team members. This evaluation report (or Take Home Package) is a kind of summary report of the AAR, supplemented with suggestions and recommendations concerning follow-up training and/or (on-the-job) coaching. This report can also be supplemented with the role-player descriptions and videotapes of the training scenario and/or the AAR.

8.16 Evaluate the results on completeness, correctness and consistency.

9. Evaluate the results

During the design of the team training scenarios, the products are developed incrementally based on regular evaluations. The evaluations of intermediate products are called the formative evaluations.

9.1 The intermediate products can best be evaluated with experts on the subject matter and instructional science and, in case of computer-based or simulator-based training, software design and man-machine interaction. Within every evaluation, the points for improvement and the alternatives should be discussed. Especially on the following aspects the scenarios need to be evaluated:

- Do the team and other participant have to take tactically correct actions and procedures?
- Is the content of the scenario consistent and complete?
- Are the most adequate training strategies implemented?
- Is the quality of the feedback adequate?
- Is the quality of the man-machine interface sufficient?

It is important that the results of the evaluations are directly related to the instructional objectives being the basis of the design process.

9.2 Based on the results of the formative evaluations, the necessary improvements need be implemented within the training scenarios. After implementing these changes it is important to check again whether the content of the scenario is still consistent. This implies that the steps 2.1 and 2.2 are followed iteratively.

9.3 When the experts and designers have reached agreement on the quality of the team training scenario, the scenario can be evaluated by means of a try-out (see Phase III, step 1).

D.3 Phase III: Evaluate

Phase III – Evaluate, consists of four steps: (1) make an evaluation plan, (2) conduct formative evaluations, (3) conduct a try-out, (4) conduct a pilot-study, and (5) evaluate the results. In first instance these steps should be followed in a linear sequence, but based on the results of the evaluations the project team members can determine to return to a previous step. The steps are depicted in Figure D.5.

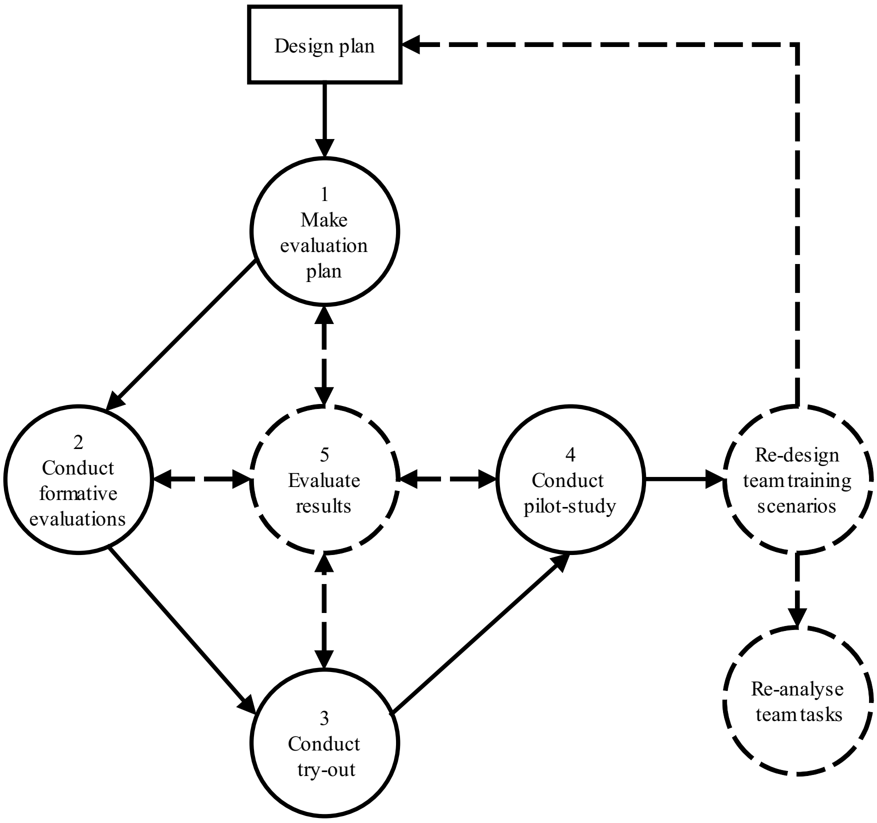

Figure D.5 Evaluate the design process.

1. <u>Make an evaluation plan</u>
   This step is already described in Phase I, step 4.3.

2. <u>Conduct formative evaluations</u>
   This step is already described in Phase II, step 9.

3. <u>Conduct a try-out</u>
   The quality of rather final products can be assessed by means of a try-out using (representatives of) the actual target group.

3.1 During the try-out expertise is required on the subject matter, instructional science, group dynamics and, in case of computer-based or simulator-based training, software design and man-machine interaction. Especially on the following aspects the scenarios need to be evaluated:

- To what extent is the scenario realisable?
- Are the critical tasks, performed by the team, clearly observable by the instructors/observers?
- Are the criteria of good team task performance clear to the instructors/observers and the team members?
- To what extent is it possible to prepare an AAR within reasonable time?
- Do the team members and other (role) players have to take tactically correct actions and procedures?
- Is the content of the scenario consistent and complete?
- Are the most adequate training strategies implemented?
- Is the quality of the feedback adequate?
- What is the quality of the man-machine interface?

Ideally, the members of the project team should not actively participate in the try-out, and just focus on observing the execution of the training scenario and debriefing all participants.

3.2 Based on the results of the try-out, the necessary improvements need to be implemented within the training scenarios. After implementing these changes it is important to check again whether the content of the scenario is still consistent. In case of many and/or dramatic changes of the prototype it is advised to conduct a new formative evaluation (see step 2), followed by a new try-out.

3.3 When the experts and designers have reached agreement on the quality of the team training scenario, the scenario can be evaluated by means of a pilot-study (see step 4).

4. Conduct a pilot-study

4.1 In a pilot-study the actual team and training staff (instructors/observers, role-players, and analysts) are participating. Their experiences can be gathered by means of interviews and questionnaires. The members of the project team may observe the execution of the team training scenarios. Although special attention should be paid to the aspects mentioned previously (step 3.1) during this step virtually every aspect of conducting the team training scenario can be commented on.

4.2 The results of a pilot-study can induce a necessary re-design of the training scenario. Because this need can become apparent quite some time after the initial development of the team training scenario, it is advised to consider forming a new project team and making up a new design plan. This implies that, if the evaluation results require so, the design process can be followed again as well as team task analysis process. This clearly indicates that the design and development of (team) training systems is a continuous process.

D.4 Differences between experimental and control guidelines

The participants of the experimental condition in experiment 2 used a Dutch version of these guidelines (see chapter 4), as well as all participants of experiment 3 (see chapter 5). The participants of the control condition in experiment 2 used the same Dutch version of the guidelines, however excluding all team related aspects. More specifically, the following differences between the experimental and control versions of the guidelines were made (see Table D.1). First of all, although it is the control version of the guidelines, the title still refers to supporting the design of team training scenarios. The reason is that the guidelines describe a process aimed at designing a scenario in which several team members can participate, so it would be rather strange not to use the term 'team training scenario'. However, the term 'team' has been replaced by the term 'team members' as much as possible, except when the guidelines refer to the establishment of the project team that designs the scenario. Next, it is not stressed that the primary focus of the scenario should be on the team task competencies required for effective team performance scenario (step 3.1). Neither it is stressed that the ideal behaviour of the team and its members can relate to internal actions like for instance discussion, collaborative decision making and determining the strategy (step 5.1). Within step 7, the statement about reflecting on the own behaviour in order to gain a deeper understanding of the characteristics of effective team performance, has been left out, as well as the model for the execution of team training scenarios (Figure 5.4) which stresses this team reflection. Further, step 7.7 (improve the construction of shared mental models) and step 7.9 (team training is primarily focused on the combination of team task and teamwork competencies) are left out. Next, the specific team aspects in steps 8.1, 8.2, 8.3, 8,8 and 8.9 relating to performance measurement are not mentioned, and the steps 8.10 and 8.12 have been left out.

Table D.1

Differences between experimental and control versions of the guidelines supporting the design of team training scenarios

Phases and steps	**Version of guidelines**	
	Experimental	**Control**
Phase I - Prepare	No differences	
Phase II – Design		
Step 3: Determine the key events and participants	Including focus on team task competencies	Excluding focus on team task competencies
Step 5: Determine the ideal course of action for each scenario	Including focus on team internal actions	Excluding focus on team internal actions
Step 7: Determine the training strategies	Including: (a) focus on reflecting on team behaviour (b) model for execution of team training scenarios (c) construction of shared mental models (d) combination of team task and team work competencies	Excluding: (a) focus on reflecting on team behaviour (b) model for execution of team training scenarios (c) construction of shared mental models (d) combination of team task and team work competencies
Step 8: Specify timing, modality and content of feedback	Including specific team aspects	Excluding specific team aspects and excluding steps 8.10 and 8.12
Phase III – Evaluate	No differences	

APPENDIX E: FIRE FIGHTING TEAM TASK INSTRUCTIONAL OBJECTIVES

1. Knowing how to retrieve information to determine the characteristic features of the fire and the buildings.

2. Determining the deployment for every fire and threat.
   - Every team member takes specific actions:
     - Observer: keep track of how the fire develops and the required number of fire fighting cars.
     - Dispatcher: deploying the fire fighting cars.

3. Handling the communication device:
   - Sending messages.
   - Retrieving messages.

4. Interpreting the various symbols on the display:
   - The various buildings.
   - Burning, or not.
   - Threatened, or not.

5. Determining the priorities after deliberation, based on current fires and threats:
   - Type of building and number of victims are important.
   - The pyromania follows a fixed pattern.

6. Knowing of the interdependencies between the task performance of the team members:
   - No single team member has all information.
   - The observer cannot see directly how many cars the Dispatcher has deployed: the observer can ask for this information.
   - The dispatcher cannot see were the threats are (he has no map); the observer can give him this information.

7. Handling adequate time-management:
   - Know the number of time steps.
   - Know the duration of a time step.
   - Know that it takes time to deploy and call back a fire fighting car.

8. Determining a joint strategy:
   - Most effective is to focus the fire fighting on the buildings with the highest number of victims.

9. Communicating with each other adequately:
   - Only by e-mail.
   - Information can be given after being asked for, but also uncalled-for.

10. Recognising the importance of giving feedback to each other:
    - Correcting errors and informing a team member after making a wrong decision: in case insufficient cars are deployed near a specific building, again asking for additional cars.

APPENDIX F: TANDEM INSTRUCTIONAL OBJECTIVES

1. Knowing how to retrieve information in the various menus to determine the characteristic features of the target.

2. Determining the (partial) identity of a target.
   - Every team member gathers specific information:
     - Alfa: type (plane, submarine, ship).
     - Bravo: status (civil, military).
     - Charlie: intention (neutral, hostile).
   - Interpreting the various symbols on the radar screen.

3. Handling the communication device:
   - Push the button of the respective team member followed by pushing the button ‘Speak’.

4. Recognising the (pop-up) targets:
   - An unidentified target looks like an asterisk (*).
   - Pop-up targets appear randomly.

5. Recognising the importance of drawing one’s attention to (pop-up) targets.
   - Unrecognised pop-up targets nearby the ship cause a decreasing team score.

6. Determine a joint priority order, based on the characters of the targets:
   - The nearness, the direction of movement and speed are important.
   - The (pop-up) targets close to the ship get a high priority (as these are causing a decreasing team score).

7. Knowing of the interdependencies between the task performance of the team members:
   - No single team member has all information on his own.
   - Bravo can conduct his task only after Alfa has finished.
   - Charlie can undertake an action towards a target only if both Alfa and Bravo are finished. But Charlie can already conduct his own task as part of the identifying process.
   - Alfa does not need to wait for another team member to perform his task.

- The sequence of performing the various subtasks is left to the team. Of course, first a target needs to be selected before the team can prioritise, identify and/or take further actions.
- Knowing that an individual team member after identification of a target does not need to wait until further actions have been taken to start identifying a next target.

8. Handling adequate time-management.
   - Knowing that within the team somebody should watch the available time.

9. Determining a joint strategy:
   - Most effective is that all team members together focus on one target.

10. Knowing who has which information:
    - Alfa: speed, height/depth, elevation/descent, strength of signal, communication time.
    - Bravo: starting direction, initial distance, intelligence, origins, patterns of movements.
    - Charlie: level of threat, counter measures, electronic warfare, answer, missiles in position.

11. Recognising the importance of verifying the information because of the ambiguity and incompleteness:
    - Nobody has all information on his own.
    - Information can be partly unreliable.
    - The majority of information elements (three out of five) represent the truth.

12. Communicating with each other adequately:
    - Only using the head-set.
    - Following a standardised communication protocol.
    - Information can be given after being asked for, but also uncalled-for.

13. Looking after the fact that all team members contribute to accomplish the mission:
    - Relating a change in the team score to the own task performance and those of the others.

14. Recognising the importance of giving feedback to each other:

- Correcting or informing a team member after making a wrong decision (after noticing a decreasing team score).
- An increasing team score is more important than a increasing individual score.

15. Determining the most adequate action towards a target:
    - Integrating all information with respect to a target.

16. Evaluating the own task performance (and other team members' task peformance) based on changing team scores after acting upon a target.

APPENDIX G: EVALUATION QUESTIONNAIRES FOR THE PARTICIPANTS

Pre-test

1) Which difficulties did you encounter during conducting the task analysis (experiment 1) or during designing the training program and training scenario (experiment 2)?

