THIRD TNO-CONFERENCE ON NEW COMMERCIAL TECHNICAL DEVELOPMENTS

Interaction of Marketing and
Research & Development in the Chemical Industry

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The role of R & D
in the product life cycle
Part I

Mr. Max Geldens
Director of Mc Kinsey & Co. Inc., Düsseldorf

Introduction

Alcon Copisarow and I are very honored to deliver the opening address of the 1970 TNO Conference on New Commercial and Technical Developments - and to contribute to the subject of this conference:

The Interaction of Marketing and Research & Development In the Chemical Industry

Our presentation has two purposes: First, we wish to create a framework for thinking about the broad subject of interaction between Research & Development and Marketing. Secondly, we hope to very broadly describe how the contributions of subsequent speakers will fit into this framework.

We would like to introduce the subject and describe what we hope will operate as fundamental building blocks in dealing with functional interaction - specifically between Marketing and R&D. I will approach the subject from the perspective of the product. In contrast, Alcon Copisarow will approach the subject from the perspective of the organization and its processes. He will describe and define similarities and differences between R&D and Marketing, review the need and the how of creating effective interdepartmental relationships and suggest the concepts of a R&D-oriented corporate strategies.

I would like to open our discussion with a very practical example to illustrate the essence of our conference and the problem we are trying to solve.

Slide Two

Introduction - A Case in Point *

The diesel locomotive was successfully used in Europe before it appeared in the United States. The first one was built by Swedish General Electric in the year 1913. In 1923, the General Electric Corporation of the United States built a commercial diesel/electric switching locomotive to be used predominantly in railroad yards. The first commercially successful road diesel was built by General Motors in 1934.

Slide Three

Management's Perspective

It is of interest to this conference to note what the chief executives of the giant locomotive manufacturers were saying as late as the year 1935.

Robert Binckert, then the Vice President of the Baldwin Locomotive Works told the meeting of the New York Railroad Club the following:

"Today we are having quite a balley-hoo about streamlined, light-weight trains and diesel locomotives and there is no wonder that the public feels that the steam engine is about to lay down and play dead. Yet over the years certain simple, fundamental prin-

* - Based on "The will to manage" by Marvin Bower

ciples continue to operate. Sometime in the future, when all this is reviewed, we will not find our railroads any more dieselized than they are electrified."

Mr. Binckert's position was not eccentric. Four years later, William Dickerman, chief executive of the American Locomotive Company, ALCO, spoke to the Western Railroad Club. He began, in a speech entitled Steam Marches On:

"For a century, as you know, steam has been the principal railroad motive power. It still is, and in my view, will continue to be.

True, other power units have challenged steam. This is as it should be. But steam has graciously met every succeeding challenge to its supremacy and I feel sure in due course will meet and improve on this challenge at less initial operating cost, with no sacrifice to passenger safety and comfort.

The old iron horse literally breathes fire and water. It likes a challenge from the youngsters, like the electric and the diesel electric, especially in the spring of the year.

It enjoys a race, it is young for its years, and it simply will not be its age."

Slide Four

Facts Available

While it is understandable that steam locomotive oriented executives are emotionally supportive of their product - you find similar points of view in many industries - the real question was if the facts actually supported these points of view.

It seems only short of astounding that these statements were made against a background of production decline in steam engines. Approximately 2,000 locomotives were built in the year 1924; 200 units were built in the year 1931.

It was known, certainly there were well founded guesses, that the General Motors Corporation had invested over $ 11 million in diesel engine research by the year 1932, and that this amount of money was substantially more than all the steam engine manufacturers in the United States had spent on this new form of locomotion jointly.

Furthermore, the railroads had already been purchasing diesel locomotives claiming that they could recover their initial investments in 3 to 4 years, in comparison to steam engine.

ALCO, the dominant force in the industry, declined in net income from $ 8 million in profit in 1926 to a $ 4 million loss in the year 1931. Interestingly enough, we noted in reviewing their annual statements that the company continued to pay dividends to its stockholders through 1931, thus weakening their financial position materially and preventing a reinvestment of such earnings in either better forms of locomotion or into new activities.

Against these facts, the industry experienced dramatic reversals in terms of market share.

Slide Five

The Results

ALCO produced its last steam engine as late as the year 1963. The Baldwin Locomotive Works abandoned the industry many years ago and became a sub-division of the

Worthington Corporation. And today, General Motors controls 75 percent of the diesel locomotive industry.

You can, of course, pose the question: "Is the steam engine versus the diesel engine example relevant to other products and industries, and is it pertinent to the chemical industry ?"

Slide Six

Relevance of Case in Point

Examples of technological revolutions are all around us.

I found similar quotations and facts stretching back to the year 1948, when various noted experts predicted that jet fuel would never be commercially viable - despite the revolutionary 50 jet fighter planes thrown into the air by the Germans in the closing moments of the second World War.

There is the more recent example of the vacuum tube's replacement by the transistor. The problem steel is having from substitute products made of aluminum or plastic. The virtual collapse of the movie industry as you and I know it through the introduction of television. Our wives are replacing woven carpets with tufted carpets. We are today witnesses to a revolution in general cargo transport as piece-good cargo is being replaced by containers. All of us use many more ballpoint pens than the fountain pen manufacturers would like to see us use. And there is the replacement of linoleum by vinyl floor coverings.

There are scores of examples, but the most important point that I can make today is not that product revolutions occur, but that recognized industry leaders seldom introduce or benefit from such revolutions. Crudely put, more often than not, they are caught with their pants down.

Looking at the list of examples on the screen, in not a single case do we find that the industry leader for the original product is also the dominant force in the industry for the substitute product. For example, RCA and General Electric dominated the vacuum tube industry. Transistor production - the substitute product for vacuum tubes - was dominated by Texas Instruments and Fairchild Camera. RCA and General Electric market shares are substantially smaller.

In exploring this phenomenum somewhat further, we can find partial explanations in the writings of Arthur Clarke - a noted science writer and science fiction novelist - and some interesting - although impractical solutions - in several articles written by Maxwell Hunter. Mr. Hunter is the Director of advanced space programs at the Lockheed Missiles and Space Company.

In an article entitled The Hazards of Prophesy, Arthur Clarke defined two types of prophetic failures. Het talked of "failures of nerve" and defined this as - "knowing it could be done, but believing it would not be". He defined the second failure as "failures of imagination" and defined this as "not realizing it could be done". Arthur Clarke concludes after some investigation, that technological upheavals in a company are more often caused by "failures of nerve" than through "failures of imagination".

It can be added that a company exploiting a profitable product is seldom motivated to look far beyond their current success and induce the development of products which may ultimately cause upheavals in their product line.

Mr. Hunter accepts the problem and has offered an unusual solution. He seems to find an analogy in the teachings of Lenin. You may recall that one of the basic premises of Lenin was that while a hard core of inter-party members - that is, top management -

must run the system, most of the fighting in a major revolution will be done by the masses under the leadership of the local militia. After a successful revolution, the power and the public appeal of the militia leaders represent the strongest possible threat to the members of the inner circle, who identified the need and created the atmosphere for change - and of course wish to remain in charge of the system they sponsored.

Lening therefore prescribed that the militia leaders must be liquidated immediately after the revolution, before they get ideas about taking over or influencing the system.

One must, according to this point of view, be cool enough to shoot some of your best friends and allies at the height of the greatest success, and in this way pave the way for further revolutions without the interference of former revolutionaries.

Mr. Hunter says, and I quote: "As management inevitably turns its attention to the new group handling the next revolution, the egos of the current revolutionaries suffer. The coming revolution no longer seems remote and, no matter how much they are honored, they will begin to view their exclusion from future revolutionary planning as intellectual death."

"The morale is self-evident. If an organization is really going to be in the forefront with respect to technological progress, it must, figuratively at least, shoot the leaders of each successive revolution the morning after their great triumph. It is a safe bet that most of today's managements wait too long to pull the trigger."

The steam versus diesel example, of course, provides other lessons than the observation that originally flexible people, who are repeatedly forced to defend their decisions, become psychologically and technically rigid. Let's leave this digression for the moment and discuss other conclusions that might be drawn.

Slide Seven

Lesson to be Learned

To begin with, from the perspective of top management, there must be a definite willingness to clearly define which market is to be served.

In other words, were ALCO and Baldwin serving the steam engine market, or should they have been willing to take a broader perspective and look at either locomotives in general, the railroad industry, or the public transportation industry. Their positions might have been preserved if they had only escalated one step above the existing product and realized the market they should have served was locomotives.

They might have become a corporate giant had they considered their market to be public transportation. This would have permitted the production of not only diesel engines, but railroad cars, busses, and possibly even aircraft. Certainly, it was a difficult for General Motors to enter the locomotive industry as it was for Baldwin and ALCO to align their efforts with the then small Douglas Aircraft Corporation to produce the first commercial aircraft. You will recall the DC-1's, 2's and 3's had their birth at the same time as the diesel engines.

A second lesson we can learn is that there must be a willingness to create or serve changing customer demands. There was a demand for steam engines and 2,000 units were sold per year. However, apparently a more pronounced demand prevailed for faster, low-investment locomotive power. This was clear to General Motors and it was even underscored quite succinctly in Robert Binkert's speech in 1935 - only 1 year after General Motors introduced its first diesel engine. ALCO's immediate reaction should have been to follow suit, particularly since they had experimented successfully in 1923 with a number of small diesel engines for yardwork.

Finally, we can learn that there must be a willingness to objectively assess the facts which govern the forces of the industry. The fact that annual production had declined by 1924 and 1935 should have led to the recognition that the steam engine had become a very mature and if not an obsolete product.

However, talking about mature and obsolete stages in a product's history opends a new area for discussion.

Slide Eight

Product Life-Cycle

It is widely recognized that all products follow a generally predictable decline in volume over time. In the case of the steam engine, a peak in volume was reached in 1924 of 2,000 units. In 1963, the very last unit was produced. ALCO achieved a net profit of $ 8 million in 1926. By 1931, it was suffering $ 4 million in losses. It is this subject which receives the bulk of my presentation today and we will return to it in just a moment.

Slide Nine

Organizational Perspective

A final lesson can be learned from the steam and diesel engine example in terms of managerial processes. Clearly, there was a lack of sensitivity to the marketing function - or on the part of the marketing function. The inter-functional relationships between the President and his staff must have been non-existant. And while they may have said so at the time, certainly the R&D laboratories of ALCO and Baldwin were unable to convince their management to compete dollar-for-dollar with General Motors in developing new types of locomotion.

Slide Ten

Product Life-Cycle

With this background, we introduce our first conerstone of the conference: the premise that the fundamental relationship between Marketing and R&D revolves around the product, the product life-cycle, and the market it serves.

Slide Eleven

The Program

We will explore this premise first from the point of view managerial processes. In this regard, Alcon Copisarow will discuss the inter-functional managerial processes, the development of R&D-oriented marketing strategy, and the establishment of investment targets. He will be followed by Dr. Freiensehner, who will describe the collaboration of Marketing and R&D, particularly as they take place at the BASF. Tomorrow, Doctor Lodge, the Director of Research of ICI Fibers, will outline how to organize a new product effort.

Four case examples about specific products will be presented to illustrate many of the conclusions and recommendations introduced.

Slide Twelve

Program: Case Examples

First, will be Mr. Brug, who will describe the introduction of a new pharmaceutical product Duphalac. He will be followed this afternoon by Mr. Atkinson, Marketing Manager of Elastomers Division and Dr.Ir. Goppel, Director of the Koninklijke Shell Plastics Laboratory in Delft. They will describe the introduction of their product Polyisoprene.

Tomorrow morning, Dr.Ir. Ruiter of the Unilever Research Laboratory, will discuss enzymatic detergents - a revolutionary development in the field of the consumer detergents which has enjoyed an amazing market response in the last 2 years. We will conclude the Conference on Friday afternoon with the case study of Mr. Valerio, Vice President Marketing of Merck, Sharp & Dohme International, who will discuss the interplay of marketing and research using a new animal health product as a case example.

Slide Thirteen

The Product Life-Cycle Concept

The product, its behavior and profitability plays a pivotal role in the relations between Marketing and R&D. The Product Life-Cycle concept is based on the generally observable fact that a product's sales volume tends to follow a typical pattern that can be charted and segmented into four phases. After its birth, a product seems to pass through a low-volume introduction phase. During the ensuing growth phase, volume and profits both rise. Ultimately, volume stabilizes during a period of maturity but the unit profits typically deminish. Eventually, in the absolescence stage, the sale volume declines.

The length of the life-cycle, the duration of each phase, and the shape of the overall curves which follows volume and profits, will vary widely by product and by industry. However, in most cases, obsolescence ultimately sets in for one of three reasons.

Slide Fourteen

Causes of Obsolescence

First, the need for the product may disappear. We all know about the buggy whip and the radio adventure story which has been replaced by the television drama. In the United States, the orange squeezer is disappearing as orange juice, frozen in small cans, could be conveniently defrosted and water added.

Second, a better, cheaper, or a more convenient product may be developed which fulfills the same need. For example, oil-based paints have lost their position in the home to the water-based paints. Similarly, plastics are replacing wood, metal and paper in product categories ranging from dry-cleaning bags to aircraft parts.

Third, an existing competitive product may, through superior marketing strategy, suddenly gain a decisive and temporarily insurmountable advantage. When Proctor & Gamble was able to persuade the American Dental Association to endores its decay prevention claims for Crest toothpaste, then spelled disaster for all other toothpaste manufacturers. Similarly, in Europe, the Mars chocolate bar - with its superior advertising and distribution - has claimed a disproportionate part of a market even though the product itself was not substantially better.

Slide Fifteen

Product Life Concept Cycle *

The exhibit on the screen suggest that the profit cycle of a product has a shape quite different from that of the sales cycle. During introduction, the product may not earn any profit because of high initial advertising and promotion costs, and unusual R&D write-offs.

In the growth period, before competition catches up, unit profits typically reach their peak. Then they generally start declining, though total profits may continue to rise for a time with rising sales volume.

In the chemical industry, for example, we find that rapid volume increases often more than offset the price reductions required early in the growth phase to discourage competition and appeal to new customer uses.

During the late growth and early maturity, increasing competition finally cuts deeply into profit margins.

For example, as a result of drastic price cutting, general purpose, semi-conductors - once a highly profitable product - now returns so little unit profit that major companies such as Columbia Broadcasting System and Clevite left the business entirely and at an early stage in the product life-cycle. A comparable picture can be drawn for nylon, where dramatic price declines in the past 5 years have been so severe, that even the DuPont Corporation for the first time since the war has been forced to reveal that overall return on investment declined below their highly publicized target of 10 percent.

Finally, in the obsolescence phase, declining volumes eventually push costs up to a level that eliminates profits entirely.

In recent years, most marketing and research executives have become aware of the fact that products are maturing more rapidly and that product life cycles are getting much shorter. This trend is responsible for some of the major problems facing many corporations today.

The razor blade is a classic example of accelerated maturity. For decades, with their blue blades and thin blades, Gilette dominated the razor blade market and enjoyed steady growth. Some 10 years ago, the super blue blade was introduced as a new and revolutionary product. Because of special chemical coatings, greatly improved shaving qualities could be claimed and Gilette normally could look forward to a growth period of many years, if not decades.

In less than 3 years, the stainless steel blade was introduced in Europe and later in the United States. A totally new industry participant, Wilkinson of England, had a product which cut dramatically into the market of Gilette. As a result, the Super Blue Blade suddenly moved from a period of growth to a period of late maturity or early obsolescence well before anyone could have predicted it.

Not only are individual products maturing more rapidly, but product life-cycles as a whole are growing much shorter. For example, for more than 15 years, the DC-3 held its position as the leading commercial airliner. But the DC-7, and later the turbo prop Electra, were obsolete in less than 5 years after their introduction as a result of the pure jet DC-8 and the Boeing 707 - the early introduction of both aircrafts was stimulated by the threat of the British Comet - the first all-jet airliner. And today, only 8 years later, DC-8's and Boeing 707's are facing replacement by a new generation of jet aircraft, the 747 and the Lockheed airbus.

* - Based on "Managing the Product Life Cycle" by Don Clifford

Faced with the challenge of earlier maturity and shortening life-cycles, many companies still fail to recognize that their products have a life-cycle. Let me cite the example of a well-known client we are serving on the chemical industry. R&D management conducted at our request an audit of their product line and classified their products by the four phases described earlier. As a result of the audit, the Marketing and R&D staff were very much surprised to find themselves with two products in the late growth phase, nine products in the maturity or early obsolescence phase, and no products at all in what they would be willing to slot into introduction and early growth phases.

Second example. Another chemical company we serve acknowledges that it is pouring money into product improvements for a specific plastic that - according to marketing executives - was obsolete soon after its introduction. While there is some question about who is right, it is clear both parties - when we meet with them individually - that the product is doomed to failure unless its proper location in the life-cycle curve is identified and appropriate joint efforts are initiated to support its commercial exploitation.

The classical product life cycle concept - as it was defined in the early 1960's - holds that R&D and Marketing decisions should largely be determined by the product's life cycle position and it is around this basic tenant that all relationships between Marketing and R&D should be built.

There should be a clear understanding when a product is moving from one phase to the next.

Slide Sixteen

Introduction Phase

It is the responsibility of marketing to provide R&D with a proper assessment of marketing demands for a specific product, thus permitting R&D to develope a customer-oriented design or product specification. Thereafter, R&D should develop the evidence necessary to prove technical or cost superiority which can in turn be used as a marketing lever to the customer.

The fundamental responsibility of marketing - as defined by Theodore Levitt - is to create a customer demand. Thereafter, it must be able to capture enough sympathy and confidence from top management to earmark the substantial cash outlays necessary for introductory marketing.

Slide Seventeen

Growth Phase

Once a product has successfully been commercially accepted, the responsibility of Marketing is to feed back to R&D accurate data describing the relative performance of that product in the market. This will permit R&D to more readily improve product reliability and its quality. Secondly, R&D can begin to anticipate in what forms competitive substitution will ultimately be encountered.

Marketing must in parallel improve product distribution both in terms of availability and delivery. In addition, Marketing is generally responsible for strengthening market awareness and achieve the broadest possible exposure.

Slide Eighteen

Maturity Phase

In the third phase, Marketing continues to be responsible for feeding back to R&D information which properly describes product performance. R&D responsibilities are now to develop variations on the basic product theme, and to identify new uses for the same basic product.
Marketing responsibility is to further expand the distribution to new customers. Marketing will generally begin experimenting with price concessions to attract both new types of customers and, if possible, discourage the entrance of competition.

Obsolescense Phase

In the final phase of a product's life-cycle, Marketing and R&D interplay can generally be held to a minimum. This permits both functions to spend the majority of their time in preparing for the development and the introduction of new products.

Marketing's prime responsibility is to suggest and introduce programs which lead to drastic cost control - thereby maximizing the profit take-off for the longest possible period. Ultimately, Marketing should organize a proper departure from the market.

The DuPont Corporation is in my mind one of the really successful chemical companies in terms of developing effective R&D and Marketing strategies during the late 1950's and 1960's. Its products lines have undergone dramatic changes and they claime that over 40 percent of their total volume comes from products introduced less than 5 years ago. To the casual observer, DuPont never seems to hesitate in taking major strategic steps with their products. For example, they were the first to completely step out of the rayon market in late 1950, at the time when it was still a major part of their fiber business. Similarly, they were also the first to begin dramatically revitalizing cellophane operations rather than deciding to step out when the polyethelyne films were introduced in the early 1950's. Finally, they are the acknowledged leaders in entering new markets: synthetic leather and flu-preventatives.

It is interesting to note that in the area of marketing pharmaceuticals DuPont, while it has developed a technically superior line of products, has not been as successful as many feared they would be.

For the purposes of today, however, let me trace their activities in cellophane, a product which had become so well known that it became synonimous with transparent packaging.

By the end of the Second World War, flexible packaging, and cellophane in particular, entered a period of rapid growth. By the 1950's, however, new products, notably polyethelyne, began to meet certain packing needs better than cellophane. Polyethelyne film, for example, was not so easily ruptured in cold weather and, in time, it also became cheaper. Cellophane, as a result, began losing its share of the flexible packaging market and it was clear that overall sales volumes would begin falling unless certain corrective actions could be taken. DuPont faced the decision to step out of the market entirely - as it had done in the case of rayon - or technically rejuvenate the product line.

Despite being faced with the immediate threat of obsolescence of a highly profitable product, DuPont - followed in most cases by the two other major cellophane manufacturers - introduced a series of innovative product modifications destined to maintain cellophane's growth and to prolongue its maturity period. These modifications included special coatings to reduce winter breakage, and increased product protection, new types of cellophanes tailored to meet the needs of different products, and lighter grades of cellophane that were priced more competitively with the more modern packaging material. All in all, the customer's choice of cellophane types mushroomed from a hand-

ful to well over 100. These steps gave DuPont a few moments to breathe. In fact, in the face of wide-spread prediction of a rapid decline, cellophane as a whole maintained its sales volume through the 1960s. With over half of a $ 300 million market, DuPont had of course been the primary beneficiary of this temporary reversal of fortunes.

However, greater testimony to Dupont's effectiveness in its management of life cycles was its dedication to remain a leader in flexible packaging materials. Recognizing the ultimate maturity of cellophane, DuPont developed a strong line of polyethelene products becoming one of the few enterprises that succeeded in remaining dominant in the market despite technological upheaval.

Slide Nineteen

Functional Interface

Managing the life-cycle of a product can form the basis for an effective interface between Marketing and R&D in two ways: First, new product introductions and the pruning of old products from the line, and secondly, the allocation of money, manpower and enthusiasm.

Slide Twenty

Managerial Processes

To support this functional interface, two processes have been successfully adopted by many corporations who - in one way or another - think of their products in terms of life-cycles. First, arranging periodic informal and formal contacts among Marketing and R&D personnel for the purpose of completely auditing the overall product line performance and outlook. Secondly, to establish mutually satisfactory targets about the number of new products to be introduced, old products to be deleted.

One way several companies are developing the information necessary to pinpoint a product's position in the life-cycle may be described as follows.

Slide Twenty-one

Steps in Pinpointing Performance

The first step is to obtain 3 to 5-year historical data to include unit and dollar sales, profit margins, total profit contribution, return on invested capital, market share, price, and so forth.

Second, trace recent volume and profit trends in the market, identify the number and nature of competitors, number and market share rankings of competing products, identify competitive performance advantages, uncover any shifts in distribution channels, and determine the relative advantages enjoyed by competitive products in these distribution channels.

Third, short-term competitor strategies should be identified and evaluated. For example, recent competitive announcements of new product introductions, or plans for expanding production capacity or for increasing the range of its product line.