2) Which parts of conducting the task analysis (experiment 1) or designing the training program and training scenario (experiment 2) were easy for you?

3) Which parts of the task analysis (experiment 1) or designing the training program and training scenario (experiment 2) were, according to your opinion, not done well by you?

4) Which parts of the task analysis (experiment 1) or designing the training program and training scenario (experiment 2) were, according to your opinion, done well by you?

5) Other remarks:

Post-test

1) Mention at least three weak points of the guidelines. Please point out your argumentation.

2) Is there information you missed in the guidelines?

   0 No
   0 Yes, namely…

3) Is there superfluous information in the guidelines?

   0 No
   0 Yes, namely…

4) I would use these guidelines on my own work.

0	0	0	0	0
Disagree				Agree

Remarks:

5) Other remarks:

APPENDIX H: CODING SCHEME OF EXPERIMENT 1

The bold numbers in the second column are the codes that were used for scoring the protocols.

Code		Description	Illustration
I		PREPARE	
1		*Determine the goal of the analysis*	
	1.1	Determine goal of analysis	"Do I have to make a new training program, or can I adapt an existing training?"
	1.2	Determine the conditions (e.g. time, money, personnel, target group)	"How many teams need to be trained?"
	1.3	Match the goal and the conditions	"So, every year eight teams need to be trained on this task."
2		*Determine the scope of the analysis*	
	2.1	Orientate on domain (obtain general overview)	"Let's see what they should do."
	2.2	Determine scope of domain	"So all team members need to be trained in conducting both their own individual tasks and the team tasks."
3		*Establish a project team*	
	3.1	Determine the expertise to be included in the project team (as soon as it is allocated to an individual, the code should be 3.3)	"Are there any team members with operational experience that I can ask to join my team?"
	3.2	Match the required expertise with available personnel	"I would go to my manager to ask if these persons would be available."
	3.3	Determine the final set up of project team	"So, these six persons would be the project team."
4		*Make up an analysis and evaluation plan*	
	4.1	Determine the methods of data collection and analysis (select information sources, select subject matter experts, determine for each information source the method of data collection and analysis, determine the conditions for selecting sources and data collection methods)	"I would definitely conduct interviews with the pilot team and go to the industry that develops this system."
	4.2	Distribute tasks among the members of the project team	"I would be doing the interviews, and we will all be trying to conduct the particular team task ourselves."
	4.3	Determine the methods of evaluation of the results	"We will discuss the results of the analysis within our project team."
	4.4	Evaluate the analysis and evaluation plan (this evaluation is specifically aimed at step 4; broader evaluations are coded with 11.1)	"OK, all aspects of the plan are dealt with. I guess this plan will do."

5		*Present the analysis and evaluation plan*	
	5.1	Present the analysis and evaluation plan to the management	"Well, now I would go to my manager and ask him if he agrees with this plan."
II		CONDUCT AND EVALUATE	
6		*Orientate on domain*	
		Dropped; this should be coded with 2.1	
7		*Conduct a context analysis*	
	7.1	Determine the system the team is part of	"So the team is working on a large ship."
	7.2	Determine the mission(s) of the system and the team	"The mission of the team is to protect the own ship."
	7.3	Determine the phases of a mission	"First the team has to detect the targets and than to identify these targets."
	7.4	Determine the relations between team and other subsystems/teams	"I guess the team is supervised by an overall commander?"
	7.5	Describe the environment in which the team operates	"So the team members are all together in one room, but they cannot see each other?"
8		*Analyse the tasks conducted by the team*	
	8.1	Identify the tasks performed by the team	"The team needs to determine which target to deal with first."
	8.2	Identify the tasks performed by individual persons	"Alfa checks the starting direction of the target."
	8.2.1	Describe individual (sub)task performance	"The observer can see how many fire fighting cars are needed for this fire."
	8.2.2	Describe interactions with other team members	"The observer can send e-mail messages to the dispatcher by clicking on that button."
	8.3	Conduct cognitive task analysis	"Let's see how they really conduct their tasks."
	8.3.1	Analyse cues, information and critical behaviours with respect to individual task performance	"Does the dispatcher have a quicker way of doing his task?"
	8.3.2	Analyse cues, information and critical behaviours with respect to interactions with other team members	"How do the team members determine collaboratively to deal with which target?"
9		*Determine the prerequisite knowledge, skills and attitudes (ksa's)*	
	9.1	Determine the prerequisite ksa's shared by at least two team members	"The team members need to communicate adequately with each other."
	9.2	Determine the prerequisite ksa's to perform an individual task	"Bravo needs to know how to interpret the display."

10		*Formulate the instructional objectives*	
	10.1	Determine to what extent the trainees possess the ksa's	"You can expect that somebody with this school diploma can handle a computer mouse."
	10.2	Formulate the instructional objectives at the team level	"The team should recognise the need to support and correct each other during the team task performance."
	10.3	Formulate the instructional objectives at the individual level	"Every team member should be able to operate the computer equipment."
11		*Evaluate the results*	
	11.1	Check the (final and/or intermediate) results of the analysis process	"Aha, that piece of information was still missing."
III		PRESENT	
12		*Make up a final analysis report*	
	12.1	Make up a final analysis report	"I would write these results properly in a report, and hand it over to my manager."
IV		PREREQUISITE TO ANALYSIS	
14		*Monitor progress*	
	14.1	Monitor progress (where is the participant in the analysis process: what has he done already and what should he still do?)	"OK, so I've formulated the instructional objectives: what is next?"
15		*Familiarisation with experimental task*	
	15.1	Familiarisation with experimental task (FFTT, TANDEM, doing the analysis)	"Is this a real existing task?"
16		*Asking for clarification of guidelines*	
	16.1	Asking for clarification of guidelines	"What is a mental model?"
	16.2	Making remarks about guidelines	"That's quite a lot of text."
17		*Reading*	
	17.1	Reading the task descriptions	"Let's see what Alfa needs to do."
	17.2	Reading the guidelines	"I am now going to read the second phase again."
V		OTHER	
18		*Miscellaneous*	
	18.1	Miscellaneous (e.g. training program design)	"I would handle this topic first in the classroom, and than go to the simulator."
VI		PROGRESSIVE DEEPENING	
19		*Progressive deepening*	
	19.1	Is a certain aspect of the task repeated several times, and does this lead to more specific and new information?	"Going through this several times gives you more information: unfortunately I do not have that much time."

VII		MENTAL SIMULATION	
20		*Mental simulation*	
	20.1	Does the participant try to imagine certain aspects of the task performance (e.g. saying “first this, and then this”) and does he make decisions based on this mental simulation?	“Do I see it clear that he first has to select a message, than click on the button to send it, and that he can not check whether the other team member has received it? That is a bad system design. However, this should be stressed during the training program.”
VIII		NEW	
N	**N**	Parts of the protocol that can not be coded with the existing codes of the coding scheme.	“That reminds me of the training I have followed several years ago.”

APPENDIX I: CODING SCHEME OF EXPERIMENT 2

The bold numbers in the second column are the codes that were used for scoring the protocols.

Code		Description	Illustration
I		PREPARE	
1		*Determine the goal of the design process*	
	1	Determine the goal of the design process	"Is this new training program a pilot training or a new standard training program?"
2		*Establish a project team*	
	2	Establish a project team	"I will include a TANDEM-expert and a computer expert in the project team, and I am the instructional designer."
3		*Determine the conditions (e.g. time, money, personnel, target group)*	
	3	Determine the conditions (e.g. time, money, personnel, target group)	"Is there already a simulator that I can use?"
4		*Make up a design and evaluation plan*	
	4.1	Assign tasks to the different project team members	"I will observe a team in real-life and interviews will be conducted by the two of us."
	4.2	Determine which products need to be delivered on what dates	"After six weeks we should report the result of the design process to our management."
	4.3	Determine the way the (intermediate and final) products will be evaluated	"We will discuss the results of the interviews within our project team."
	4.4	Discuss the design and evaluation plan with all members of the project team until everyone has agreed upon it	"So in real life I would have a discussion with all members of the project team."
	4.5	Make up the final version of the design and evaluation plan	"Based on the discussion the plan would be finalised."
	4.6	Present the design and evaluation plan to the management and have them committed to it	"Now I would go to my manager and ask him if he agrees with this plan."
II		DESIGN	
5		*Instructional objectives and learning trajectory*	
	5.1	Review, change and/or add the instructional objectives	"I do not regard this as an instructional objective."
	5.2	Make draft of learning trajectory (relations between learning environments, theory and hands-on lessons, relations between scenarios, relation between training and assessment)	"First comes a theory part in the classroom, followed by the hands-on training with the simulator."

6		*Specify context and conditions of scenario*	
	6	Specify context and conditions of scenario	"So every team member has a radar screen displaying all ships, aircraft and submarines, but none of them has the overall and complete picture."
7		*Determine the key events and participants*	
	7.1	Determine the key events that trigger the behaviour	"And then an aircraft comes in and they should take appropriate action on it."
	7.2	Identify the key parties and the tasks and actions they perform	"So there is only the observer and the dispatcher doing their own tasks."
	7.3	Determine tools and (weapon) systems that can be affected by the events	"If Charlie decides to destroy a target, this can be seen on everybody's radar screen."
8		*Combine the events into a coherent scenario (also: combine topics in a theory lesson)*	
	8.1	Indicate in a timeline the relations between the various events in the scenario	"The third event builds on the preceding event."
9		*Determine the ideal course of action for each scenario*	
	9.1	Indicate the ideal behaviour of the team and its members	"And then you want Bravo to ask for that information."
10		*Determine the prototypical mistakes and errors*	
	10.1	Determine for each event in a specific scenario what the most likely typical mistakes and errors are that a team and its members will make	"I guess that a mistake they will make at the beginning, is neglecting the time available."
11		*Determine the most adequate training strategies*	
	11.1	Start with relatively easy scenarios and progressively introduce more difficult scenarios	"First only a few targets will pop up, but later on more targets will pop up pretty much on the same time."
	11.2	Provide for scaffolding and fading out	"Well, after a few times you let them run the scenario without guidance."
	11.3	Make use of various didactical methods	"I would have every team member play the roles of the other team members as well."
	11.4	Actively involve the team members in the scenario	"The other trainees can observe the dispatcher and observer."
12		*Specify the timing, modality and content of feedback*	
	12.1	Assess the team's behaviour regularly in order to assess the time-to-time changes	"If they keep on scoring insufficient, than I would suggest to stop the training."

	12.2	Indicate the quality of the team's performance based on measures of both process and product	"The simulator can record all actions and communications, and I will replay this during the after action review."
	12.3	Give feedback to the team and/or team members, during the scenario and during an After Action Review	"If somebody makes a real mess of it, I will intervene immediately."
13		*Conduct formative and summative evaluations*	
	13	Conduct formative and summative evaluations	"Every scenario will be evaluated, just as the whole training day."
III		EVALUATE	
14		*Conduct a try-out*	
	14	Conduct a try-out	"First, we will play the scenario with the members of the project team."
15		*Conduct a pilot study*	
	15	Conduct a pilot study	"Then we will ask some trainees resembling the target group to play the scenario."
IV		PREREQUISITE TO ANALYSIS	
16		*Monitor progress*	
	16	Monitor progress (where is the participant in the analysis process: what has he done already and what should he still do?)	"OK, so I've checked the instructional objectives: what should I do now?"
17		*Familiarisation with experimental task*	
	17	Familiarisation with experimental task (FFTT, TANDEM, doing the analysis)	"Is this a real existing task?"
18		*Asking for clarification, making remarks*	
	18	Asking for clarification of guidelines, making remarks about guidelines	"What is a mental model?"
19		*Reading*	
	19	Reading the task descriptions or the guidelines	"I am going to read the part about the pyromaniac again."
V		PROGRESSIVE DEEPENING	
20		*Progressive deepening*	
	20	Progressive deepening: is a certain aspect of the task repeated several times, and does this lead to more specific and new information?	"Going through this several times results in a more detailed scenario, but I do not have that much time."

VI		MENTAL SIMULATION	
21		*Mental simulation*	
	21	Mental simulation: does the participant try to imagine certain aspects of the task performance (e.g. saying "first this, and then this") and does he make decisions based on this mental simulation?	"Do I see it clear that he first has to select a message, than click on the button to send it, and that he can not check whether the other team member has received it? That is a bad system design. However, this should be stressed during the training program."
VII		NEW	
N	**N**	Parts of the protocol that can not be coded with the existing codes of the coding scheme.	"How am I doing compared to the other participants of this experiment?"

APPENDIX J: QUALITY ASSESSMENT QUESTIONNAIRES FOR THE EXPERT RATERS

Protocol number:

Explanation with respect to the quality of the reasoning process:

1 = vary bad
2 = bad
3 = mediocre
4 = good
5 = very good

Always fill out a score!

Always complement a score with an explanation!

QUESTIONNAIRE FOR ASSESSING THE QUALITY OF THE PARTICIPANT'S ANALYSIS PROCESS (EXPERIMENT 1).