Fourth, develop historical information on the life-cycles of similar or related products to help roughly suggest the shape and the duration of a life-cycle for the products under study. For example, several companies have traced possible polyester life-cycle curves on nylon and acrylics curves.

Fifth, project sales of each product for a 3 - 5 year period, and estimate the incremental profit ratio during each of these years. A profit ratio typically expresses the relation of total profit to total direct costs which include manufacturing, advertising, product development, sales and distribution.

Finally, roughly estimate the number of profitable years remaining in the product's life-cycle, and then, based on all this information, classify the product's position in the life-cycle.

Once this is completed for each product, a more important step may be taken: determining what percentage of the company's overall sales and profits respectively fall within each phase of the product life-cycle.

The information necessary to complete the six steps previously described, is almost always available in the companies we serve. However, it is seldom organized in a manner which would permit one to quickly develop a product performance profile. More importantly, such data, when collected by Marketing, is almost never shared with R&D in a meaningful way.

To illustrate the practical use of the life-cycle analysis, let's consider a diversified company in the packaging business we are currently serving. Packaging is a field where new materials and new forms of packaging are being introduced every year. Yet mature and obsolescent products still account for the bulk of the sales volume for all participants - a picture which would not be true, for example, in the electronics and space equipment manufacturing industries.

As a basis for better planning, our client several years ago decided to carry out a life-cycle audit - developing for each of its products sales and profit information which dealt with such factors as annual sales volume, gross margin, profit contribution, return on invested capital, price per kilo, and market share. By tracing changes in each of these factors over 5 years and by averaging the annual changes over a period of 5 years, shrewd guesses were made with regard to where the product fits into the life-cycle. Recently, the CEO of this client expressed the following: "We came remarkably close in our assessments; where we erred, it was more often because we were conservative rather than really wrong."

The picture developed 5 years ago illustrated the following. For product A, a packaging film, sales growth had slackened, prices were declining, and costs were increasing significantly. Meanwhile market share, which had doubled in the previous 5 year period, had shown no gain.

Two new competitors and four new competitive products appeared within the past 3 years - eliminating a former quality advantage of product A. Sales analyses indicated that the top 50 customer accounts did 82 percent of Product A's volume 1964 - against 68 percent 5 years earlier. In the same period, the total number of customers had somewhat decreased. In this manner our client developed a life-cycle and profit profiles of their entire line and a composite is shown on the next exhibit.

Slide Twenty-two

Life-Cycle Profile

By classifying something over 200 different products, the company could conclude, somewhat disheartedly, that only 1 percent of its product line was in the introduction phase and that only 6 percent was in the growth phase. The bulk of the product line had entered the maturity and possibly obsolescence phases.

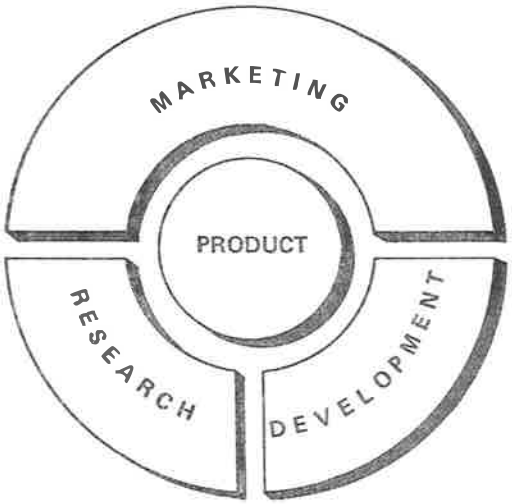
Slide Twenty-three

Profit Profile

A profit profile was also developed. The new products being introduced were costing the company approximately 5 percent of its profits. Products in the late maturity phase were accounting for well over 67 percent of total profits.

As a result of this analysis - one which was repeated every year since 1965 - the company found a far more meaningful basis on which to stimulate interaction between Marketing and R&D. In addition, specific programs were developed to rejuvenate the product line. Part of the volume came from new products developed by R&D, a second part came through acquisitions of smaller enterprises that had introduced successful products on a limited scale.

This completes my half of our presentation, Alcon Copisarow will continue and describe how interaction between the functions can be better stimulated.



INTRODUCTION - A CASE IN POINT

A Technological
Change in Perspective

- 1913 - First commercially successful diesel locomotive built by Swedish General Electric
- 1923 - U. S. General Electric introduced first diesel/electric switching locomotive
- 1934 - First commercially successful road diesel by General Motors

WHAT WERE THE CHIEF EXECUTIVES OF THE GIANT STEAM LOCOMOTIVE MANUFACTURERS SAYING IN 1935?

A Case in Point

Management's Perspective

- 1935 - Robert Binkert, Vice President Balwin Locomotive Works, in a speech to N. Y. Rialroad Club

  " ..... FUNDAMENTAL PRINCIPLES CONTINUE TO OPERATE – WE WILL NOT FIND OUR RAILROADS ANY MORE DIESELIZED THAN THEY ARE ELECTRIFIED"

- 1938 - William Dickerman, President of ALCO, in a speech to Western Railway Club

  " ..... STEAM MARCHES ON ..... STEAM HAS BEEN THE PRINCIPAL RAILROAD MOTIVE POWER ..... AND WILL CONTINUE TO BE"

DID THE FACTS INVOLVED SUPPORT THESE VIEWS

A Case in Point

The Facts Available

- 2,000 diesel locomotives produced in 1924; only 200 in 1931
- General Motors had invested over $ 11 million in diesel research by 1932, substantially more than all the steam engine manufacturers together
- A railroad's initial investment in a diesel locomotive could be recovered in 3 to 4 years
- ALCO - 1926 net profit of $ 8 million; 1931 net loss of $ 4 million

AGAINST THESE FACTS, WHAT HAPPENED TO THE INDUSTRY?

The Results

- ALCO produced its last steam locomotive in 1963
- Balwin left the industry entirely and became a sub-division of the Worthington Corporation
- General Motors controls 75 percent of the diesel locomotive industry

IS THE STEAM VERSUS DIESEL EXAMPLE RELEVANT TO OTHER PRODUCTS AND INDUSTRIES?

Relevance of the Case in Point

VACUUM TUBE	vs.	TRANSISTOR
STEEL	vs.	ALUMINUM (OR PLASTIC)
MOVIES	vs.	TELEVISION
WOVEN	vs.	TUFTED CARPETS
GENERAL PRICE GOOD CARGO	vs.	CONTAINERS
FOUNTAIN PEN	vs.	BALLPOINT
LINOLEUM	vs.	VINYL

These examples exclude the replacement of natural by synthetic products

LESSON TO BE LEARNED

Top Management Perspective

- ¶ Willingness to define the market to be served

  STEAM ENGINE, LOCOMOTIVE, RAILROAD OR PUBLIC TRANSPORTATION?

- ¶ Willingness to create or serve changing customer demands

  STEAM ENGINE OR FAST, LOW-INVESTMENT LOCOMOTIVE POWER?

- ¶ Willingness to objectively assess the facts and trends

  90 PERCENT DECLINE IN UNITS PRODUCED ANNUALLY BETWEEN 1924 AND 1935

Lesson to be learned

Product Life Cycle

- ¶ Inevitable and generally predictable decline in volume

  2,000 UNITS IN 1924; ONE UNIT IN 1963

- ¶ Inevitable and generally predicatble decline in unit profit

  ALCO NET PROFIT $8 MILLION IN 1926; $4 MILLION LOSS

Lesson to be Learned

Organizational Perspective

- ¶ Sensitivity of marketing organization, overall corporate strategy and inter-functional relationships

  "STEAM WILL CONTINUE TO BE THE PRINCIPAL RAILROAD MOTIVE POWER", WILLIAM DICKERMAN

- ¶ Scope and investments in Research and Development

  GENERAL MOTORS HAD INVESTED $11 MILLION IN DIESEL BY 1932

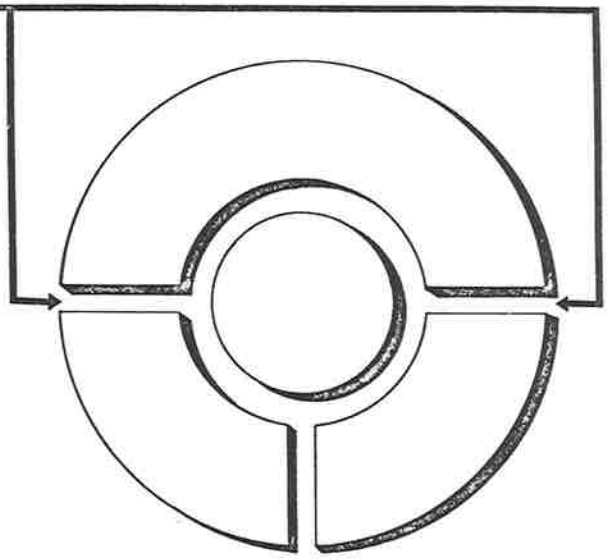
THE PROGRAM

Managerial Processes

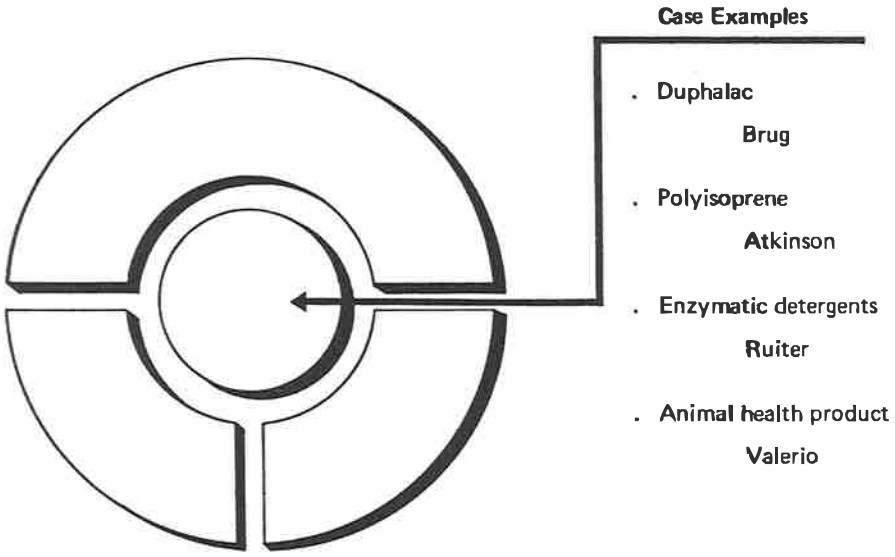
. Interfunctional
  Processes
  Copisarow

. Collaboration in
  Marketing and R & D
  Freiensehner

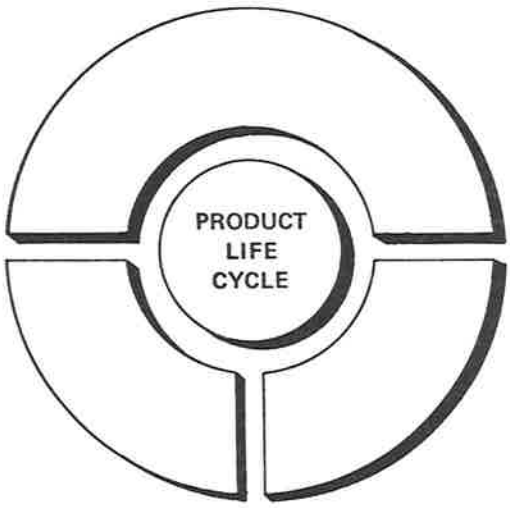
. Organizing for New
  Products
  Lodge



THE PROGRAM



THE ROLE OF R & D IN THE PRODUCT LIFE CYCLE



PRODUCT LIFE-CYCLE CONCEPT

A product's sales volume follows a predictable path:

- ¶ Low-volume introduction phase
- ¶ Growth phase
- ¶ Maturity phase
- ¶ Obsolescence phase

But, the duration of each phase is often hard to determine

CAUSES OF OBSOLESCENCE

- ¶ Disappearing need

  BUGGY WHIP, ORANGE SQUEEZER, THE RADIO ADVENTURE

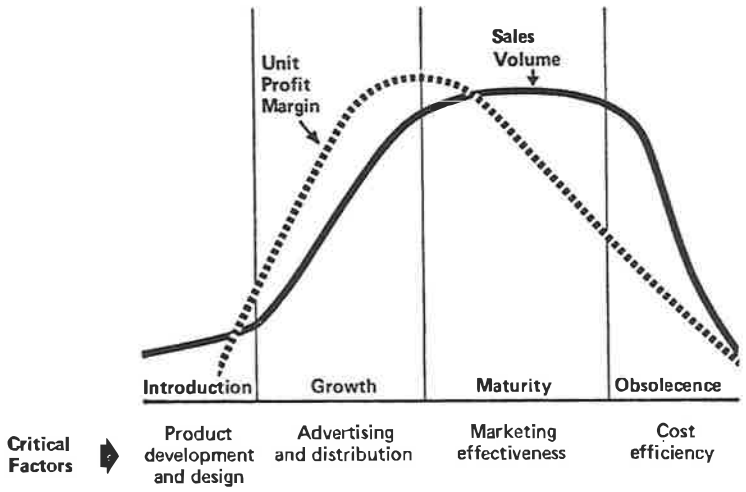
- ¶ Better, cheaper or more convenient substitute

  TRANSISTOR, VINYL FLOOR COVERING

- ¶ Competitive product with superior marketing or psychological appeal

  CREST TOOTHPASTE, MARS CHOCOLATE BAR

THE PRODUCT LIFE CYCLE CONCEPT



COORDINATION DEMANDS DURING EACH PHASE OF THE LIFE CYCLE

1 - INTRODUCTION PHASE

R & D		MARKETING
• CUSTOMER ORIENTED DESIGN	←	(ASSESSMENT OF MARKET)
• DEVELOP EVIDENCE OF TECHNICAL OR COST SUPERIORITY	→	• CREATE CUSTOMER DEMAND
		• APPROPRIATE SUBSTANTIAL FUNDS FOR INTRODUCTORY MARKETING

2 - GROWTH PHASE

F & D		MARKETING
• IMPROVE PRODUCT RELIABILITY AND QUALITY	←	(FEEDBACK ON PRODUCT PERFORMANCE)
• ANTICIPATE COMPETITIVE SUBSTITUTION	→	• IMPROVE DISTRIBUTION • STRENGTHEN PRODUCT AWARENESS

3 - MATURITY PHASE

R & D		MARKETING
• DEVELOP VARIATIONS ON BASIC PRODUCT THEME	←	(FEEDBACK ON MARKET REACTION)
• IDENTIFY NEW USES	→	• EXPAND DISTRIBUTION TO NEW CUSTOMERS • EXPERIMENT WITH PRICE TO ATTRACT NEW TYPES OF CUSTOMERS

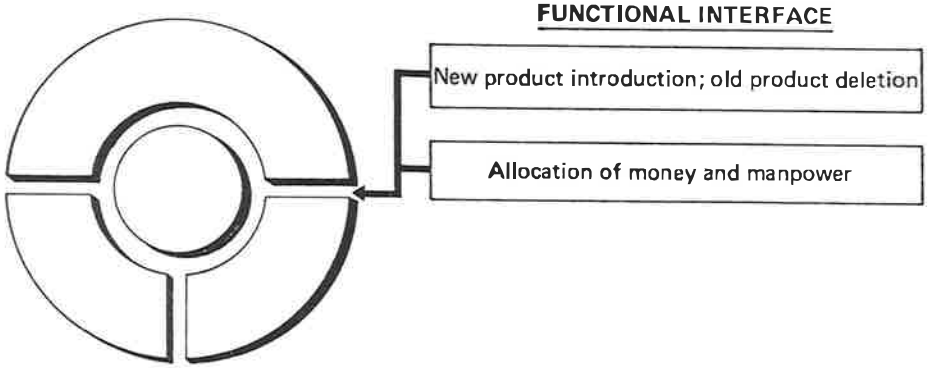
4 - OBSOLESCENCE PHASE

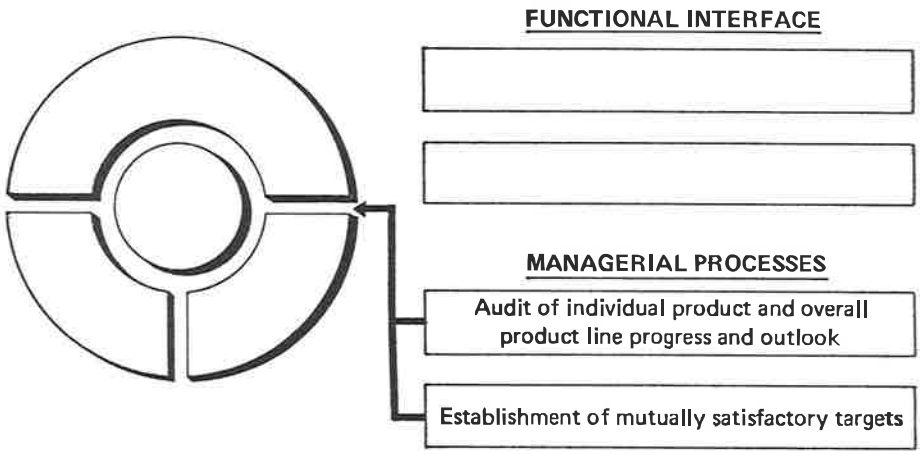
R & D

- REDIRECT EFFORT TO NEW PROJECTS

MARKETING

- INTRODUCE PROGRAMS FOR SEVERE COST CONTROL
- ORGANIZE TO STEP OUT OF MARKET

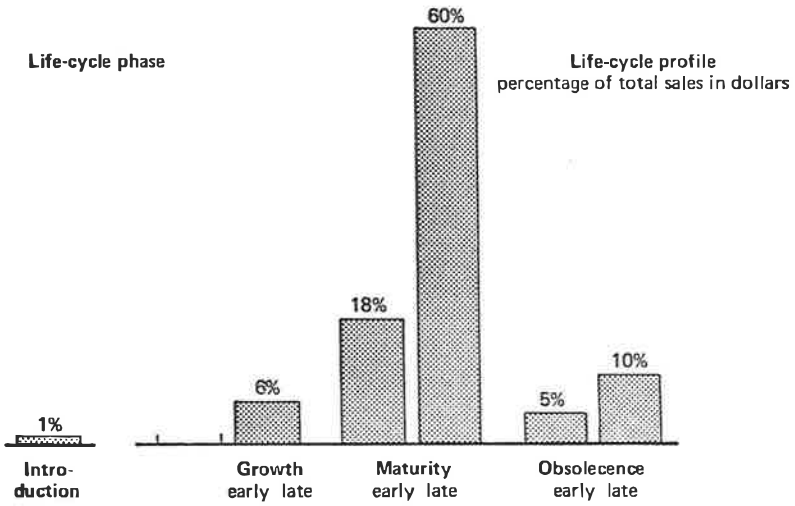




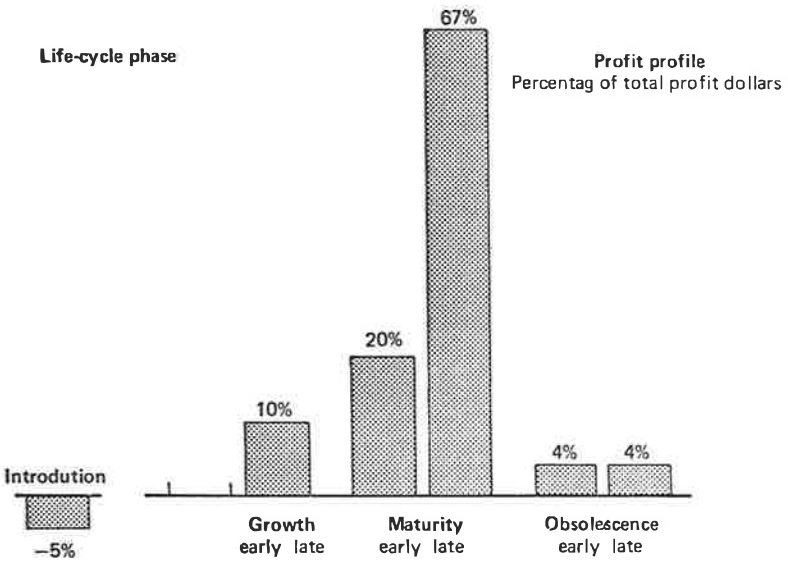
STEPS IN PINPOINTING PERFORMANCE

1. Historical performance of individual products
2. Assessment of competitive products
3. Assessment of competitive strategy
4. Review life-cycles of similar or related products
5. Project sales and profit
6. Estimate position of each product in the life cycle

LIFE–CYCLES AND PROFIT PROFILES OF A PACKAGING MATERIALS MANUFACTURER



LIFE–CYCLES AND PROFIT PROFILES OF A PACKAGING MATERIALS MANUFACTURER



The Role of R & D
in the product life cycle
Part II

A.C. Copisarow, D.Sc.
Director of Mc Kinsey & Co. Inc., London

Research and development mix

Some successful research directors describe their activities as a type of gambling game which, if played skillfully and often enough, is bound to result in a few big wins that can more than offset the cost of the losses. This is in marked contrast to the role of the development director whose objective is to engineer a process of product that is known to be technically feasible and which fits a given specification within a defined time and cost budget. For these purposes, quite different qualities are called for.

In the first place, we are speaking of different types of people. The scientist tends to seek the approval and accolade of an audience of his co-professionals, and it is highly desirable to reconcile his ambitions with those of his organization. How can a research scientist in the chemical industry, who would delight in obtaining say, the maximum yield of the end-product, or the quickest reaction, be made to bow willingly to over-riding company requirements such as simplifying manual operations, minimizing capital costs or avoiding toxic hazards?

At one end of the spectrum, the basic research effort in a large organization must be at the frontiers of science. The practioners must be judged by their professional peers and not found wanting. They must be insulated from day-to-day problems of the enterprise yet not isolated from its overall objectives. At the other end of the spectrum are the development personnel who are mainly concerned with quite specific corporate aims. Their minds must be first and foremost on the end product and the marketplace. Between these two poles lies a critical area that must be staffed by able people with a dual allegiance. They must understand science and appreciate what is does for technology and for the organization. At the same time, they must ever be sensitive to the way product goals and profit objectives can be influenced by deploying scientific an technical resources.

Now, organizations may be research intensive or else development intensive.

In our experience, the more efficient research intensive companies display six dominant characteristics: (Exhibit 1)

These are the first three:

1. They begin work with rather definite specifications. Generally, the problem can be identified but the solution to it is not clear, so that the research staff must identify and evaluate alternative solutions rather than a single one.