I. PREPARE:

1) Determine the goal of the analysis

Quality of reasoning: 1 2 3 4 5
Explanation:

2) Determine the scope of the analysis

Quality of reasoning: 1 2 3 4 5
Explanation:

3) Establish a project team

Quality of reasoning: 1 2 3 4 5
Explanation:

4) Make up an analysis and evaluation plan

Quality of reasoning: 1 2 3 4 5
Explanation:

5) Present the analysis and evaluation plan

Quality of reasoning: 1 2 3 4 5
Explanation:

II. CONDUCT AND EVALUATE:

1) Conduct a system analysis

Quality of reasoning: 1 2 3 4 5
Explanation:

2) Analyse the tasks conducted by a team (to what extent are the team aspects of the task performance analysed, like communication, co-ordination and information exchange?)

Quality of reasoning: 1 2 3 4 5
Explanation:

3) Determine the prerequisite knowledge, skills and attitudes

Quality of reasoning: 1 2 3 4 5
Explanation:

4) Formulate the team instructional objectives

Quality of reasoning: 1 2 3 4 5
Explanation:

5) Evaluate the results

Quality of reasoning: 1 2 3 4 5
Explanation:

<u>QUESTIONNAIRE FOR ASSESSING THE QUALITY OF THE PARTICIPANT'S DESIGN PROCESS (EXPERIMENT 2).</u>

I. PREPARE:

1) Determine the goal of the design process

Quality of reasoning: 1 2 3 4 5
Explanation:

2) Establish a project team

Quality of reasoning: 1 2 3 4 5
Explanation:

3) Determine the conditions

Quality of reasoning: 1 2 3 4 5
Explanation:

4) Make up a design and evaluation plan

Quality of reasoning: 1 2 3 4 5
Explanation:

II. DESIGN:

1) Review the instructional objectives

Quality of reasoning: 1 2 3 4 5
Explanation:

2) Make an outline of the learning trajectory

Quality of reasoning: 1 2 3 4 5

Explanation:

3) Specify the context and conditions

Quality of reasoning: 1 2 3 4 5

Explanation:

4) Determine the key events and participants

Quality of reasoning: 1 2 3 4 5

Explanation:

5) Combine the events into a coherent scenario

Quality of reasoning: 1 2 3 4 5

Explanation:

6) Determine the ideal course of action for each scenario

Quality of reasoning: 1 2 3 4 5

Explanation:

7) Determine the prototypical mistakes and errors

Quality of reasoning: 1 2 3 4 5

Explanation:

8) Determine the team training strategies

Quality of reasoning: 1 2 3 4 5

Explanation:

9) Specify the timing, modality and content of feedback to the team and individual team members

Quality of reasoning: 1 2 3 4 5
Explanation:

III. EVALUATE THE RESULTS:

1) Conduct a try-out

Quality of reasoning: 1 2 3 4 5
Explanation:

2) Conduct a pilot-study

Quality of reasoning: 1 2 3 4 5
Explanation:

APPENDIX K: EVALUATION QUESTIONNAIRE OF THE WORKSHOP

After both the morning session and the afternoon session, the participants were handed out an evaluation questionnaire they had to fill out immediately. Below the two questionnaires are presented in combination because of their similarity.

1) The structure of the guidelines supporting the analysis of team tasks / the design of team training scenarios has become clearer for me after following the workshop.

Completely agree	Agree	Neutral	Disagree	Completely disagree
☐	☐	☐	☐	☐

Remarks:

2) After following the workshop I have a better understanding of what is meant by the various steps of the guidelines.

Completely agree	Agree	Neutral	Disagree	Completely disagree
☐	☐	☐	☐	☐

Remarks:

3) I would like to apply these guidelines within my own job.

Completely agree	Agree	Neutral	Disagree	Completely disagree
☐	☐	☐	☐	☐

Remarks:

4) In case I would be assigned to design team training programs, I would use these guidelines.

Completely agree	Agree	Neutral	Disagree	Completely disagree
☐	☐	☐	☐	☐

Remarks:

5) The workshop is a good way to learn to work with the guidelines supporting the analysis of team tasks / design of team training scenarios.

Completely agree	Agree	Neutral	Disagree	Completely disagree
☐	☐	☐	☐	☐

Remarks:

6) What is your opinion on the timeframe (half day) to learn to use the guidelines?

Fat too short	Too short	Adequate	Too long	Far too long
☐	☐	☐	☐	☐

Remarks:

7) What are, according to your opinion, weak aspects of the guidelines? Please motivate your answer.

8) What are, according to your opinion, strong aspects of the guidelines? Please motivate your answer.

APPENDIX L: CODING SCHEME OF EXPERIMENT 3

The bold numbers in the second column are the codes that were used for scoring the protocols.

Code		Description	Illustration
I		ANALYSIS OF TEAM TASKS	
1		*Orientate on domain*	
	1	Orientate on domain (obtain general overview)	"Let's see what they should do." "I would definitely conduct interviews with the pilot team and go to the industry that develops this system."
2		*Conduct a context analysis*	
	2.1	Determine the system the team is part of	"So the team is working on a large ship."
	2.2	Determine the mission(s) of the system and the team	"The mission of the team is to protect the own ship."
	2.3	Determine the relations between team and other subsystems/teams	"I guess the team is supervised by an overall commander?"
3		*Analyse the tasks conducted by the team*	
	3.1	Describe individual task of the team members performance	"The observer can see how many fire fighting cars are needed for this fire." "Alfa checks the starting direction of the target."
	3.2	Describe interactions with other team members	"The observer can send e-mail messages to the dispatcher by clicking on that button."
	3.3	Identify the tasks performed by the team	"The team needs to determine which target to deal with first."
	3.4	Conduct cognitive task analysis, make Team Operational Sequence Diagram	"The system displays an asterisk, Alfa detects this and contacts Bravo."
4		*Determine the prerequisite knowledge, skills and attitudes (ksa's)*	
	4.1	Determine the prerequisite ksa's to perform an individual task	"Bravo needs to know how to interpret the display."
	4.2	Determine the prerequisite ksa's to perform a team task	"The team members need to communicate adequately with each other."
5		*Formulate the instructional objectives*	
	5.1	Determine to what extent the trainees possess the ksa's	"You can expect that somebody with this school diploma can handle a computer mouse."
	5.2	Formulate the instructional objectives at the individual level	"Every team member should be able to operate the computer equipment."
	5.3	Formulate the instructional objectives at the team level	"The team should recognise the need to support and correct each other during the team task performance."

II		DESIGN TEAM TRAINING SCENARIOS	
6		*Instructional objectives and learning trajectory*	
	6.1	Review, change and/or add the instructional objectives	"I do not regard this as an instructional objective."
	6.2	Make draft of learning trajectory (relations between learning environments, theory and hands-on lessons, relations between scenarios, relation between training and assessment)	"First comes a theory part in the classroom, followed by the hands-on training with the simulator."
7		*Specify context and conditions of scenario*	
	7	Specify context and conditions of scenario	"So every team member has a radar screen displaying all ships, aircraft and submarines, but none of them has the overall and complete picture."
8		*Determine the key events and participants*	
	8.1	Determine the key events that trigger the behaviour	"And then an aircraft comes in and they should take appropriate action on it."
	8.2	Identify the key parties and the tasks and actions they perform	"So there is only the observer and the dispatcher doing their own tasks."
9		*Combine the events into a coherent scenario (also: combine topics in a theory lesson)*	
	9	Indicate in a timeline the relations between the various events in the scenario	"The third event builds on the preceding event."
10		*Determine the ideal course of action for each scenario*	
	10	Indicate the ideal behaviour of the team and its members	"And then you want Bravo to ask for that information."
11		*Determine the prototypical mistakes and errors*	
	11	Determine for each event in a specific scenario what the most likely typical mistakes and errors are that a team and its members will make	"I guess that a mistake they will make at the beginning, is neglecting the time available."
12		*Determine the most adequate training strategies*	
	12.1	Increase the level of difficulty and fade out the support	"First only a few targets will pop up, but later on more targets will pop up pretty much on the same time." "Well, after a few times you let them run the scenario without guidance."
	12.2	Introduce unexpected deviations from the standard scenario	"And then the communication system does not operate anymore."

	12.3	Make use of various didactical methods	"I would have every team member play the roles of the other team members as well."
13		*Specify the timing, modality and content of feedback*	
	13.1	Specify the performance measurement (criteria, product and process, several times)	"If they keep on scoring insufficient, than I would suggest to stop the training." "The simulator can record all actions and communications, and I will replay this during the after action review."
	13.2	Give feedback to the team and/or team members, during the scenario and during an After Action Review	"If somebody makes a real mess of it, I will intervene immediately."
III		GENERAL CODES	
14		*Evaluation of results*	
	14	Check the (final and/or intermediate) results of the analysis and design process	"Aha, that piece of information was still missing."
15		*Monitor progress*	
	15	Monitor progress (where is the participant in the analysis process: what has he done already and what should he still do?)	"OK, so I've formulated the instructional objectives: what is next?" "Where am I now?"
16		*Familiarisation and reading*	
	16	Familiarisation with and reading of experimental task (FFTT, TANDEM, doing the analysis)	"Is this a real existing task?" "Let's see what Alfa needs to do."
17		*Asking for clarification of guidelines*	
	17.1	Asking for clarification of guidelines	"What is a mental model?"
	17.2	Making remarks about guidelines	"That's quite a lot of text."
18		*Irrelevant remarks*	
	18	Irrelevant remarks	"What a nice weather."
N		*New*	
	N	Parts of the protocol that can not be coded with the existing codes of the coding scheme.	"That reminds me of the training I have followed several years ago."

APPENDIX M: RESULTS OF WORKSHOP EVALUATION QUESTIONNAIRE

The numbers in the first column do not resemble the numbers of the participants. The participants filled out the questionnaire anonymously. The last row contains the answers of the instructor (I) who attended the workshop as well.

<u>Questions about the morning session (team task analysis)</u>

	1) The structure of the guidelines supporting the analysis of team tasks has become clearer for me after following the workshop.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	<u>Remarks</u>
1	X					
2			X			Should do more with it before it is of any use
3		X				
4		X				
5		X				Worked with it only little time
6		X				
I		X				The structure of the guidelines could be elaborated more

	2) After following the workshop I have a better understanding of what is meant by the various steps of the guidelines.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	<u>Remarks</u>
1	X					
2		X				
3	X					
4	X					
5		X				
6		X				
I	X					

	3) I would like to apply these guidelines within my own job.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	<u>Remarks</u>
1				X		
2			X			I do not make team training programs
3			X			
4			X			Our current guidelines are good as well, so I am not waiting for new and other guidelines

5			X			Not always applicable
6			X			
I		X				

	4) In case I would be assigned to design team training programs, I would use these guidelines.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	Remarks
1				X		
2			X			Should first be further elaborated before you know it is of any use
3			X			
4			X			See question 3
5			X			See question 3
6		X				
I		X				

	5) The workshop is a good way to learn to work with the guidelines supporting the analysis of team tasks.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	Remarks
1		X				
2		X				
3			X			Strongly depends of the kind of team
4	X					
5	X					
6		X				
I		X				Could be more elaborate

	6) What is your opinion on the timeframe (half day) to learn to use the guidelines?					
	Far too short	Too short	Adequate	Too long	Far too long	Remarks
1	X					
2		X				
3		X				
4		X				
5		X				
6		X				
I		X				

	7) What are, according to your opinion, weak aspects of the guidelines? Please motivate your answer.
1	To my opinion it is impossible / impractical to design the course of action of a scenarios too detailed in advance, including the desired actions and reactions.
2	Not yet sufficient knowledge of guidelines to answer this question.
3	Too detailed, sometimes overlap with Navy guidelines.
4	Too much text and occasionally difficult words.
5	Not always applicable in a simulator or an board of a ship.
6	Too much in too little time.

I	Too detailed, many small steps: this sometimes results in a bit confusion.

	8) What are, according to your opinion, strong aspects of the guidelines? Please motivate your answer.
1	For simple scenarios the guidelines are good to use before actually designing these scenarios.
2	See question 7.
3	The 'description' of the follow up phases (by means of the circles in the figures).
4	Clear figures with the circles.
5	The model is clear.
6	-
I	The main steps are good tools to work in a structured manner.

Questions about the afternoon session (team training scenario design)

	9) The structure of the guidelines supporting the design of team training scenarios has become clearer for me after following the workshop.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	Remarks
1	X					
2			X			Should work more with it to benefit from it.
3		X				
4		X				
5		X				
6		X				
I		X				The guidelines supporting the design of scenarios are better explained than the guidelines supporting the task analysis.

	10) After following the workshop I have a better understanding of what is meant by the various steps of the guidelines.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	Remarks
1	X					
2		X				
3	X					
4	X					
5		X				
6		X				
I		X				

	11) I would like to apply these guidelines within my own job.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	Remarks
1				X		
2			X			I do not make team training programs

3			X			
4			X			
5			X			Not always applicable.
6			X			
I		X				As complementary information, extra ideas.

	12) In case I would be assigned to design team training programs, I would use these guidelines.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	Remarks
1				X		
2			X			See question 11.
3			X			
4			X			
5			X			
6		X				
I		X				

	13) The workshop is a good way to learn to work with the guidelines supporting the design of team training scenarios.					
	Completely agree	Agree	Neutral	Disagree	Completely disagree	Remarks
1		X				
2		X				
3		X				
4	X					
5		X				
6		X				
I		X				

	14) What is your opinion on the timeframe (half day) to learn to use the guidelines?					
	Far too short	Too short	Adequate	Too long	Far too long	Remarks
1	X					
2		X				
3		X				
4		X				
5			X			
6		X				
I		X				

	15) What are, according to your opinion, weak aspects of the guidelines? Please motivate your answer.
1	See question 7.
2	See question 7.
3	The words used do not always resemble the topics of our own Navy course.
4	See question 7.
5	Not always applicable.
6	-
I	Too many small steps as well, too detailed, but clearer than the team task analysis.