2. Information on market or other objectives is often fed to the whole research group instead of being channelled to specific individuals. The aim is to stimulate the generation of ideas rather than to initiate work on a very narrowly-defined front.

3. Work assignments are relatively non-directive. As technical insight is an individual rather than a group attribute, there must be freedom for individual initiative rather than a narrow assignment to specific parts of a well-defined solution. (Exhibit 2)

4. Great value is attached to perception and the ability to spot the significance of research results. The discoveries of the potential of penicillin, or nylon, for example, could easily have been missed because the experimental results were totally unanticipated.

5. Research intensive organizations usually employ a continuing process of evaluation and selection. Frequently, potential lines of attack are overtaken by a successful alternative approach, or made obsolete by other results or by competitors. Therefore, research management must be constantly alive to the need for changes in its programme, even within a single planning period.

6. There is a tendency to value innovation more highly than efficiency. Research efficiency is difficult to measure in any absolute sense, and attempts to over-systematize research management, i.e. organization structure, planning and control can actually result in a reduction in productivity.

In contrast to this, the successful 'development' organization is typified by four different factors: (Exhibit 3)

1. The design specification is relatively complete. The development objective is reasonably clear. Performance tests can, therefore, generally be laid down at an early date, and the basic task is to reduce a number of feasible alternatives to a single solution that can be passed forward to manufacturing.

2. Supervision tends to be highly directive. Objectives and deadlines are laid down and performance measured fairly precisely, even in the short term.

3. It is frequently necessary to arrange tasks sequentially. Unlike the research intensive organization where many people can work in parallel, successive development stages frequently depend upon the completion of an earlier one and tight controls are necessary to ensure that time and cost schedules are met. The trade-off between innovation and efficiency here is usually biased towards efficiency.

4. The development organization is highly vulnerable to disruptions caused by changes in objectives or specifications from manufacturing or marketing; this is because of its higher manpower commitment, sequence of tasks and proximity to production. Our studies show that mid-stream changes in management objectives contribute much more to time and cost 'over runs' than do purely technical changes.

In view of these marked differences between the 'research' and 'development' functions, every management should decide where its own business lies in the R & D spectrum and its relation to the product life cycle, and bear these important differences in mind in choosing an appropriate form of organization. The organizational implications are summarized in the next Exhibit. (Exhibit 4)

There is much evidence to suggest that industrial weaknesses in bringing new productions to market often result from wrongly applying to a development organization, the loose long-term controls appropriate to research.

Interaction between departments

If we turn, now, to the interaction, or 'coupling', that should exist between R & D departments and succeeding functions of manufacturing and marketing, we are dealing with a critical management area.

Obviously, there are significant differences between the needs of companies concerned with, for example, branded breakfast foods and basic chemicals.

However, we have found many companies where this problem has either not been recognized or has not been properly thought through, resulting in major friction between departments and sometimes even in the development of products for which there is no market.

It is useful to distinguish three degrees of coupling - high, moderate, and low (Exhibit 5). Let us look first at the flow of technical information. In construction equipment

companies, say, the technical know-how built into the product design is important, usually to the R & D people only. In most mechanical, chemical and electrical engineering firms, the technical know-how is required by the production people as well. And, in companies manufacturing sophisticated materials such as plastics, the marketing department as well as the manufacturing department must have full technological awareness.

High coupling requires close interaction between every function of the business - R & D, manufacturing, and marketing. Accurate and detailed market information is essential to adequate product-line planning. The selection of R & D projects is influenced heavily by manufacturing costs, availability of raw materials, the abilities of the marketing organization, and countermoves by competitors. Minimizing the disruptive effect of new product introductions on manufacturing is critical. Tight control of product quality is essential to successful customer applications. And usually, the time pressures are acute. (Exhibit 5a Only 4% paid off). To give you an example of the consequences of totally inadequate coupling between departments. . . . . (Exhibit 5c).

So far as the relation between the technology and the product life cycle is concerned, where the introductory phase of the cycle is short, it may be necessary in the interests of speed to strike a compromise between technical and marketing aims. When the life cycle is longer, the technology may be planned in a more orderly fashion, with a view to economy rather than to speed. When the technological effort has been great but the commercial life is likely to be short and the return uncertain, it becomes important to apply the technological cutoff at the point when returns begin to diminish, rather than wait for technological perfection.

Turning then to the question of

Marketing strategy

It is important for R & D departments to know the intended rate and direction of company growth; the relative importance placed on improving operations, improving and diversifying products, or altering the industrial base; and whether, for example, product improvements are sought primarily in the area of quality, performance, or price. And again R & D must know whether their efforts are to be geared to hold-the-line strategies, modest gain strategies, or breakthrough strategies.

Most companies adopt a blende of strategies according to the requirements of their different markets or product lines, but four broad categories may be identified: (Exhibit 6)

1. Might be called the 'First to market' - strategy based upon a strong R & D programme, technical leadership and risk-taking.

2. Follow the leader - requiring strong development resources and an ability to react quickly as the market starts its growth phase.

3. Application engineering - based on product modifications to fit the needs of particular customers, in a mature market.

4. 'Me too' strategy - usually based on superior manufacturing efficiency and cost control.

To elaborate, a little, on each of these:

First to market. This is a risky, but potentially rewarding strategy and it has a number of important implications for the business. It calls for (a) an intensive research effort, supported by major development resources, and thus a higher R & D investment ratio; (b) secondly, close downstream coupling in product planning, and moderately close coupling thereafter; (c) thridly, close proximity to the 'state of the art' (a term

denoting both the frontiers of technology and associated economic considerations); and (d) finally, it means accepting a high risk of failure for individual products.

Top management must be able to make important judgments of timing, balancing the improved product development stemming from a delayed introduction, against the risk of being second into the market. Such a company must have more than its share of long-range thinkers who can assess market trends in their earliest stages and plan with confidence and flexibility.

Follow the leader. This marketing strategy implies: first, technical effort of a development-intensive, or development-oriented, character, secondly, moderate competence across the spectrum of relevant technologies, thirdly, exceptionally rapid response time in product development and marketing on the basis of completed research, fourthly, high downstream coupling of R & D with marketing and manufacturing and fifthly, superior competitive intelligence.

The company that follows this strategy is - or should be - an organization that gets things done. It uses many interfunctional techniques, responds rapidly to change, and almost seems to be performing a perpetual fire drill. Normally, it has few scientists on its payroll, but some of the best development engineers available. Its senior executives are constantly concerned with maintaining the right balance of strengths among the technical, marketing, and manufacturing functions so that the company can respond effectively to the market leader's moves in any of these three areas.

Application engineering. This strategy requires: (i) substantial product design and engineering resources, but no research and little real development, (ii) ready access to product users, (iii) technically perceptive salesmen and sales engineers who work closely with product designers, (iv) good productline control to prevent cost inflation, (v) considerable cost consciousness in deciding what applications to develop, (vi) an efficiency-oriented manufacturing organization, and finally, a flair for minimizing development and manufacturing cost by using the same elements in diverse applications.

The applications-engineering strategy tends to avoid innovative efforts in the interest of economy. Planning is precise, assignments are clear, and the new technology is introduced cautiously. Return-on-investment and cash-flow calculations are standard practice, and the entire management is essentially profit-oriented.

Finally, the 'Me too' strategy. This has flourished in the past decade as never before. It is distinguished by having (a) neither a research nor development activity; (b) a strong manufacturing function; (c) impressive performance in price and delivery; and (d) ability to copy new designs quickly, modifying them only to reduce production costs. Competing on price, taking a low margin, but avoiding all development expense, a company that has adopted this strategy can wreak havoc on competitors following the first-to-market or follow-the-leader strategies. This is because the 'me too' strategy, effectively pursued, shortens the profitable period after market introduction when the leaders' margins are most substantial. The 'me too' strategy requires a 'low-overhead' approach to manufacturing and administration, and a direct hard sell on price and delivery to the customer. It does not require any technical enthusiasm, nor does it aim to generate any.

R & D investment ratio

The final issue we might consider is the size of a company's investment in technological innovation. While the question of how much should be spent on R & D has no simple answer, it is plain that there are major differences between industries.

A high investment ratio has four important implications for the organization of a company. (Exhibit 7)

1. The first is the need for top management constantly to evaluate alternative procurement strategies:

These alternatives may include:

- o Developing the required skills internally by a continual training process
- o Hiring technical group leaders from outside, in order to bring in specific kinds of technical competence
- o Taking over smaller companies that have demonstrated a high degree of technical competence
- o Acquiring technology through licensing, or where feasible from technical consultants.

We sometimes see these procurement alternatives brought together, and then they can be translated into company profit objectives (Exhibit 8).

2. Then (Exhibit 7 again). A high investment ratio, usually accelerates product and process change. This, in turn requires an adaptive organization. The source of the change can be either external or internal. Externally, competitors investing in the same technology may render a market, a plant, or an investment obsolete and compel the organization to respond swiftly. Internally, R & D results can produce similar pressures for change. In a company with a high R & D investment ratio, a major criterion of organization is the ability, therefore, to adapt to new technology without sacrificing market share or efficiency.

3. Next, high investment ratios usually result in a highly dynamic market with emphasis shifting rapidly from introducing new products to reducing unit costs, and back again. Such markets, where products readily substitute for one another impose some special requirements.

First, management must be able to cut off a development project quickly or switch resources into a new technology.

The second requirement is explicit strategy formulation. Even in a rapidly changing market this will permit a clear definition of project alternatives, and enable a better choice to be made between them.

The third special need is a well-developed planning system tying R & D closely to annual corporate planning and control and allowing rapid re-direction of resources if this is called for.

4. The fourt implication of a high R & D ratio is that is requires closer top-level supervision of technical efforts. Since the company is highly dependent on technology for competitive survival and therefore commits proportionately more resources to the effort, top management needs to know more about technical problems and performance. They should be aware of the long-term corporate effects of lower level decisions and have a good grasp of the time and cost implications of particular technological developments.

At the other end of the investment ratio spectrum, where there is relatively little R & D, organization requirements are generally the converse of those just identified. For example, technology can normally be developed internally, marketing is usually well-separated from product development and resources devoted to individual projects do not necessarily have to be clearly identifiable in the short term.

Whatever the total investment, management must decide whether there is a threshold of investment in any project below which efforts are likely to be ineffective.

Such thresholds are difficult to measure precisely, but an estimate can be made by critically assessing both the company's own past performance in introducing new products and also the record of competitors.

In the electronics industry, for example, a company must keep abreast of technical changes in components, it must introduce a flow of improvements, and launch completely new models when forced to do so by the competition. This is the threshold level of effort. It is an absolute level of resources, not a ratio of sales. It is derived by dividing the estimated R & D costs of new products by their typical lead times - defining lead time as the time required to take a new idea from the initial secision through R & D and design to first regular production.

To develop a high-quality oscilloscope, let us say, a team of about 20 qualified scientists, engineers and designers may be required full-time for about three years. The annual cost in Europe might, therefore, be some $ 400,000. For small and large computers, the corresponding R & D costs are of the order of $ 1.5 million a year and $ 11 million a year, respectively. A communications satellite with five-year lead time would require some $ 22 million a year. In each case, a manufacturer aiming to shorten the lead-time sufficiently to become the leader in the field might well have to double the indicated annual expenditure.