	16) What are, according to your opinion, strong aspects of the guidelines? Please motivate

	your answer.
1	See question 8.
2	See question 7.
3	See question 8.
4	See question 8.
5	-
6	The feedback loop after each step.
I	The main steps.

UITGEBREIDE SAMENVATTING

Ontwerpen van teamtraining: Ontwikkeling en validering van richtlijnen

Mensen functioneren in omgevingen die steeds complexer worden als gevolg van technologische ontwikkelingen. Deze omgevingen worden gekenmerkt door een sterke dynamiek, hoge werk- en tijdsdruk, soms vijandige elementen, tegengestelde doelen, onvolledige en tegenstrijdige informatie en samenwerking met anderen in verschillende rollen en verantwoordelijkheden (Salas, Bowers & Cannon-Bowers, 1995; Orasanu & Salas, 1993; Rouse, Cannon-Bowers & Salas, 1992). Veel taken kunnen niet meer door een enkele functionaris uitgevoerd worden, maar slechts door een team. Een team is een groep van twee of meer mensen, met een gezamenlijk doel, een specifieke opdracht, en taken en activiteiten die afhankelijk van elkaar zijn (Dyer, 1984). Ongevalsrapportages en analyses van militair optreden laten zien dat louter een on-the-job teamtraining niet optimaal is: het bij elkaar zetten van individuele experts leidt niet vanzelf tot de vorming van een expert-team (Salas, Cannon-Bowers, & Johnston, 1997). Gerichte teamtraining is dus noodzakelijk. Voor teamtraining betekent dit dat de leden van een team leren met elkaar samen te werken (Druckman & Bjork, 1994). Slechts recent zijn organisaties begonnen met het trainen van teams. Met name binnen de krijgsmacht worden hierbij virtuele omgevingen ingezet, alsmede al dan niet genetwerkte simulatoren en games. Het is echter niet altijd duidelijk welke, en hoe, onderwijskundige principes worden toegepast bij de training van teams (Salas & Cannon-Bowers, 1997). Het lijkt er op dat deze zijn afgeleid uit individuele functie-opleidingen, en dat er nauwelijks rekening wordt gehouden met de karakteristieke eigenschappen van teams, het leren door teams en het evalueren en verbeteren van teamprocessen. Als gevolg hiervan ligt bij het ontwikkelen van teamtrainingen voornamelijk de nadruk op technische zaken (zoals de interoperabiliteit van systemen) en minder op onderwijskundige en leerpsychologische zaken. Het proces van het ontwerpen en ontwikkelen van teamtraining zou effectiever en efficiënter kunnen verlopen als hiervoor een meer formele en systematische methode beschikbaar is (Armstrong & Reigeluth, 1991; Miller, Guerette & Morgan, 1987; Rizzo, 1980; Van Berlo, 1996a). Om meer inzicht te krijgen in de complexiteit van het ontwikkelen van teamtrainingen is een literatuurstudie uitgevoerd (Van Berlo, 1996a, 1998a), gebaseerd op conferentie proceedings, boeken en rapporten; artikelen in gereviewde tijdschriften bleken nauwelijk te gaan over opleidingsontwikkeling voor teamtraining. Verschillende databases zijn geraadpleegd (ERIC, Picarta, Psychinfo, RAND en Stinet) op publicaties van de afgelopen 25 jaar, gebruikmakend van de combinatie van de zoektermen ‘teamtraining’, ‘instructional design’, ‘guidelines’ and ‘methodology’. Daarnaast is een veldstudie verricht om meer zicht te krijgen op de specifieke problemen die de krijgsmacht op dit gebied heeft. Twaalf interviews zijn uitgevoerd met personen verantwoordelijk voor het ontwikkelen van teamtrainingen. Andere bronnen van informatie (Yin, 1984) waren documenten (rapporten, beschrijvingen van interviews en bezoeken), observaties (bijwonen van oefeningen) en fysieke artefacten (met name simulatoren). Uit de veldstudie bleek dat er veel activiteiten zijn op het gebied van teamtraining, maar dat deze niet altijd goed gestructureerd zijn: opleidingsontwikkelaars hebben geen duidelijke middelen en richtlijnen die hen hierbij ondersteunen. Het uitvoeren van een taakanalyse lijkt daarom een belangrijke activiteit om te komen tot de leerdoelen, die het uitgangspunt van het ontwikkelproces vormen. Met betrekking tot teamtaken wordt deze analyse echter nauwelijks uitgevoerd, met als gevolg slecht geformuleerde leerdoelen. Dit is een belemmering voor het ontwikkelen van teamtraining scenario's. De primaire gedachte bij het ontwikkelen van een teamtraining scenario is dat het de realiteit zo goed mogelijk benadert en dat het uitdagend is. Maar het is te weinig gebaseerd op systematisch geformuleerde leerdoelen waarin het aan te leren gedrag is beschreven, wat vervolgens gebruikt kan worden voor de prestatiemeting en het geven van feedback. Er lijkt derhalve ruimte voor verbetering van de analyse en de ontwikkeling van teamtrainingen als fasen voorafgaand aan de daadwerkelijke uitvoering ervan. Dit kan bereikt worden door het geven van ondersteuning aan het personeel verantwoordelijk voor de opleidingsontwikkeling. De Nederlandse krijgsmacht erkende deze situatie en vroeg TNO een onderzoeksprogramma te starten gericht op het optimaliseren van de kwaliteit van teamtrainingen. Het onderzoek beschreven in dit proefschrift is uitgevoerd als onderdeel van dit onderzoeksprogramma en is gericht op (a) de wijze waarop opleidingsontwikkelaars ondersteund kunnen worden bij het analyseren van teamtaken en het ontwikkelen van teamtraining scenario's, (b) het valideren van deze ondersteuning, en (c) hoe de resultaten kunnen bijdragen aan een opleidingsontwikkelingsmodel voor teamtraining.

Analyse en ontwikkeling zijn slechts twee fasen van het creëren van een leeromgeving, en ze worden aangeduid met de term opleidingsontwikkeling (Instructional Design, oftewel ID). ID is gericht op het analyseren van taken en competenties, het formuleren van leerdoelen, het definiëren van trainingsstrategieën en het ontwerpen van leeromgevingen. Het eerste hoofdstuk geeft een beschrijving van en reflectie op ID expertise. De karakteristieken van teams, teamprestatie en teamleren worden beschreven in hoofdstuk 2, gevolgd door een discussie over ID voor teamtraining (hoofdstuk 3). De opleidingsontwikkelaars in dit onderzoek zijn beginnende militaire opleidingsontwikkelaars. Er wordt beargumenteerd waarom richtlijnen voor hen de meest geschikte vorm van ondersteuning zou zijn. Huidige richtlijnen voor het ontwikkelen van teamtrainingen zijn beoordeeld, en de richtlijnen die zijn ontwikkeld ter ondersteuning van de analyse van teamtaken en het ontwikkelen van teamtraining scenario's worden beschreven. Het zal duidelijk worden dat in dit proefschrift een constante spanning aanwezig is tussen nieuwe en constructivistische paradigma's op leren, de karakteristieken van ID, de behoefte aan het systematisch ontwerpen van training en de beste wijze waarop opleidingsontwikkelaars ondersteund kunnen worden. De empirische studies die zijn uitgevoerd om de richtlijnen te valideren zijn beschreven in hoofdstukken 4 en 5. Tenslotte wordt er in hoofdstuk 6 afgesloten met een discussie.

1. Opleidingsontwikkeling

ID is zowel toegepast onderzoek, gericht op werkbare oplossingen voor concrete opleidingsproblemen als meer fundamenteel onderzoek gericht op het testen van theoretisch gefundeerde ondersteuningsmogelijkheden (Elen, 1994). In de afgelopen twintig tot dertig jaren is er binnen de ID-gemeenschap een paradigmaverschuiving opgetreden. Visies op leren en opleidingsontwikkeling zijn verschoven van een behavioristische, via een cognitieve naar een constructivistische visie (Greer & Verschaffel, 1990; Vanmaele, 2002). Deze paradigmaverschuiving is gerelateerd aan opvattingen over de relatie tussen het lerende individu en de realiteit, evenals aan de wijze waarop iemand kennis verwerft (Vanmaele, 2002). Dit zal kort worden toegelicht. In de *behavioristische* visie wordt het leren door een individu van buitenaf gecontroleerd door een instructeur of een computerprogramma, waarbij de nadruk ligt op het verwerven van observeerbaar gedrag. De leerinhoud is opgedeeld in duidelijke blokken, gepresenteerd in een lineaire volgorde, nauwelijks ingebed in een bepaald domein of realistische context, en dient eenvoudigweg gereproduceerd te worden door de lerende. Opleidingsontwikkeling is lineair en volgt een pad met duidelijke stappen van begin tot een duidelijk herkenbaar eind. Onderzoeksresultaten vanuit de psychologie zijn makkelijk te vertalen in voorschriften voor opleidingsontwikkeling.

In de *cognitieve* visie is leren gericht op het verwerven van complexe, cognitieve processen. Gagné, Briggs en Wager (1992) onderscheiden vijf typen leerdoelen: intellectuele vaardigheden (o.a. probleem oplossen), cognitieve strategieën, verbale informatie, motorische vaardigheden en attituden. Elk leerdoel op een hoger niveau omvat de leerdoelen op een lager niveau. Deze visie impliceert dat de lerende zijn/haar eigen leerproces kan reguleren. Niet alleen het resultaat, maar het leerproces zelf wordt beschouwd als een belangrijke focus van instructie. De leerinhoud is vastgesteld op basis van een uitgebreide analyse van het domein zoals een expert dat ziet. De instructie geeft duidelijk aan welke weg de beginnende leerling dient te volgen om de leerinhoud te beheersen. De leerinhoud wordt beschouwd als samenhangende onderdelen, toe te passen in een realistische context (zie ook Van

Merriënboer, 1997). Onderzoeksresultaten vanuit de psychologie zijn relatief makkelijk te vertalen in voorschriften voor opleidingsontwikkeling.

In de *constructivistische* visie wordt het leren van een individu beschouwd als zelf-gestuurd en constructief. Leerdoelen en criteria voor beoordeling kunnen echter niet vooraf vastgesteld worden. Het leerproces en de hieruit voortvloeiende veranderende behoeften van de lerende resulteren in steeds veranderende en nieuwe leerdoelen. Niet de opleidingsontwikkelaar reguleert het leerproces, maar de lerende zelf. Opleidingontwikkeling is gericht op het creëren van open leeromgevingen waarin de lerende wordt geconfronteerd met een complexe en uitdagende (gesimuleeerde) realiteit, die hem/haar uitdaagt om nieuwe domeinen de ontdekken en kennis op te bouwen gebaseerd op eerdere leerervaringen. Dit vereist een complexe balans tussen gestructureerde didactische ondersteuning enerzijds, en het creëren van de meest geschikte condities voor zelf-regulering anderzijds (De Corte, 1996; Verschaffel, 1995). Als gevolg van de complexiteit en onvoorspelbaarheid van het leerproces, zijn onderzoeksresultaten uit de psychologie moeilijk te vertalen in voorschriften voor opleidingsontwikkeling. Binnen de constructivistische visie kunnen drie varianten op een continuum worden onderscheiden: een sterke, een milde en een zwakke (Lowyck & Elen, 1993). Sterke constructivistische theorieën veronderstellen dat kennis niet is gebonden aan een externe realiteit, maar uitsluitend is gebaseerd op persoonlijke ervaringen van het individu (Jonassen, 1990). Zij zien leren als een voornamelijk cognitieve activiteit, die volledig wordt geïnitieerd en bewaakt door de lerende zelf (Lowyck & Elen, 1993). Alhoewel zelf-gereguleerd leren het ideaal kan zijn, beargumenteren milde constructivistische theorieën dat het meeste leren een interactie inhoudt tussen het intern (cognitieve) en extern (het leermateriaal) initiëren en bewaken van het leerproces. Volgens de zwakke constructivistische theorieën oefenen cognitieve activiteiten en processen slechts een beperkte invloed uit op het leerproces dat immers wordt geïnitieerd en bewaakt door externe stimuli (Lowyck & Elen, 1993).

Ongeacht de visie of theorie die men aanhangt is het geaccepteerd dat lerende mensen actief zijn: ID zou zich daarom niet moeten richten op het controleren van het gehele leerproces, maar op het bevorderen van de capaciteiten die leren mogelijk maken. In navolging van Lowyck en Elen (1993) wordt in dit proefschrift een milde constructivistische visie op ID aangehouden en worden de moeilijkheden erkend van het vertalen van onderzoeksresultaten uit de psychologie naar voorschriften voor ID. Lowyck and Elen (1993) definiëren ID als (1) een theorie-gebaseerde discipline die niet alleen procedures aanbiedt die werken, maar ook verklaringen waarom deze werken in bepaalde omstandigheden, (2) gericht op voorschriften, implicerend dat theorie-gebaseerde en empirisch gevalideerde regels, procedures en/of instrumenten worden ontwikkeld die een meer onderbouwde besluitvorming mogelijk maken in concrete situaties en (3) een toegepaste discipline gericht op de toepasbaarheid in concrete situaties van resultaten van fundamenteel onderzoek.

ID heeft een sterke behavioristische traditie. De meeste ID modellen zijn gericht op het controleren van specifieke leerresultaten door het geven van richtlijnen die de waarschijnlijkheid verhogen dat deze leerresultaten daadwerkelijk bereikt worden. De modellen hebben dus een meer controlerende dan een voorspellende waarde (Lowyck & Elen, 1993). Prescriptieve modellen helpen de opleidingsontwikkelaar wel bij het verbeteren van materialen (Braha & Maimon, 1997), maar het nemen van beslissingen tijdens het ontwikkelproces valt moeilijk te ondersteunen. Verstegen (2004) geeft hiervoor verschillende verklaringen: (a) modellen geven tegenstrijdige adviezen, (b) in werkelijkheid worden beslissingen meer gebaseerd op pragmatische dan op theoretische gronden (c) beslissingen worden beïnvloed door verschillende mensen in een ontwikkelteam en/of belanghebbenden die elk verschillende meningen hebben en (d) modellen beschrijven welke beslissingen genomen dienen te worden maar niet hoe dat het beste kan.
Tegelijkertijd met de paradigmaverschuiving in ID, is de definitie van 'ontwikkelen' eveneens aan het veranderen (Elen, 1995). Aanvankelijk sloeg ontwikkelen op het maken van beslissingen over, en de toepassing van, procedures, methoden, voorschriften en middelen ten behoeve van het realiseren van effectief, efficiënt en productief leren (Romiszowski, 1981). De introductie en toennemend gebruik van open elektronische leeromgevingen heeft geleid tot de definitie van een "grounded learning systems design" (Hannafin, Hannafin & Land, 1997, p. 102), gedefinieerd als "the systematic implementation of processes and procedures that are rooted in established theory and research in human learning." Dit leidt tot het vervagen van de traditionele grenzen tussen ontwikkelen en implementeren (Lowyck, 2000; Tennyson, 1995). Ontwerp wordt niet meer beschouwd als een lineair en extern gestuurde activiteit, maar als een flexibel en iteratief proces waarbij meerdere actoren (o.a. lerenden, coaches, instructeurs, ontwerpers) zijn betrokken. Dit interactie perspectief lijkt de kern te zijn van het ontwikkelen van krachtige leeromgevingen (Lowyck, 2000). ID wordt beschouwd als een intuïtieve, artistieke onderneming (Lowyck, 1991) en als een open taak gekenmerkt door weinig beperkingen, meerdere correcte oplossingsmogelijkheden en weinig standaard toe te passen ontwerpregels (Perez, Fleming Johnson & Emery, 1995). De effectiviteit van deze regels en procedures ter ondersteuning van de opleidingsontwikkeling wordt door meerdere auteurs betwijfeld. Een belangrijk punt van kritiek is de reductionistische benadering door het eindeloos opsplitsen van de te leren taak en de voorwaardelijke kennis en vaardigheden (Winn, 1990), gebaseerd op een behavioristische visie op leren (Perez et al., 1995). Gerelateerd hieraan is het probleem van het te zeer proceduraliseren van complexe stappen

en processen tot op het niveau van triviale activiteiten (McCombs, 1986). Alhoewel specifieke regels worden gegeven, benadrukken deze meer de procedurele kennis ('wat en hoe te doen') van opleidingsontwikkeling en niet zozeer de declaratieve kennis ('waarom te doen') (McCombs, 1986; Perez et al., 1995) of de conditionele kennis ('wanneer te doen'). Volgens Wilson en Cole (1992, p. 73) is er "a growing indication that instructional designers do not apply formal models in a lock-step fashion. Indeed, ID models often fail to capture expert designers' knowledge and skill. This common problem between theory and practice is aggravated when the 'prescriptive' ID models are represented in a highly technical and rigidly proceduralized fashion". Prescriptieve richtlijnen beschrijven dan wel wat de mechanismen zijn die ten grondslag liggen aan leren, maar de toepassing hiervan in de praktijk blijkt problematisch te zijn omdat van ontwikkelaars wordt verwacht dat ze generieke principes voor opleidingsontwikkeling afleiden van generieke principes van leren en deze vervolgens toepassen op een specfieke taak of domein (Perez et al., 1995). Wilson en Cole (1992) geven aan dat de procedurele benadering twee problemen kent: (a) de procedurele voorschriften gaan vaak veel verder dan de kennis die een ontwikkelaar heeft over leren en opleiding en (b) opleidingsontwikkelaars lijken modellen meer op basis van de principes toe te passen dan exact de regels te volgen. Het toepassen van ID modellen leidt niet automatisch tot effectieve trainingssystemen (Carroll, 1990; Winn, 1990). Volgens Winn (1989, in Lowyck, 1991) werken recepten soms, en alleen in contexten die opvallend veel overeenkomsten vertonen met de context waarin de recepten zijn ontwikkeld. Omdat opleidingsontwikkelaars vaak niet beschikken over de kennis, vaardigheden en/of ervaring om deze voorschriften op de juiste wijze te gebruiken, is de kwaliteit van de output van het ontwikkelproces teleurstellend (McCombs, 1986). In combinatie met de complexiteit van het ID proces zorgt dit ervoor dat ID duur, arbeidsintensief en tijdrovend is en dat verschillende stappen niet of slechts gedeeltelijk worden uitgevoerd (Perez et al., 1995; Rowland, 1992). Tenslotte, omdat persoonlijke ervaring en creativiteit kritische succesfactoren zijn, wordt ID eerder beschouwd als een kunst dan een kunde (Lowyck, 1991; Winn, 1990).

2. Functioneren en trainen van teams

Kenmerkend voor het optreden van teams is dat de werkzaamheden kunnen worden onderverdeeld in taakwerk ('taskwork') en teamwerk ('teamwork'). Taakwerk slaat op de cognitieve en technische competenties die nodig zijn om werkzaamheden te kunnen uitvoeren. Teamwerk slaat op de sociale en communicatieve competenties die nodig zijn om als team te kunnen functioneren. Niet alleen een individueel teamlid, maar ook het team als geheel dient over deze competenties te beschikken. In feite zijn er dus vier typen competenties te onderscheiden (Van Berlo, 1997b): individuele taakwerk competenties (bv.

plotten van data op tactische schermen), sociale en communicatieve competenties om in een groep te kunnen functioneren (bv. leiding geven, overleggen), teamtaak competencies (bv. uitvoeren van een evacuatieplan), en de teamwerk competenties, oftewel de sociale en communicatieve competenties om te functioneren als een team (bv. elkaar ondersteunen). Smith-Jentsch, Johnston en Payne (1998) hebben deze teamwerk competenties verder onderverdeeld in vier dimensies: informatie-uitwisseling, communicatie, ondersteunend gedrag en initiatief/leiderschap. Informatie-uitwisseling heeft betrekking op het gebruiken van alle beschikbare informatie, het geven van informatie aan de juiste personen voordat hiernaar wordt gevraagd, en het regelmatig geven van situatie updates. Communicatie heeft betrekking op het gebruiken van de juiste terminologie, de volledigheid van berichten, het vermijden van irrelevante communicatie en het ervoor zorgen dat de communicatie goed doorkomt. Ondersteunend gedrag omvat het corrigeren van fouten en zowel het geven als vragen om assistentie als dit nodig is. Initiatief/leiderschap houdt het geven van begeleiding en suggesties aan teamleden in en het stellen van duidelijke prioriteiten.

Opleidingsontwikkeling voor teamtraining blijkt nauwelijks te worden ondersteund vanuit de literatuur. De gevonden richtlijnen zijn vrij generiek van aard. Stappen beschrijven wat een ontwikkelaar of instructeur dient te doen, maar niet waarom en hoe dit het beste kan gebeuren. Sommige richtlijnen (Armstrong & Reigeluth, 1991; Miller, Guerette & Morgan, 1987) proberen een relatie te leggen tussen de ontwikkelingsfasen die een team van nature doorloopt (Morgan, Glickman, Woodward, Blaives & Salas, 1986) en onderwijskundige richtlijnen. De overgang van de ene fase naar de andere fase, en wat dit betekent voor training van teams, wordt echter nauwelijks concreet aangegeven. De enige methode waarvan de toepasbaarheid voor de training van teams empirisch is vastgesteld is de Team Dimensional Training (TDT) methode (Smith-Jentsch et al., 1998). Hierin wordt duidelijk aangegeven op welke wijze de teamwerkcompetenties kunnen worden getraind en geëvalueerd. De richtlijnen ondersteunen het team in het zelf evalueren en verbeteren van de teamprocessen, en de instructeur in het faciliteren van dit proces. Specifiek met betrekking tot de analyse van teamtaken zijn nagenoeg geen richtlijnen beschreven in de literatuur. Een uitzondering is de Multiphase Analysis of Performance (MAP: Levine & Baker, 1991), maar de toepasbaarheid hiervan in het kader van opleidingsontwikkeling voor teamtraining lijkt beperkt. Een veldstudie liet zien dat de domeinexperts het moeilijk vonden om de voorwaardelijke kennis en vaardigheden voor de uitvoering van de teamtaken te identificeren terwijl dit toch een essentiële voorwaarde is voor het formuleren van de leerdoelen. Een Team Operational Sequence Diagram (TOSD: Helsdingen, Bots, Riemersma, Schijf & Van Delft, 2000) beschrijft de interacties tussen het team en de

omgeving, evenals de processen binnen een team, en visualiseert deze in een tijdsafhankelijke volgorde.
Met betrekking tot het ontwikkelen van teamtraining scenario's is slechts een specifieke set van richtlijnen gevonden (Prince, Oser, Salas & Woodruff, 1993). Deze richtlijnen slaan echter op een deel van het gehele ontwikkelproces: het ontwikkelen van een blauwdruk, het implementeren hiervan in een prototytpe scenario en het uitvoeren van een try-out worden slechts gedeeltelijk beschreven. Het op welk moment geven van welk type feedback wordt evenmin toegelicht, alhoewel dit wel belangrijke aspecten van een trainingscenario zijn. Hoewel niet specifiek gericht op teams, kan het Goal-Based Scenario raamwerk (Schank, Fano, Bell & Jona, 1993/1994) waardevol zijn. De waarde zit in de gestructureerde opbouw van een scenario: een missie bestaat uit verschillende taken, die vervolgens kunnen worden opgesplitst in handelingen. Een scenario kan ontwikkeld worden op elk van deze onderscheiden niveaus. Een ander sterk aspect is de nadruk op het leren van vaardigheden en op een scenario dat de ruimte moet bieden om deze daadwerkelijk te leren. Het goed omschrijven van het te leren teamgedrag, en hoe dit te observeren, is beschreven in de TARGETs methode (Fowlkes, Lane, Salas, Franz & Oser, 1994).

3. Richtlijnen ter ondersteuning van ID voor teamtraining

Principes die ten grondslag dienen te liggen aan de training van teams (Cannon-Bowers, Salas, Tannenbaum & Mathieu, 1995; Salas & Cannon-Bowers, 1997) leiden niet automatisch tot een besef bij opleidingsontwikkelaars hoe deze het beste toegepast kunnen worden in een concreet opleidingsontwerp. Deze principes dienen dus vertaald te worden in praktisch toepasbare ondersteuning voor de opleidingsontwikkelaar. Deze ondersteuning kan op verschillende manieren worden gegeven variërend van een handboek voor het ontwikkelen van teamtraining, richtlijnen of een computer-ondersteunde tool, tot een cursus, workshops, job-aids en coaching door een meer ervaren collega. In dit onderzoek is gekozen voor ondersteuning in de vorm van richtlijnen. Verschillende redenen liggen hieraan ten grondslag. Ten eerste is het onderzoek uitgevoerd als onderdeel van een onderzoeksproject voor de krijgsmacht. De ondersteuning dient derhalve geschikt te zijn voor militaire opleidingsontwikkelaars. In het algemeen is militair personeel gewend om te werken met procedures, richtlijnen en specifieke werkinstructies: en dat geldt ook voor militaire opleidingsontwikkelaars. Bovendien is opleidingsontwikkeling voor teamtraining een relatief onontgonnen terrein. Met betrekking tot opleidingsontwikkeling voor teams kunnen de militaire opleidingsontwikkelaars worden beschouwd als beginners. Bovendien wisselt het militaire personeel binnen drie jaar van functie, waardoor het lastig is expertise op te bouwen. Een voorwaarde om toepasbaar te zijn, is dat de ondersteuning zo concreet mogelijk is. En de intentie van richtlijnen is juist om zo goed mogelijk aan te sluiten bij de wijze waarop mensen werken. Daarom is er voor gekozen om de richtlijnen een analytische structuur te geven, bestaande uit diverse stappen en deelstappen. Dit heeft het risico van cognititieve overbelasting bij de opleidingsontwikkelaars. Aan de andere kant kunnen de richtlijnen de opleidingsontwikkelaars op een stapsgewijze manier ondersteunen, waarbij tegelijkertijd aandacht kan worden besteed aan het dynamische en iteratieve karakter van opleidingsontwikkeling. Dit heeft geleid tot verschillende stappen die elkaar gedeeltelijk overlappen en in elkaar overgaan, en tot het aangeven van relaties tussen verschillende stappen. Verder wordt regelmatig gelegenheid geboden tot het expliciet evalueren van de (tussentijdse) resultaten van het opleidingsontwikkelingsproces. Dit heeft tot gevolg dat de aard van de richtlijnen zich situeert tussen lineair en iteratief. Een andere nuttige manier van ondersteuning is het geven van een meer interactieve workshop. Maar om deze vorm van ondersteuning te kunnen bieden, dient de specifieke inhoud ervan wel bekend te zijn. Daarom is er voor gekozen om in eerste instantie richtlijnen te ontwikkelen en te testen, en om later te bepalen of een workshop nuttig zou zijn (Van Berlo, 1997c). Op deze wijze hebben we getracht om te gaan met de spanning tussen nieuwe en meer constructivistische paradigma's op leren, de eigenschappen van ID, de behoefte aan het systematisch ontwerpen van opleidingen en de beste wijze waarop opleidingsontwikkelaars ondersteund kunnen worden, hierbij tevens in acht nemend de kenmerken van de militaire organisatie waarin zij werken. De richtlijnen ter ondersteuning van het analyseren van teamtaken en het ontwikkelen van teamtraining scenario's worden hieronder kort beschreven.