If a company with a small market share merely matches the ratio of R & D to sales of a larger and more successful competitor, its research expenditure may fall below the 'threshold' level. The company may find itself caught in a vicious circle. Because its effort is below the threshold, its lead times will be too long, and its market share will decline further. Its ratio of R & D expenditure to sales will rise, diminishing its profitability and reducing the cash flow needed for future development and investment. Many companies have got into this situation.

If the R & D threshold in a particular field is too high for a company, its only alternative to abandoning the product line, may be to join with another company with resources sufficient to exceed the threshold for a period long enough to retrieve the poritions.

To summarize, in a single sentence - and possibly to moralize:

It is imperative that any company that wishes to protect or expand its business through application of technology should devote the same care to creating the best possible form of organization and management processes as it gives to selecting the right plant and equipment.

Exhibit 1

CHARACTERISTICS OF EFFICIENT RESEARCH INTENSIVE ORGANIZATIONS

1. They work with rather indefinite specifications
2. Market and other information is 'broadcast' to research groups rather than specific information being channelled to individuals
3. Work assignments are relatively non-directive, recognizing the importance of individual insight

Exhibit 2

4. They stress the perception of results of technical or commercial significance
5. They usually employ a continuing process of evaluation and selection
6. They value innovation more highly than efficiency

Exhibit 3

FOUR DIFFERENT FACTORS TYPIFY THE SUCCESSFUL, PREDOMINANTLY DEVELOPMENT, ORGANIZATION

1. They have relatively complete design specifications
2. Supervision is highly directive
3. Tasks are arranged sequentially
4. They are highly vulnerable to disruption by changes in objectives or specifications from manufacturing or marketing

Exhibit 4

DIFFERENCES BETWEEN "RESEARCH" AND "DEVELOPMENT" GROUPS HAVE A NUMBER OF ORGANIZATIONAL IMPLICATIONS

Characteristic	High "Research" Content	High "Development" Content
1. Type of organization	-Relatively 'flat' -with few tiers of management, high degree of 'mobility' of personnel	-Well-structured, clear lines of responsibility
2. Type of leadership	-Creative, intuitive -but with feet firmly on the ground	-Analytical, disciplined
3. Nature of work assignments	-Non-directive; except in the broad sense	-Objectives and work programs precisely defined
4. Frequency of change	-Fairly great in response to changing technical insights	-Low, once objectives are spelled out
5. Performance measurement and control	-Relatively long term	-Well-defined programs and frequent checks on performance

Exhibit 5

AMOUNT OF "COUPLING" BETWEEN SUCCESSIVE FUNCTIONS CAN VARY WIDELY

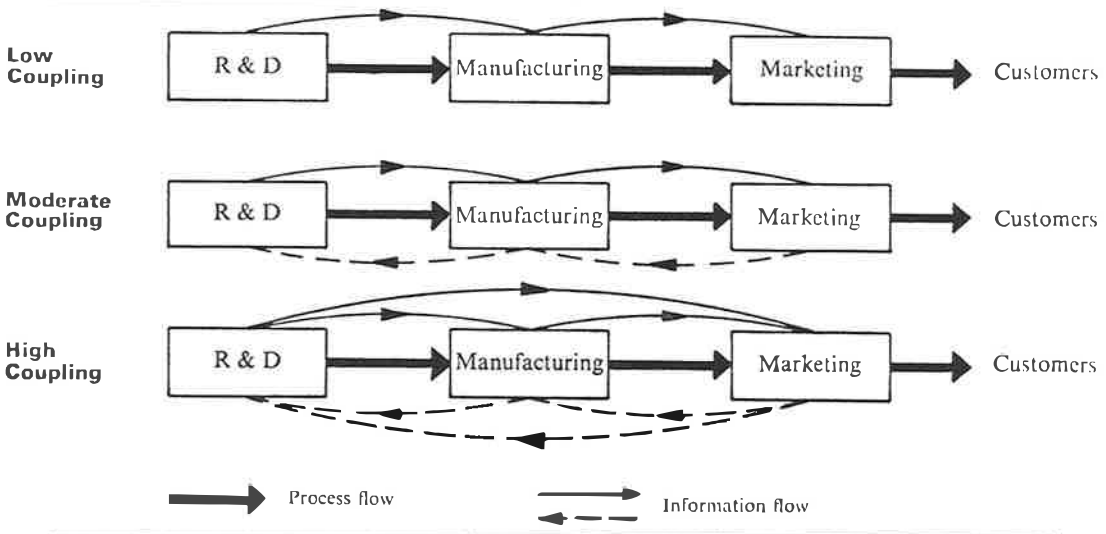


Exhibit 6

FOUR MAJOR MARKETING STRATEGIES

1. First to the market
2. Follow the leader
3. Application engineering
4. 'Me too'

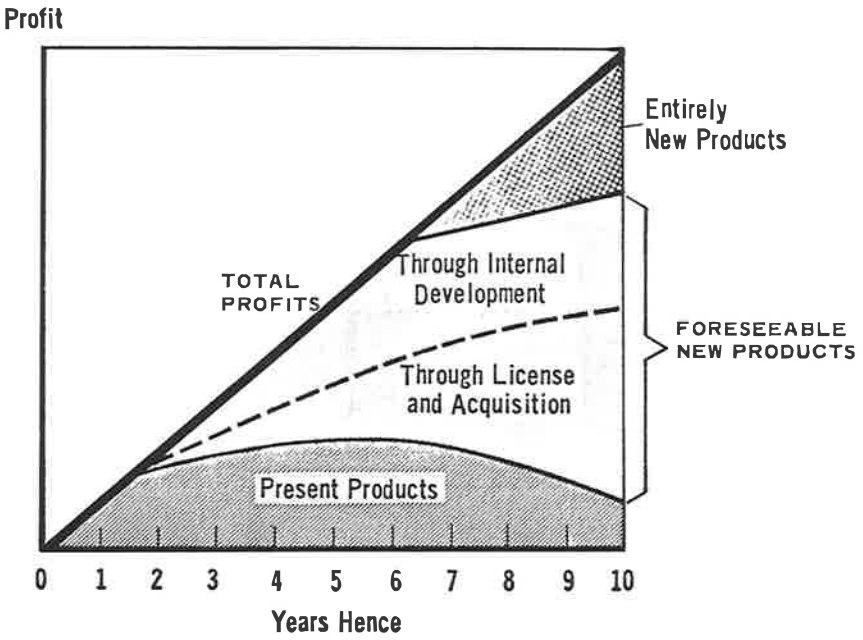
Exhibit 7

FOUR MANAGEMENT IMPLICATIONS OF HIGH R & D INVESTMENT RATIOS

1. Require constant evaluation of alternative procurement strategies
2. Usually accelerate product and process change
3. Usually cause highly dynamic market with emphasis shifting from new product introduction to reducing unit costs, and back again
4. Demands close top-level supervision of development efforts

Exhibit 8

CORPORATE R & D OBJECTIVES MAY BE EXPRESSED IN TERMS OF PROFIT TARGETS . . . .



DISCUSSION

Question

Could the speaker comment on the following problem? Should a product manager be a man with a technical background and special commercial training, or a man with a commercial background and special technical training?

Answer

We could better leave this question unanswered and wait for the case study from the Unilever-group. In his presentation the speaker from Unilever will talk about product-teams in terms of the management of new products. There it will be outlined that very often in the beginning, when a product is introduced, the team leader is a R & D man, or a person with a technical background. When the product matures within the development cycle, the team leadership is often passed on to a marketing executive.
The concept of having either a group of people, or in a product team some people, each representing one of the functions needed to launch a new product, is an excellent one. We have seen it used many times with tremendous success. As a matter of fact it is the easiest way we can think of to split up the company in the small units necessary to ensure that on its introduction a specific product has the best chances of marketing success.

Collaboration in Marketing and R. & D.

Dr. H. Freiensehner
Vice-President of the Board of Badische Anilin- und Sodafabrik
Ludwigshafen
German Federal Republic

The program committee was very wise in having limited the subject matter of the present conference to the Chemical Industry. There is no question that many other industries are dependent on R & D to a large extent, for example the electronics industry, but the situation in the Chemical Industry is unique in some respect and not to be compared with other industries. The manufacture of consumer or capital goods in other industries in based normally on a mechanical or physical treatment, combination or arrangement of materials of known properties so that new products of these industries are, inspite of their novelty, not new in a chemical sense.

In contrast thereto, the activity of the Chemical Industry consists in converting one chemical element or compound into another, and thereby frequently creating new chemical compounds. Looking for new compounds and new chemical reactions to improve chemical processes is one of the principal duties of R & D in the Chemical Industry and a conspicuous characteristic thereof.
In addition to these characteristics, there are a number of other specific factors which influence the management of the Chemical Industry.

Firstly, the technical progress in the Chemical Industry is accelerating, and the competition in achieving this progress is increasing too.
It is not only the life cycle of a chemical product which is getting shorter but the life of chemical processes is getting shorter too.
To exaggerate it somewhat : Once you start Marketing a new product a better competing product is already in the test tube of pilot plant somewhere, and once you start a new plant it is already obsolete.

Secondly, the size of chemical plants is steadily increasing. Consequently capital costs and financial risks are getting bigger too.

Thirdly, the number of chemical products is also growing continuously so that it becomes increasingly more difficult to be active everywhere. Selection between potential new ventures becomes a must.

Fourthly, costs for labour and capital and as a consequence, costs for R & D are growing. However, this is not a specific concern in the Chemical Industry but in all industries and, if I may say so, it concerns all people.

Marketing in the Chemical Industry, naturally, has a lot in common with this function in other industries but also here the impact of the specific situation in the Chemical Industry is distinct.

In the years from 1963 to 1968 the Battelle Institute has made an extensive study about "Marketing in the capital goods industry in Germany". In the course of this study the German Chemical Industry was included. One result of the study was that a systematic and methodical Marketing concept for the capital goods industry has not yet been worked out. Admitting that Marketing forecasting in the consumer goods industry which is based on well tried methodical foundations and transparent statistics is not easily transferable to capital goods industries, the Chemical Industry as one of the fast growing industries in the last years has tried very hard to close the "Marketing gap". This task has to be handled by each firm individually but it can be supported very essentially by joining our forces, as this is being done at this TNO conference.

There are numerous definitions of "Marketing". I don't intend to add another one, but to express it simply, I include in the term Marketing all our efforts to investigate the requirements of the market, and to satisfy the requirements of the market with the ultimate goal of having the company operating at a profit. It has become fashionable to speak about the various "gaps" developed between the USA and Europe, may it be a "technological gap", a "Management gap" or an "educational gap". Now we are also faced by a "Marketing gap" in European capital goods industry. How far is this allegation that Europe is underdeveloped in Marketing justified? Has not the European Chemical Industry, including the German Chemical Industry, shown a tremendous growth in the last two decades, a growth which compares fairly well with that of the American Chemical Industry? Nevertheless, there is some distinction between the two continents, and I spent some time in the preparation of my present speech trying to find out and to explain what is this distinction. You will note that this distinction also affects the relation between R & D and Marketing.

Now it is a fact, and here I can speak only for Germany, that the chemists, physicists and physicochemists employed by the Chemical Industry in Germany all have a thorough academic training. Actually no scientist of these professions will be hired unless he has left the University with a doctor's degree. With very few exceptions they have never been confronted with economic or industrial problems before they started their professional career in industry. And it is only then that these scientists have a chance to become acquainted with the economic facts of life.