Het analyseren van teamtaken omvat drie fasen: (I) voorbereiden, (II) uitvoeren en evalueren, en (III) presenteren. Elke fase bevat verschillende stappen. Gedurende het gehele proces worden regelmatig evaluaties uitgevoerd. Hoewel de primaire volgorde van de fasen voorbereiden → uitvoeren en evalueren → presenteren is, kan de opleidingsontwikkelaar eerder doorlopen fasen en stappen opnieuw volgen als de resultaten van tussentijdse evaluaties hiertoe aanleiding geven. De derde fase houdt niet meer in dan het presenteren van de uiteindelijke resultaten aan het management van de organisatie. De overige fasen en stappen worden hieronder kort beschreven. Fase I - Voorbereiden, bestaat uit zes stappen: (1) bepalen van het doel van de analyse, (2) bepalen van het bereik van de analyse, (3) samenstellen van een projectteam, (4) maken van een analyse- en evaluatieplan, (5) presenteren van het analyse- en evaluatieplan aan het management van de organisatie, en (6) evalueren van de resultaten. De input van fase II - Uitvoeren en evalueren, is de output van de eerste fase. Het uitvoeren en evalueren van de teamtaak analyse is een iteratief proces. Het projectteam dient continu te monitoren welke informatie is verzameld, wat de kwaliteit van de informatie is, of aanvullende informatie nodig is, en of bijkomende informatiebronnen geraadpleegd dienen te worden. Gebaseerd op deze tussentijdse evaluaties kan besloten worden om eerder doorlopen stappen opnieuw te volgen. Het uitvoeren en evalueren van de analyse is dus een geïntegreerd proces dat uit de volgende zes stappen bestaat: (1) oriënteren op het domein, (2) uitvoeren van een systeem analyse, (3) analyseren van de taken die door het team worden uitgevoerd, (4) vaststellen van de vereiste kennis, vaardigheden en attituden, (5) formuleren van leerdoelen, en (6) evalueren van de resultaten. Omdat veel karakteristieke eigenschappen van teamfunctioneren niet direct observeerbaar zijn (de teamprocessen) wordt een gedragsanalyse aangevuld met een meer cognitieve taakanalyse. De gedragsanalyse wordt uitgevoerd door de teamtaak op te splitsen in deeltaken aan de hand van de hiërarchische taak analyse (HTA) methode. Een HTA is een beschrijving van de taak op verschillende niveaus: ze geeft inzicht in de wijze waarop en de volgorde waarin (deel)taken kunnen of zouden moeten worden uitgevoerd. Een HTA levert een beschrijving op van de context waarbinnen de taak wordt uitgevoerd en de eisen die aan de taakuitvoering worden gesteld, identificeert de problematische en moeilijke taakaspecten, evenals de deeltaken die complexe cognitieve vaardigheden vereisen. Vervolgens worden de teamtaken gedetailleerder geanalyseerd met behulp van de Team Operational Sequence Diagrams (TOSD's) om meer inzicht te verkrijgen in de cognitieve aspecten van de taakuitvoering. Een TOSD is een beschrijving van de teamtaak op één niveau en geeft een beter overzicht van de afhankelijkheden en temporele relaties tussen de (deel)taken dan de HTA. De teamprocessen kunnen worden gevisualiseerd door in kolommen de verschillende teamleden te onderscheiden en daarin, in een logische tijdsvolgorde, de stappen waaruit de teamtaak bestaat weer te geven. Een extra kolom kan expert-informatie bevatten, zoals bijvoorbeeld specifieke overwegingen, tips en trucs, en verkorte werkwijzen. Hoewel dus eerst een HTA wordt uitgevoerd en vervolgens een TOSD wordt opgesteld, zijn waarschijnlijk diverse iteraties vereist om alle relevante informatie te verkrijgen.

De output van de teamtaakanalyse (de leerdoelen) vormt de input voor het ontwikkelen van teamtraining scenario's. Het ontwikkelen van scenario's is een iteratief proces: de ontwikkelde (tussentijdse) producten worden namelijk frequent geëvalueerd om vervolgens weer te worden aangepast. De richtlijnen bestaan uit drie fasen: (I) voorbereiden, (II) ontwikkelen, en (III) evalueren. Elke fase bestaat uit verschillende stappen en deelstappen. Hoewel de primaire volgorde van de fasen voorbereiden → ontwikkelen → evalueren is, kan de opleidingsontwikkelaar eerder doorlopen fasen en stappen opnieuw volgen als de resultaten van tussentijdse evaluaties hiertoe aanleiding geven. Fase I - Voorbereiden, bestaat uit vier stappen: (1) bepalen van het doel van het ontwikkelproces, (2) samenstellen van een project team, (3) vaststellen van de randvoorwaarden, en (4) maken van een ontwikkel- en evaluatieplan. Fase II - Ontwikkelen, bestaat uit negen iteratief te volgen stappen aan de hand waarvan het te ontwikkelen scenario steeds gedetailleerder wordt uitgewerkt. De volgende stappen worden onderscheiden: (1) beoordelen van de leerdoelen, (2) specificeren van de context en voorwaarden, (3) bepalen van de belangrijkste gebeurtenissen en deelnemers, (4) combineren van de gebeurtenissen in een samenhangend scenario, (5) bepalen van het ideale verloop van het scenario, (6) voor elke gebeurtenis voorzien van de typische fouten die leerlingen kunnen maken, (7) bepalen van de meest geschikte trainingsstrategie, (8) bepalen van de timing, modaliteit en inhoud van de feedback, en (9) evalueren van de resultaten. Fase III - Evalueren, bestaat uit vier stappen: (1) maken van een evaluatieplan, (2) uitvoeren van formatieve evaluaties, (3) uitvoeren van een try-out, en (4) uitvoeren van een pilotstudie.

4. Testen van het effect van de richtlijnen

ID is een complex terrein met verschillende fasen waarin diverse actoren een rol spelen. Afhankelijk van de actoren en de fasen waarin ze werkzaam zijn, zijn verschillende vormen van ondersteuning mogelijk. In dit onderzoek is gekozen voor richtlijnen ter ondersteuning van opleidingsontwikkelaars tijdens de analyse- en ontwerpfasen. Deze inperking leidde uiteraard tot een beperkte generaliseerbaarheid van de resultaten. Desalniettemin kunnen de resultaten bijdragen aan het ontwikkelen en testen van nieuwe inzichten. Empirisch onderzoek is een essentiële stap om te komen tot gevalideerde richtlijnen. Vanwege het praktijkrelevante karakter van ID-onderzoek dient dit onderzoek ecologisch valide te zijn (Elen, 1995). Deze ecologische validiteit wordt zoveel mogelijk bereikt in naturalistische omgevingen en door het uitvoeren van ontwikkelexperimenten (design experiments). Een ontwikkelexperiment is gericht op het ontwikkelen van innovatieve onderwijskundige omgevingen en tegelijkertijd op het uitvoeren van experimenteel onderzoek naar deze innovaties (Brown, 1992). Dit type onderzoek streeft naar het overbruggen van de kloof tussen de kennisbasis van de onderzoeker (met betrekking tot een onderwerp en het leren door de lerende) en de onderwijskundige ondersteuning die tijdens het leren geboden wordt. Een ontwikkelexperiment is een empirische studie waarin de onderwijskundige ondersteuning op een iteratieve manier wordt ontwikkeld, geïmplementeerd, gevalideerd en herzien (Brown, 1992; De Corte, 2000). Doel is het overbruggen van de kloof tussen descriptief en prescriptief onderzoek. Descriptief onderzoek is gericht op het beschrijven en verhelderen van de realiteit, terwijl prescriptief onderzoek zoekt naar mogelijkheden om die realiteit te veranderen door middel van interventies (Elen, 1995). De behoefte hiernaar werd al aangegeven door Munsterberg (1899, geciteerd door Dewey, 1900) die pleitte voor een link tussen het onderwijskundig onderzoek en de onderwijskundige praktijk. Ontwikkelexperimenten kunnen worden beschouwd als gestructureerde casestudies, eerder gericht op het genereren en verkennen, dan op het testen van hypothesen. Niettemin is het belangrijk op te merken dat de naturalistische omgeving waarin ontwikkelexperimenten worden uitgevoerd, niet automatisch experimentele controle in de weg staat. In dit onderzoek zijn hypothesen geformuleerd om de data-analyse te structureren en accurate conclusies te formuleren, in het besef van de beperkte generaliseerbaarheid van de resultaten.

Het onderzoek is gericht op het (a) nagaan van de wijze waarop opleidingsontwikkelaars ondersteund kunnen worden bij het analyseren van teamtaken en het ontwikkelen van teamtraining scenario's, (b) valideren van deze ondersteuning, en (c) nagaan hoe de resultaten kunnen bijdragen aan een opleidingsontwikkelingsmodel voor teamtraining. Aanvankelijk lag de focus primair op het bepalen van de inhoud van de richtlijnen: welke stappen en deelstappen, in welke volgorde en hoe gedetailleerd. In het licht van deze focus zijn twee ontwikkelexperimenten uitgevoerd gericht op het valideren van de richtlijnen. Het doel van het eerste experiment was het bepalen van het effect van de richtlijnen ter ondersteuning van de analyse van teamtaken (Van Berlo, 2002a, 2000b). Het doel van het tweede experiment was het bepalen van het effect van de richtlijnen ter ondersteuning van de ontwikkeling van teamtraining scenario's (Van Berlo, 2003). Tijdens het onderzoek zelf is de focus evenwel verschoven van de inhoud van richtlijnen naar hoe opleidingsontwikkelaars deze richtlijnen het best kunnen leren toepassen. Daartoe is een derde ontwikkelexperiment uitgevoerd, gericht op het testen van het effect van een interactieve workshop met een meer praktische introductie op de richtlijnen (Van Berlo & Baartman, 2004).

In de twee ontwikkelexperimenten gericht op het testen van het effect van de richtlijnen, zijn de volgende drie hypothesen getest. De eerste hypothese luidt dat het toepassen van de richtlijnen leidt tot verbetering van de kwaliteit van het analyse- (experiment 1) en ontwikkelproces (experiment 2). De tweede hypothese stelt dat het toepassen van de experimentele versie van de richtlijnen leidt tot hogere verbetering van de kwaliteit van het analyse- (experiment 1) en ontwikkelproces (experiment 2) dan het toepassen van de controleversie van de richtlijnen. De derde hypothese tenslotte luidt dat proefpersonen van wie de kwaliteit van het proces goed is, ook goede producten leveren. De resultaten kunnen bovendien inzicht geven in de sterke en zwakke punten van de richtijnen en in de noodzakelijke verbeteringen.

<u>Methode</u>
De proefpersonen waren militaire opleidingsontwikkelaars van de Nederlandse Koninklijke Landmacht en de Koninklijke Marine (beide experimenten) en de Koninklijke Luchtmacht (alleen experiment 1). Alle proefpersonen hadden wel ervaring als instructeur, maar ze

waren beginners op het gebied van opleidingsontwikkeling: ze stonden aan het eind van een initiële militaire cursus voor opleidingsontwikkelaars, of hadden die pas afgerond. Geen van hen had ervaring met het trainen van teams, hoewel één proefpersoon ervaring had met het verzorgen van teambuilding oefeningen (experiment 2). Alle proefpersonen namen vrijwillig deel aan de experimenten. Het aantal proefpersonen dat deelnam aan het eerste experiment was tien. Aan het tweede experiment namen acht proefpersonen deel: aanvankelijk zouden dit er ook tien zijn, maar twee van hen meldden zich kort voor aanvang af.

Tijdens de experimenten werd de proefpersonen gevraagd om voor een specifieke teamtaak een analyse uit te voeren (experiment 1) of een trainingsscenario te ontwikkelen (experiment 2). Ter ondersteuning hiervan kregen zij de experimentele of controleversie van de richtlijnen. In de experimentele versie werd specifiek aandacht geschonken aan de teamaspecten. De controleversie van de richtlijnen bevatte deze specifieke ondersteuning niet, maar was voor het overige dezelfde als de experimentele versie. Deze controleversies waren min of meer conform met de richtlijnen voor opleidingsontwikkeling die de Nederlandse krijgsmacht gebruikt. Om de domeinkennis van de proefpersonen onder controle te houden, werd gebruik gemaakt van twee fictieve teamtaken, zowel voor de taakanalyse als voor het ontwikkelen van een scenario. Deze taken zijn de brandweertaak (Rasker, 2002) en de TANDEM-taak (Weaver, Morgan & Hall, 1993). Beide zijn taken waarbij de teamleden onder druk met elkaar dienen samen te werken om tot een goed resultaat te komen. Ze vertonen bovendien overeenkomsten met militaire besluitvormingstaken in commandocentrales. Tijdens het eerste experiment kregen de proefpersonen van beide taken een papieren beschrijving en van TANDEM nog een instructie-video. Tijdens het tweede experiment werden beschrijvingen van de leerdoelen uitgereikt om alle proefpersonen dezelfde uitgangssituatie te geven. Als de proefpersonen meer informatie wilden hebben (bijvoorbeeld van domeindeskundigen) konden ze deze in de vorm van een rollenspel vragen aan de proefleider.

Voor beide experimenten werden de proefpersonen willekeurig toegewezen aan de twee condities waarbij de militaire achtergronden gelijk werden verdeeld. Tijdens de voormeting, die plaats vond op de eigen werkplek, dienden alle proefpersonen de brandweertaak te analyseren of hiervoor een scenario te ontwikkelen: hiervoor kregen ze geen ondersteuning. Tijdens de nameting die twee tot drie weken later werd uitgevoerd bij TNO, deden de proefpersonen hetzelfde, maar dan voor de TANDEM-taak: hierbij kregen ze ter ondersteuning de experimentele of de controleversie van de richtlijnen.

Experiment 1 begon met een korte introductie van circa 10 minuten door de proefleider waarna de proefpersonen gedurende maximaal een uur de beschrijvingen van de brandweer- of TANDEM-taak konden lezen, gevolgd door de 20 minuten durende TANDEM-video

(alleen bij nameting). Vervolgens konden de proefpersonen gedurende maximaal een uur de richtlijnen lezen (alleen bij nameting) en analyseerden ze de betreffende taak gedurende maximaal drie uur. Tenslotte dienden de proefpersonen gedurende maximaal een half uur een vragenlijst in te vullen over wat goed en minder goed ging tijdens het analyseproces, en over de sterke en zwakke punten van de richtlijnen (alleen bij nameting). Het experiment werd afgesloten met een interview van maximaal een half uur waarin de ingevulde vragenlijst werd besproken en overige punten die door zowel de proefpersoon als de proefleider konden worden ingebracht. De procedure van experiment 2 had dezelfde structuur. De enige verschillen zijn dat er geen instructie-video over TANDEM werd getoond, dat er in plaats van de taakbeschrijvingen uitgewerkte leerdoelen werden uitgereikt die de proefpersonen in maximaal een half uur konden lezen, en dat het ontwikkelen van een trainingsscenario twee en een half uur duurde. Tijdens de nametingen werd de proefpersonen gevraagd om de richtlijnen zoveel mogelijk te volgen, maar ze waren vrij om hiervan af te wijken zolang ze dat maar beargumenteerden.
Tijdens het analyse- en ontwikkelproces konden de proefpersonen aantekening maken en hun resultaten op papier vastleggen. Tijdens dit proces werden de proefpersonen geïnstrueerd zoveel mogelijk hard-op te denken. Deze sessies werden op tape opgenomen en uitgewerkt in protocollen. Deze protocollen werden gescoord aan de hand van een codeerschema door twee onderzoekers van wie er een blind was met betrekking tot de opzet van het onderzoek. De kwaliteit van het proces dat de proefpersonen hadden doorlopen en de bijbehorende resultaten werden door deze twee onderzoekers beoordeeld aan de hand van een vragenlijst.

Resultaten en conclusies

De resultaten van experiment 1 laten zien dat het analyseproces van de proefpersonen tijdens de nameting significant beter is dan tijdens de voormeting. Uit de protocol-analyse blijkt dat de experimentele groep meer uitspraken doet over het samenstellen van een projectteam en het analyseren van de individuele taakuitvoering, en de controlegroep over het bepalen van het doel van de analyse, het samenstellen van een projectteam, opstellen van een analyse- en evaluatieplan, en mentale simulatie. Op basis van de oordelen van de experts blijkt dat tijdens de voormeting de kwaliteit van het analyseproces van de experimentele en controlegroep dezelfde is, maar dat tijdens de nameting de kwaliteit van de experimentele groep significant beter is. Meer specifiek geldt dat de proefpersonen in de experimentele groep significant beter scoorden op het samenstellen van een projectteam, het opstellen van een analyse- en evaluatieplan, het presenteren van het analyse- en evaluatieplan, het analyseren van de teamtaak, en het vaststellen van de voorwaardelijke kennis, vaardigheden en atttituden. De proefpersonen in de controlegroep scoorden significant beter op het samenstellen van een projectteam en het opstellen van een analyse- en evaluatieplan. De proefpersonen maakten nauwelijks aantekeningen zodat afzonderlijke oordelen over de producten niet konden worden uitgevoerd. In de zelfrapportages gaven de proefpersonen aan dat het moeilijk was om een analyse uit te voeren over een voor hen onbekende taak, dat ze veel moesten lezen, en dat sprake was van een behoorlijke tijdsdruk. De richtlijnen werden als vrij compleet en gestructureerd beschouwd, maar de proefpersonen gaven toch enkele suggesties voor aanvullingen en verbeteringen, zoals een korte checklist die als afvinklijst kan worden gebruikt, meer voorbeelden van elke stap, minder en gemakkelijker tekst en meer ondersteuning bij het maken van een TOSD. Op een vijfpuntsschaal (waarbij '1' zeer slecht is, en '5' zeer goed) waarop de proefpersonen konden aangeven of ze de richtlijnen op de eigen werkplek zouden willen toepassen, scoorde de experimentele groep met 4,2 en de controle groep met 4,6.

De resultaten van experiment 2 laten zien dat het ontwikkelproces van de proefpersonen tijdens de nameting beter is dan tijdens de voormeting, maar dit is niet significant. Op basis van de oordelen van de experts blijkt dat tijdens de voormeting de kwaliteit van het analyseproces van de experimentele en controlegroep dezelfde is, maar dat tijdens de nameting de kwaliteit van de experimentele groep niet significant beter is. Meer specifiek geldt dat de proefpersonen in de experimentele groep significant beter scoorden op het bepalen van het doel van het ontwerp en het specificeren van de timing, modaliteit en inhoud van de feedback. De proefpersonen in de controlegroep scoorden significant beter op het bepalen van de randvoorwaarden voor het ontwerp en het evalueren van (tijdelijke en finale) resultaten. In de zelfrapportages gaven de proefpersonen aan dat het moeilijk was om een scenario te maken van een voor hen onbekende taak, dat het lastig was te werken met leerdoelen die ze niet zelf hadden geformuleerd, en dat er sprake was van een behoorlijke tijdsdruk. De richtlijnen werden als vrij compleet beschouwd en de figuren als waardevol, maar de proefpersonen gaven toch enkele suggesties voor aanvullingen en verbeteringen, zoals een korte checklist die als afvinklijst kan worden gebruikt, meer voorbeelden van elke stap, en minder en gemakkelijker tekst. Op de vraag of ze de richtlijnen op de eigen werkplek zouden willen toepassen, scoorde de experimentele groep op een vijfpuntsschaal met 3,5 en de controle groep met 3,75.

Samenvattend kan op basis van de resultaten worden geconcludeerd dat de eerste en tweede hypothese in experiment 1 worden aangenomen, maar in experiment 2 verworpen. De derde hypothese kon in beide experimenten niet worden getoetst, omdat de proefpersonen nauwelijks aantekeningen maakten.

5. Testen van het effect van een interactieve workshop

Zoals beschreven is de focus van het onderzoek verschoven van de inhoud van de richtlijnen naar de wijze waarop opleidingsontwikkelaars konden leren om de richtlijnen toe te passen. Een belangrijke aanleiding hiervoor waren de opmerkingen van de proefpersonen uit de voorgaande twee experimenten dat zij de korte introductie (maximaal een uur lezen) als problematisch ervaarden, voornamelijk vanwege het niveau van detail en de moeilijke woorden. Daarom werd een derde experiment uitgevoerd, gericht op het testen van het effect van een interactieve workshop waarin de proefpersonen een meer uitgebreide en praktische introductie van de experimentele versie van de richtlijnen kregen (Baartman, 2003; Van Berlo & Baartman, 2004). In dit derde ontwikkelexperiment werden de volgende twee hypothesen getoetst. De eerste hypothese luidt dat het volgen van de workshop leidt tot een verhoging van de kwaliteit van zowel het analyse als het ontwerp proces. De tweede hypothese stelt dat de verhoging van de kwaliteit hoger zal zijn na de workshop (dit experiment) dan na het louter lezen van de experimentele richtlijnen (experimenten 1 en 2).

<u>Methode</u>

Een voorwaarde om de resultaten van dit experiment te vergelijken met die van de voorgaande experimenten was dat de steekproef vergelijkbaar zou zijn. In alle experimenten zijn de proefpersonen beginnende militaire opleidingsontwikkelaars. In dit derde experiment zijn de proefpersonen zes mannelijke opleidingsontwikkelaars van de Koninklijke Marine in de laatste fase van de initiële cursus voor opleidingsontwikkelaars. De instructeur van de Koninklijke Marine nam ook deel aan de workshop, maar was geen proefpersoon.

Tijdens de experimenten werd de proefpersonen gevraagd om voor een specifieke teamtaak een analyse uit te voeren evenals een trainingsscenario te ontwikkelen. Ter ondersteuning hiervan kregen zij de experimentele versie van de richtlijnen. Om de domeinkennis van de proefpersonen onder controle te kunnen houden, werd ook hier gebuik gemaakt van dezelfde twee fictieve teamtaken als in de voorgaande twee experimenten: de brandweertaak en de TANDEM-taak. De proefpersonen kregen ook de betreffende beschrijvingen van de taken en de uitgewerkte leerdoelen. Als de proefpersonen meer informatie wilden hebben om de analyse uit te kunnen voeren of het scenario te ontwikkelen, konden ze deze in de vorm van een rollenspel vragen aan de proefleider.

Tijdens de voormeting, die net als de nameting plaatsvond op de eigen werkplek, dienden alle proefpersonen de brandweertaak te analyseren en hiervoor een scenario te ontwikkelen: hierbij kregen ze ondersteuning van de experimentele richtlijnen. Tijdens de nameting die een tot drie weken later werd uitgevoerd, deden de proefpersonen hetzelfde, maar dan voor de TANDEM-taak: ook hierbij kregen ze ter ondersteuning de experimentele versie van de richtlijnen. Tussen de voor- en nameting werd de workshop verzorgd die uit twee delen bestond. In de ochtend werden de richtlijnen ter ondersteuning van de teamtaak analyse toegelicht. Speciale aandacht werd gegeven aan die onderdelen die in het eerste experiment lastig bleken te zijn: het uitvoeren van een systeem-analyse, het maken van een missie-diagram, het uitvoeren van een cognitieve taakanalyse en het opstellen van een TOSD. In de middag werden de richtlijnen ter ondersteuning van het ontwikkelen van een teamtraining scenario behandeld. Gedurende de hele dag werden korte theoretische presentaties afgewisseld met individuele en groepsoefeningen om concreet ervaring op te doen met de richtlijnen.

De voormeting begon met een korte introductie van circa 10 minuten door de proefleider waarna de proefpersonen gedurende maximaal een half uur de beschrijvingen van de brandweertaak konden lezen. Vervolgens konden de proefpersonen gedurende maximaal anderhalf uur beide sets van richtlijnen lezen (zowel taakanalyse als scenario ontwerp). Hierna analyseerden ze de brandweertaak gedurende maximaal anderhalf uur. Fase I (voorbereiden) van de richtlijnen konden ze overslaan en een beschrijving van de resultaten hiervan werd uitgereikt. Nadien konden de proefpersonen gedurende maximaal anderhalf uur een scenario ontwikkelen op basis van de uitgereikte leerdoelen. Tenslotte dienden de proefpersonen gedurende maximaal een half uur een vragenlijst in te vullen over wat goed en minder goed ging tijdens het analyse- en ontwikkelproces, en over de sterke en zwakke punten van de richtlijnen. Het experiment werd afgesloten met een interview van maximaal een half uur waarin de ingevulde vragenlijst werd besproken en overige punten door zowel de proefpersoon als de proefleider konden worden ingebracht. De procedure van de nameting had dezelfde structuur, met als enige verschil dat de proefpersonen met de TANDEM-taak werkten. Tijdens zowel de voor- als nameting werd de proefpersonen gevraagd om de richtlijnen zoveel mogelijk te volgen, hoewel ze vrij waren om hiervan af te wijken zolang ze dat maar beargumenteerden.

Tijdens het analyse- en ontwikkelproces konden de proefpersonen aantekeningen maken en hun resultaten op papier vastleggen. Tijdens dit proces werden de proefpersonen geïnstrueerd zoveel mogelijk hard-op te denken. Deze sessies werden op tape opgenomen en uitgewerkt in protocollen. Deze protocollen werden gescoord aan de hand van een codeerschema door twee onderzoekers van wie er een blind was met betrekking tot de opzet. De kwaliteit van het proces dat de proefpersonen hadden doorlopen en de bijhorende resultaten werden door deze twee onderzoekers beoordeeld aan de hand van een vragenlijst.