Another fact has to be considered. For a long time and even today industrial chemistry was overwhelmingly governed by product thinking and product orientation. This means that the selection of objectives by R & D is technical, primarily orientated towards product research and production. All efforts are made to prolong the life cycle of a product or product groups, research is intensively directed to applications, and as many different applications as possible looked for. This orientation is typical and fully justified for chemical companies producing raw or intermediate materials and if the technical progress is steady and slow. A product-orientated company may very successfully diversify one product.

The market orientation on the other side is, strictly speaking, problem orientated. There the problems of the customer influence the activity and the policy. The changing over from product to market orientation was favored by development of mass-production, even over-production, the advance of competition in a free economy where practically every product meets with a competing product which in turn makes it necessary to investigate very thoroughly markets and application possibilities. Germany and other European countries have lived for many years under a controlled economy and with a shortage of goods. They were confronted much later with the necessity of Marketing instead of selling than the USA. For the Chemical Industry many preconditions for successful Marketing were already existent. This very industry started quite early, first in the application of dyestuffs, to give service to the consumer of its products. Service, however, is one of the chief ingredients of Marketing. We understand that Marketing consists in giving service to the customer and we have to emphasize this fact. We also understand that this includes possible and optimal adaption to existing and changing market conditions with the objective to assist the customer in solving his problems and to induce him to spend his money for our products. One of the most well known slogans in the USA is "Call Geigy for service" together with a picture of a phone, or DuPonts "Better things for better living - through Chemistry".

Looking at the Collaboration in Marketing and R & D from the point of view of Marketing, I would like to postulate that one of the most important objectives in carrying through this collaboration consists in making R & D understand Marketing. Even admitting and recognizing the high standard of education of R & D personel, they should be convinced and satisfied that Marketing activities are not an inferior a less qualified contribution to the prospering and growing of a company as compared with purely scientific R & D work.

To become more specific, I see four principal objectives in Marketing chemical products.

Firstly, we will try to get an optimal share within existing markets with established products. Secondly, we will aim at developing new markets for established products. Thirdly, we will endeavour to develop the existing markets for new or improved products. Fourthly, we will attempt to develop new markets for new products.

As to the first objective of getting an optimal share of the present markets with established products this should be a normal task for Marketing and doesn't require an active cooperation with R & D. However, it is very important that R & D gets continuous information about the market situation for already established products. I shall refer later on to the methods how to ensure such information.

The second objective of developing new markets for established products of the Chemical Industry apparently requires collaboration between Marketing on the one hand and R & D on the other hand, particularly of the development side of R & D.

I don't intend to anticipate the case studies of my colleagues who will speak after me. But you will allow me to illustrate the result of joint efforts of R & D and Marketing in a very recent development. Since a product of my company BASF is concerned I want to make it clear that no clandestine advertising is intended.

As you may know expandable polystyrene has been developed in the last years, first in particular as an insulation material. In later years also its use in packaging has been growing. We have tried very hard to get EP accepted in vegetable packaging which would have been a logical application in view of its properties. It is very light and, nevertheless, mechanically very stable. It doesn't take up moisture, it is rot-proof and very hygienic. But to our surprise we found it very difficult to substitute the conventional packaging materials, such as wood or cardboard, by E. P. Apart from the question of the price, the form of the box and a rational method of producing the boxes offered some problems. By constant investigation of the requirements of the customers by teams of Marketing man, engineers and chemists we finally succeeded in developing the right size of the E. P. granulate, the proper type and design of the mold, the most suitable film to give the box a transparent cover and a dispersion to stick the film to the box. This finally broke the Dutch farmers' resistance. They accepted the new method of shipping their cucumbers to Germany. I repeat, please ignore that it was a product of my firm. But the example is so typical that I couldn't desist from mentioning it. It clearly demonstrates that Marketing had to familiarize itself with the customers', in this case the farmers' problem.
We knew that the existent method of packaging in cardboard or wooden boxes was unsatisfactory. Cardboard lost its mechanical strength when it became moist and didn't protect the contents from moisture. Wooden boxes or crates didn't protect the contents from moisture either and they were heavy. To provide open boxes made from E. P. would still leave the cucumbers unprotected against moisture. Closed boxes would have required two parts. The people of R & D were thus confronted with several problems. Provide a closed box which, though being somewhat more expensive to manufacture, would be more economic ultimately by reducing the losses incurred by rot, and the impairment in quality and appearance of the vegetables. The final solution was, so to say, a package solution and a typical example of being of service to the customer by collaboration of R & D and Marketing.

The development of new markets for established products might give the impression that the role of R & D consists only in assisting the Marketing people in realizing their concept of having a new market, new customers to accept certain established products for new applications. This assistance, however, will only be successful if Marketing and Development experts cooperate very closely. The products of the Chemical Industry, as a rule, are capital goods and have to converted into consumer or other capital goods. It is, therefore, not sufficient to keep contact with the immediate market and with the customers who are directly supplied with products from the Chemical Industry. The

secondary market, as I will call it, and in some cases the tertiary ones have to be closely studied in order to open new markets. I shall not go into a detailed discussion what methods have to be used to get the economic situation and outlook of secondary and tertiary industries, in particular statistical data and market trends, consumer habits and so on. I shall concern myself more with the practical approach. In the first place, it has become apparent that the normal sales force canvassing the market from the sales agencies distributed over the country will not be able to furnish the necessary data. They are fully occupied by their routine work, though much information may be gathered during the routine work, such as intended investments by the customers, type of new equipment ordered by the customer, future capacity and potential intake of starting material, state of their business etc. Special task forces, we call them "market development groups", were formed, consisting of members of both product and application sections of R & D on the one hand and Marketing experts picked out from the central sales department ad hoc for specific tasks.

These teams are visiting systematically the customer of the second line. To cite an example, a manufacturer of suit-cases was visited by a team consisting of an economist to assist the client in assessing the profitability of substituting a conventional raw material by a plastic, a mechanical engineer to give advice about the equipment required for substituting the conventional material by the plastic, and a chemist with specific knowledge about the properties of the product proposed for the substitution.

The composition of the market development groups will change according to the specific task before them. Approaching the producers of packaging material, for example, a packaging specialist from the transportation department will be added to the team. Or, to cite another example, the use of plastic products in farming will be handled by a team including a trained agriculturist. It is self-understood that a certain selection should be made what secondary customers should be approached in this way depending on the growth possibilities of the industry concerned and on the profits to be expected. A specific and in some way rigid budget should be set up for each of the projects contemplated. Since many factors for establishing a budget are hardly to be defined exactly R & D and Marketing should set up two budgets one being pessimistic or conservative and the other being optimistic.

Now, we all know that no R & D work can be a 100 per cent success. It is the same as in advertising where the President of Unilever once remarked: "I know that half of the money we spend on advertising is thrown away but I don't know which half it is." Only those staying inactive and lethargic and do nothing won't run the risk of being unsuccessful, for example by helping competitors. The risk can never been avoided. However, as I said before, by pooling their experience and information, R & D and Marketing can contribute substantially to reduce the financial risk in planning.

So far I have spoken about the subject of finding new markets for established products. An even more important objective in the Chemical Industry is to find markets for new products. This involves considerably higher financial committments and, therefore, requires an even closer collaboration between R & D and Marketing. It is, as I said in my introduction, one of the particularities of Chemical Industry that it grows by creating chemically new compounds. Either these products are the result of research started by R & D on their own initiative or R & D got information that products of certain properties would be welcome in the market. The relation between R & D and Marketing, therefore, is a two way street. In many cases it will even be difficult to really find out where the initiative came from. Most probably, in large chemical companies more time, effort and money is being spent on developing new and improved products to replace established ones in order to strengthen the market position, as for example in plastics, dyestuffs or adhesives, than in creating fundamentally new compounds. Since no company can afford to spend money on R & D without limitations, the allocation of money to the various branches of R & D in a budget is required.

Turning first to the information which should be provided by Marketing I have to repeat that the speed of change in the markets is growing. The demands of the customers for

better quality of chemical products is more and more pressing. Frequently technical developments in the equipment of the customers add to this demand for improved products. To be up to date, the sales force has to maintain a very close contact to the customer not only in order to get information but to get fresh information. It is not sufficient to have good relations with the purchasing agent of a customer. Gaining the confidence of the technicians, such as operators, research people, marketing men, if possible on the management level, is far more essential. In order to be accepted as a partner by the customer the men in the market field should have sufficient knowledge of the economics of the industry they are visiting regularly and of the technical problems concerned. They should be able to understand the customer's problem so well that they are able to convey them back home in a manner that R & D will know what the problem is. The success of the sales people in the field is greatly improved by an active sales service force consisting of fully trained technicians. These technicians should be picked out of R & D or at least be trained there, and R & D should watch that they never get stale. People with a technical background are ideally suited to gain the respect and confidence of the customer. If he realizes and feels that he may expect expert assistance in solving his problems he will be ready to disclose much more about his plans for the future than to an ordinary salesman. It is self-understood that the customer has to be completely confident that his affairs won't be disclosed to his competitors. The information collected by Marketing with the objective of creating possibilities for expanding the business with new products has as a primary target again to find out how the customer may be assisted in solving his problems by buying the new products. In order to enable R & D to select from the multitude of product ideas they have created those which are most likely to succeed and to avoid unprofitable investments in the development proceeding, the following basic factors should be contained in the information. What is the minimum profitable volume of the new product or group of products that might be sold? For what period of time has the product to be produced to be an economic success (life cycle)? On what markets might the product be sold? Is it for the domestic market or for export or both? For what price might the product be sold? In addition to these inherent characteristics of the new product outside information is needed about the present situation on the market where it might be successfully introduced. How big is this market? Is it growing or stagnant? Is it influenced by changes in business conditions, depressions and booms? What yearly growth rates are to be expected? How many potential customers do exist? How are they distributed geographically? To assess the chances of a new product one should know as much as possible about existing products which might be substituted by the new product. How have the prices and the profits of existing products developed? Do the established products require much service and is a similar service required from us? What competing product is to be replaced? What are the most important competitors; how is their sales policy? What disadvantages have competing products as compared to the new one? Is it known how much the competitors spend for advertising, what is their pricing policy? What percentage of the market do various competitors possess? Have competitors lately introduced new products and have they been successful?

As to the new product: Is it protected by patents and how long. Does it infringe patents and where? Is the new product fully mature or are improvements to be expected? Will we offer a single product or a complete line? Are packaging problems involved?

As to the potential customers: Have they certain purchasing habits? How are the terms of payments? Are they willing to experiment and ready to expand?

As to the own marketing organisation: Is the present selling force sufficient to handle the job? Are there enough technically trained people? What will the costs of selling be in percentage of gross sales?

As to other factors: What percentage of gross sales will be required for advertising? When has advertising to be started and what advertising means have to be considered?

It may be that this collecting of so much information seems to be not wholly justified to R & D in view of the costs incurred. Such an objection is perfectly legitimate, and it

may be that in some cases not all informations listed by me are essential or the time and money necessary to collect them doesn't justify the expense. With this reservation, I feel that the more thoroughly the forecasting of the market is prepared the more a selection from a number of potential new products by R & D is possible, and the more the efforts of R & D with the assistance of Marketing may be directed into fields where the expenses for R & D will bring the highest profits. Nevertheless, the methods of market analysis in the Chemical Industry are not as efficient as in the Consumer Goods Industry. It is much easier to forecast the potential market of men's shirts or motor cars than that a new poly-acrylic ester.