<u>Resultaten en conclusies</u>

Op basis van de oordelen van de experts blijkt dat de gemiddelde kwaliteit van het analyseproces van de proefpersonen tijdens de nameting niet beter of slechter is dan tijdens de voormeting. Met betrekking tot het analyseren van de individuele taakuitvoering scoorden de proefpersonen significant slechter, en met betrekking tot het maken van een TOSD en het evalueren van de resultaten is een positieve trend zichtbaar. Alle proefpersonen halen gemiddeld wel hogere scores op de nameting, maar dit is niet significant. De gemiddelde kwaliteit van het ontwikkelproces van de proefpersonen blijkt tijdens de voor- en nameting nauwelijks te verschillen. Wel presteren de proefpersonen op ongeveer de helft van alle stappen beter, met name met betrekking tot het evalueren van de resultaten, maar dit is evenmin significant. Drie proefpersonen halen gemiddeld wel hogere scores op de nameting, maar ook dit is niet significant. In de zelfrapportages tijdens de voormeting gaven de proefpersonen aan dat ze moeilijkheden hebben ervaren met het uitvoeren van een systeemanalyse, het maken van een TOSD, het formuleren van leerdoelen, en het bepalen van het ideale verloop van een scenario. Meer positief waren ze over het vaststellen van de voorwaardelijke kennis, vaardigheden en attituden, formuleren van leerdoelen, maken van een schets van een scenario, en bepalen van trainingsstrategieën. In de zelfrapportages tijdens de nameting gaven de proefpersonen aan dat ze moeilijkheden hebben ervaren met het formuleren van voldoende gedetailleerde leerdoelen, bepalen van trainingsstrategieën, en specificeren van de feedback. Meer positief waren ze over het uitvoeren van een systeemanalyse, het maken van een TOSD, het formuleren van leerdoelen, en het bepalen van inhoud en structuur van een scenario. De richtlijnen werden als vrij compleet en gestructureerd beschouwd, de figuren als waardevol, evenals het maken van een TOSD. Zwakke aspecten waren de hoeveelheid tekst en de moeilijke woorden, en een te ingewikkelde structuur. De proefpersonen gaven enkele suggesties voor aanvullingen en verbeteringen, zoals een korte checklist die als afvinklijst kan worden gebruikt en een korte samenvatting van de richtlijnen. Op de vraag of ze de richtlijnen op de eigen werkplek zouden willen toepassen, scoorden de proefpersonen op een vijfpuntsschaal tijdens de voormeting met 2,2 en op de nameting met 2,8. De proefpersonen waardeerden de workshop met een gemiddelde score van 4,2 op een vijfpuntsschaal.

Om het effect van de interactieve workshop te vergelijken met het slechts lezen van de richtlijnen, zijn de resultaten van de proefpersonen op de nametingen van de eerste twee experimenten vergeleken met de resultaten van de proefpersonen op de voormeting van het derde experiment. Deze resultaten verschilden niet significant van elkaar. Een vergelijking tussen de resultaten van de proefpersonen op de nameting van het derde experiment en de nametingen van de eerste twee experimenten laten ook geen significante verschillen zien.

Samenvattend kan op basis van de resultaten worden geconcludeerd dat zowel de eerste als de tweede hypothese dienen te worden verworpen. De toegevoegde waarde van de workshop komt niet tot uiting in een significant verbetering van zowel het analyse- als het ontwikkelproces.

6. Discussie

In de discussie behandelen we de onderwerpen waarop dit onderzoek zich heeft gericht: (a) nagaan van de wijze waarop opleidingsontwikkelaars ondersteund kunnen worden bij het analyseren van teamtaken en het ontwikkelen van teamtraining scenario's, (b) valideren van deze ondersteuning, en (c) nagaan hoe de resultaten kunnen bijdragen aan een opleidingsontwikkelingsmodel voor teamtraining.

(a) Ondersteuning van opleidingsontwikkelaars

In dit onderzoek was er een spanning tussen nieuwe en meer constructivistische paradigma's op leren, de eigenschappen van ID, de behoefte aan het systematisch ontwerpen van opleidingen en de beste wijze waarop opleidingsontwikkelaars ondersteund kunnen worden, hierbij tevens in acht nemend de kenmerken van de militaire organisatie waarin zij werken. Zoals eerder gezegd is hier gekozen voor richtlijnen als ondersteuning van opleidingsontwikkelaars. Hoewel deze vorm van ondersteuning de proefpersonen wel aansprak, was een belangrijk punt van kritiek de omvang en mate van detail van de richtlijnen. De interactieve workshop werd goed gewaardeerd, en hoewel geen significante effecten werden gevonden, lieten de resultaten wel positieve trends zien op de specifieke onderwerpen die werden behandeld en op onderwerpen die niet in de militaire richtlijnen terug kwamen. Wellicht dat een combinatie van verschillende vormen van ondersteuning het meest geschikt is. Bijvoorbeeld, eerst een interactieve, praktische workshop volgen, daarna een checklist als ondersteuning op de werkplek gebruiken aangevuld met de richtlijnen als een elektronisch naslagwerk, en het raadplegen van een meer ervaren collega. Als uitbreiding op de richtlijnen zelf dienen vele en gevarieerde concrete voorbeelden toegevoegd te worden als illustratie van de stappen en beslissingen die tijdens de opleidingsontwikkeling zijn genomen.

De positieve effecten van de richtlijnen ter ondersteuning van de analyse van teamtaken tonen aan dat deze een waardevolle aanvulling kunnen betekenen op de huidige richtlijnen van de militaire opleidingsontwikkelaars. Een andere nuttige aanvulling betreft het projectmatig aanpakken van ID. Een mogelijke verklaring voor het wel verkrijgen van significante effecten tijdens het eerste experiment (taakanalyse) en niet tijdens het tweede (scenario-ontwikkeling), is dat taakanalyse een proces is dat van nature gestructureerder is en beter ondersteund kan worden door middel van richtlijnen. Scenario-ontwikkeling daarentegen is een creatiever proces met veel meer alternatieve mogelijkheden waarbij op voorhand niet altijd goed is aan te geven welke de beste is (Goel & Pirolli, 1992). Een mogelijke verklaring voor het niet verkrijgen van significante effecten van de workshop, is dat tijdens de nameting de proefpersonen niet werd gevraagd de richtlijnen nogmaals te lezen. De periode tussen de workshop en de nameting varieerde echter van 5 tot 18 dagen, en hierin werkten de proefpersonen aan een eindopdracht in het kader van de militaire initiële cursus voor opleidingsontwikkelaars. Aangenomen mag worden dat gedurende deze periode de eigen militaire richtlijnen intensief zijn gebruikt, met als gevolg dat de experimentele richtlijnen als het ware werden verdrongen.

Hoewel deze studie diverse non-significante resultaten heeft laten zien, lijken deze slechts gedeeltelijk toegeschreven te kunnen worden aan de opzet en methode van het onderzoek. De zelfrapportages laten namelijk zien dat ook de perceptie van de ondersteuning (richtlijnen en workshop) door de proefpersonen van invloed was op de mate waarin deze ondersteuning werd gebruikt en gewaardeerd. "Indeed, discrepancies between interpretations by designers or teachers, on the one hand, and by learners, on the other hand, commonly lead to a mismatch and sub-optimal use, (…). Interventions are often neglected, or used in a way that deviates form that which is intended" (Elen & Lowyck, 2000, p. 422). In alle ID-fasen spelen (subjectieve) waarden, opvattingen en voorkeuren een belangrijke rol (Utsi, Canters & Lowyck, 2001). Dit geldt vanzelfsprekend ook bij de ontwikkeling en implementatie van ondersteuning van opleidingsontwikkelaars. In navolging van Elen en Lowyck (2000), kan verder onderzoek zich richten op het analyseren van de wijze waarop (militaire) opleidingsontwikkelaars denken over ondersteuning, hoe deze kennis het opleidingsontwikkelproces beïnvloedt en wat het effect hiervan is op de gegeven ondersteuning.

<u>(b) De methode van het valideren van de ondersteuning</u>

De belangrijkste wijze van dataverzameling in dit onderzoek was de proefpersonen hard-op te laten denken, en het uitwerken en analyseren van de protocollen. De aanname hierbij was dat de proefpersonen, hoewel ze beginners zijn, in staat zijn dit te doen, zonder dat het een negatief effect heeft op de kwaliteit van het opleidingsontwikkelproces. De proefpersonen waren inderdaad beginners, echter in de laatste fase van hun eigen opleiding en dus zonder enige praktijkervaring. Het is de vraag in hoeverre dit gebrek aan (minimale) praktijkervaring ertoe heeft bijgedragen dat het hard-op denken tijdens de voor- en nametingen bij de proefpersonen een zodanige werkdruk heeft opgeleverd dat dit toch een negatieve invloed op het ID-proces heeft gehad. Om dit te kunnen testen, hadden we cognitieve belasting kunnen meten (Paas, Renkl & Sweller, 2004), maar dat hebben we niet gedaan. Niettemin leek de huidige wijze van dataverzameling de enig beschikbare om een dieper inzicht te verkrijgen in het denkproces van de proefpersonen. De implicatie voor vervolgonderzoek is dat de proefpersonen toch enige mate van praktijkervaring dienen te hebben, om er zeker van te zijn dat het hard-op denken geen negatieve invloed heeft op de kwaliteit van het ID-proces.

De ondersteuning die in dit onderzoek is ontwikkeld en gevalideerd, is in belangrijke mate tot stand gekomen op grond van literatuur- en veldstudies. Toekomstig onderzoek zou een meer bottom-up en cognitieve benadering kunnen volgen. Het kan zich niet zozeer richten op individuele opleidingsontwikkelaars, maar op een team van ervaren opleidingsontwikkelaars die kritisch kunnen reflecteren op zowel de ontvangen ondersteuning als het eigen opleidingsontwikkelproces. Bovendien benadert dit werken in een team de naturalistische omgeving van de opleidingsontwikkelaar beter. Het individueel werken door de proefpersonen in het huidige onderzoek.heeft echter wel geleid tot een goede experimentele controle.

(c) Een ID-model voor de training van teams

Een ID-model behoort uit de volgende componenten te bestaan (Elen, 1995): ontwikkelparameters (variabelen van de lerenden en de leeromgeving), ontwikkelprocedures, ontwikkelprocessen, de theoretische kennisbasis, en het referentiekader oftewel de context waarin het toegepast wordt. Om een ID-model voor de training van teams te ontwikkelen, dienen deze componenten verder uitgewerkt te worden. Voor wat betreft de ontwikkelprocessen, bijvoorbeeld, betekent dit een verbetering van de ondersteuning tijdens het selecteren en specificeren van trainingsmethoden en -strategieën: het sequentiëren van leertaken van makkelijk naar moeilijk, het vaststellen van ondersteunende en procedurele informatie, en het bepalen van de karakteristieken van deeltaak training (vgl. het 4C/ID model: Van Merriënboer, 1997). Dit kan wellicht ook implicaties hebben voor de wijze waarop de teamtaken opgedeeld worden in de onderliggende vaardigheden.

Een andere component die verder ontwikkeld dient te worden, is de theoretische kennisbasis. De theorie omtrent teamleren, trainingsstrategieën en wat dit betekent voor het presteren van teams, is nog niet volledig duidelijk en lang niet altijd gevalideerd (Salas, Bowers & Cannon-Bowers, 1995; Salas & Cannon-Bowers, 1997). De inhoud van de kennisbasis wordt bepaald door vier typen onderzoek (Elen, 1995), namelijk naar: (1) hoe mensen leren, (2) de effectiviteit van instructiemethoden, procedures en interventies, (3) het ontwikkelen en valideren van meetinstrumenten, en (4) hoe opleidingsontwikkelaars daadwerkelijk werken. Dit komt min of meer overeen met de drie werelden van opleidingsontwikkeling zoals beschreven door Van Merriënboer en Kirschner (2001), namelijk de werelden van Kennis, Leren en Werken. Deze drie werelden dienen met elkaar verbonden te worden. Het optimaliseren van de ontwikkelprocessen, specifiek gericht op technologie-ondersteunde leeromgevingen voor de training van militaire teams, zou kunnen resulteren in het definiëren van ankerpunten voor opleidingsontwikkeling ('Instructional Design Anchor Points': Elen, 2004) die wellicht deze brugfunctie kunnen vervullen. De effectiviteit van diverse trainingsstragtegieën en methoden voor prestatiemeting en feedback dient vastgesteld te worden in verschillende situaties evenals de transfer van de trainingssituatie naar de werkplek. Deze onderzoeksresultaten en praktische ervaringen zullen meer inzicht geven in de vorm, inhoud en toepasbaarheid van een opleidingsontwikkelingsmodel voor het trainen van teams.

CURRICULUM VITAE

Marcel Van Berlo was born in Deurne, on June 5, 1968. He attended secondary school at the Peelland College in Deurne. In 1992 he received his master's degree in instructional science from the University of Nijmegen (currently Radboud University). As part of his military service, he was detached to the Netherlands Organisation for Applied Scientific Research (TNO). After his military service until present, he has been affiliated to the Business Unit Human Factors of TNO Defence, Security and Safety. Within the department of Training and Instruction he was the co-ordinator of the Team Training Research Group from 2000 to 2005. From 2004 until present, he is the business unit's domain manager Public Safety. He has experience in the design, execution, and management of research projects in the field of military training, crisis management, instructional design, team performance measurement and feedback, and designing team training environments. The field of work covers both the military (army, navy, airforce) and civil organisations. Marcel van Berlo is married and has three children.