But let us assume that the information on hand is optimal, again, as in the case of investigating new markets for established products, macro economic data have also to be collected by the economics department. In order to get sufficient information about the particular industries where a new product is to be introduced some field work by trained economists together with R & D representatives will be required for interviews and consultations with the prospective customers who are already using established products. It is very important during these economic field studies to assess the potential profits on the customer's side when he would be adopting the new product and what sales appeal his product made from ours will have in his own market.

When Marketing and R & D are satisfied that there is sufficient information from the market it has to be decided finally whether a new or improved product should be manufactured or not. The decision should be governed mainly by financial considerations because after all the new product to be marketed should bring a profit and should help to ensure the existance and the growth of the company. In view of the decisive importance of the financial aspects the selection has to be done jointly. It follows that R & D and Marketing cannot be regarded separately.

Some minimum data are necessary to enable the team R & D and Marketing to find their joint decision. We may assume that analysis and forecast of the markets has shown the possible volume of a new product to be sold and the price acceptable to the market. These figures should allow to calculate the possible gross sales of the product. On the other side, those costs have to be assessed which will be caused in developing the new product and introducing it into the market. These costs include for example those for product development in R & D, those for producing the amount necessary for market development, the costs for market development and the costs for the Marketing itself.

All these assessments have to be done at a date where one cannot foresee how much time R & D and Marketing will need to perform the introduction so that some costs can be estimated only inexactly. One can also not forecast exactly the capital to be invested in a plant on a technical scale and other items of production costs. It is also a problem to estimate size and intensity of Marketing efforts required and their costs. Consequently, it frequently boils down to the necessity to estimate an amount of money which the management is willing to invest and leave it to the various groups concerned to budget the different activities within this amount. If in the course of the introduction of the new product into the market it becomes obvious that the expected minimum profit cannot be realized within the budget on the basis of the forecasted prices in the market, the management has to decide whether the project should be continued or not, and a new budget has to be set up.

There is no doubt that in the course of a development program there exists a certain danger of losing control of the costs. This is not only true with respect to Marketing where development costs are likely to be amalgameted with normal costs of sales. Usually the sales people looking after their profit will watching this very closely.

In R & D clear separation of costs between various programs and regular control of existing costs against budget should be kept. Since, after all, R & D and Marketing are jointly responsible for the financial success of the programs it is recommended that the running budget control should also be done jointly.

The costs of developing marketable products based on the results of R & D may vary considerably. Introducing, for example, a new dyestuff into the market, the costs of producing the samples to be tested in the mills of customers are relatively low since they usually require only existing and generally applicable pilot plant equipment. Experimental dyeing can also be done in existing laboratories as well as the testing of the dyed fabric. Only the try-out in the plants of customers will bring some expenses if larger amounts of fabric are consumed. R & D and Marketing, therefore, should have no difficulty to assess the expenses of such a development study. It is quite another story to introduce a new plastic into the market. Even if it may be produced on a pilot plant scale in existing facilities, R & D of plastics require considerable capital investment and high running costs. May it be possible that the process of preparing the plastic is conventional and - as I said - can be done in normal pilot plant equipment, the testing of the properties of a new plastic usually requires such kind of machinery as it is used in the plastics processing industry. Since the size of the articles made from plastics has grown more and more technical equipment necessary for the development work on plastics has reached higher dimensions too. Think of the size of modern extruders or injectionsmoulding machines, to cite a few examples. It is obvious that here the budgeting of costs and their control is particularly important.

A good Marketing organisation can contribute substantially in keeping development costs of R & D down if the relations to important customers have been handled skillfully and carefully. A customer who feels that a company is really and continuously interested in helping him solving his problems and increasing his profits will often be ready to allow representatives of the seller to make use of the customer's equipment. I am fully aware that making experiments in a customer's plant may involve some risks. If the experiments take more time than expected or show very poor results, the customer might get annoyed and bored. Experiments at a customer's plant, therefore, have to be prepared by the marketing people very carefully. R & D and Marketing should jointly work out a program and it should be tried to get the customer's agreement before starting.

It has quite understandably been tried to find some kind of formula for estimating the costs of introducing new products into the market based on a larger number of practical cases available. Booz, Allan and Hamilton investigate this problem in their book "Management of New Products". They came to the conclusion that more than 50 per cent of the costs of R & D and Marketing with the objective of introducing a new product have been already spent before the decision could be reached to market the new product on a commercial scale. I personally believe that a generally applicable formula doesn't exist. Too many factors have to be considered depending on the specific conditions in each case, and therefore varying to a considerable degree. I have mentioned already as an example the difference between a textile dyestuff and a plastic. When I add other examples, such as introducing a new synthetic resin as a binder in the paint industry or the introduction of a new herbicide into the agriculture, you will concur with me that a generally applicable rule can hardly be established and one has to consider each case on its own merits. At most, one may develop some rules for groups of products having a common application. It is far more important to get as much information and data from outside and inside and let R & D and Marketing make a detailed study of expenditures.

I want to come to the last chapter of my speech. Collaboration of R & D and Marketing, a very important relation between these functions in a company is based as I have shown on imparting information to each other, drawing conclusions therefrom and coming to decisions to be approved by the management and implemented again by R & D and Marketing. Even, if much of the information necessary in the evolution of a new product can be processed by computers or even taken out of data banks at one time or the other, discussion and decision will be left to human brains.

Much depends on how R & D and Marketing are placed in the organisation of a company. In some cases R & D is a product orientated integrated department of a division in which also other departments such as Production and Marketing are included. In some

companies R & D is not integrated and its activity is distributed between different organisational groups. Thus research may be part of a functional research division and development may be part of a functional production division in combination with part of the sales service. As in all other things in this world there seems to be no ideal solution, and one should be satisfied to have found the second best.

Independently from the organisational set-up I would like to repeat that the collaboration between R & D and Marketing will be efficient and productive if sufficient information is freely passed from one to another where it is necessary. The sales organisation working on the market field has the duty of reporting everything of interest to the central office. Field reports should be collected and digested at home, the information combined, coordinated and included in a market survey which is to be distributed regularly to the interested people within Marketing and also to R & D.

It is most important that these field reports are unbiased and give a neutral picture of the market situation, in particular of the place own products have established. It is not in the interest of the company if the quality and performance of its products is jugded too optimistically. R & D has to be informed exactly how the market has accepted the products and how products of competitors are regarded. For this reason, there has to be an organisational separation between the people watching the market and reporting their findings back home on the one hand and the people responsible for the quality of the products on the other hand. There are numerous cases on record where a company lost market share because R & D didn't know that one or the other of the company's products did no longer satisfy the customer.

An additional step to avoid any complacence consists in arranging regular meetings between Marketing and R & D personel dealing with a specific field. These meetings may also be used to inform Marketing about new developments to come out of R & D. This will give confidence to the sales force and enable them also to convey this confidence to the customer. Some caution, however, is necessary to avoid overoptimistic presentations on the part of R & D for obvious reasons. If a company doesn't live up to the promises it has made to the customers it hurts far more than to understate future developments and surprise the customer by being better than promised.

I have tried to give some kind of background to the case histories which will follow and which most certainly will also illustrate the importance of collaboration between R & D and Marketing. I am looking forward with great interest to the lecture of Dr. Lodge who will present the view of a Research manager.

DISCUSSION

Question

Firstly, the problem of evaluation of products, which is of course, a very interesting one. It seems that it does not suffice to have only 'ex ante' evaluation of projects, one also ought to have the possibility of an 'ex post' evaluation, if only to decide whether the firm has made the right choices between the various possibilities. The program for R & D activities of a firm is build upon that kind of knowledge. It would be interesting to know whether BASF uses a system for 'ex post' evaluation.

Secondly, the total budget for Research & Development. Dr. Freiensehner has informed us that his firm is spending for R & D about five per cent of the sales volume of BASF. It would be interesting to hear whether BASF has some process for making the decisions about spending that five per cent. Is there any policy, is there any basic philosophy, or is it just being in line with other chemical firms that are doing just the same?

Answer

If I understood you rightly, the first point you mentioned concerns the performance of a product after introduction into the market. In my speech I mentioned performance, because in my opinion it is quite obvious that, after a product has been on the market for some time, management should check whether the profits conform to the forecasts and expectations. So my answer to your first question is quite simple: Yes, we do use a system for 'ex post' evaluation.

Your second question is rather complex. If I were a cynic, I would say: Yes, we are in line with other industries, we spend about five per cent. But it is not as simple as that. We have a fairly specific budget for the various R & D activities of our company. About 80 per cent of our total R & D budget is used for keeping our position on the market, either by developing new products or by improving existing ones. The 80 per cent of our total R & D budget are spread in a certain way over reach of our product groups. This leaves about 20 per cent for fundamental research. We try not to duplicate research done at the universities, we try to direct our research effort to fields with potential economic value for our company. The research budget is decided upon at the beginning of a year and brought up to date in the course of that year, for, as you all know, market conditions can change frequently and sometimes one has to drop one project and has to start another one.

Question

Dr. Freiensehner made some very illuminating remarks about the embarrassing confrontation between Research, Development and Marketing people. He mentioned the scientists who did not like to be involved in marketing at all, and he also said that when you send R & D people to a customer, they sometimes make naive remarks. Is not that partly due to the fact that you should distinguish rather stringently between Research and Development, as Mr. Geldens did this morning?
In my opinion research-people are a different breed from development people and the embarrassing situations you described seem typical for the meeting of marketing- and research people. But people engaged with development should watch the market closely because the thing they are developing will be sold on the market. So I think there should be close co-operation between your departments for marketing and for development and your research department should only occasionally be drawn into this teamwork. This has consequences for your remarks for marketing and R & D to prepare a budget in teamwork. In my view the budgeting should be done by your departments for development and marketing.

Answer

I have a practical answer to your questions: the world is not as black and white as that. In many fields of modern chemistry it is very difficult to draw a distinct line between research and development. In our company we try to separate these two functions, but in many cases we simply do not have any success. So we have a more or less constant flow of people between the fields of research and development. In the plastic field, for example, it is very difficult to draw a clear line between research and development, because rather early in the research phase people have to use big and expensive machinery to test the new materials. Here you simply must have close co-operation between research and development. As a manager you must be pragmatic about this and you have to accept that in this case you cannot separate the two functions. For if you try to do that, you may have to parallel your expenses and that is bad policy. In dyestuffs, to take the other extreme, the situation is clear cut. The research people are in a separate laboratory and the development people are working in close contact with the market.
As to your remarks on budgeting, here you meet the same difficulties. It all depends on your product line. In some cases it is well nigh impossible to decide wether a man should be on the budget of the research group or on the budget of the development group. But we at BASF have rough estimates about the distribution of costs between research and development. For example, the development part is much higher in plastics than in dyestuffs, and the research part is much higher in herbicides than in plastics.

Question

Who ought to be responsible for the profitability of research? The research people or the marketing people?

Answer

That is a $ 64,000 question. We have heard this morning from the people from McKinsey that it is difficult to assess the profitability of research. In our organization at least the management is responsible for the whole research budget. Then the money must be distributed among the various projects and that is very difficult because there are so many factors involved. People in research cannot exactly forecast the marketing possibilities of their inventions and the people in marketing do not know what the departments of Research and Development will produce in new developments and new inventions. So you are gambling a bit when you distribute your research costs among the various functions.

Question

You mentioned people in technical service and you warned that the R & D department should see to it that they do not get stale. But where should they be incorporated, with the Marketing department or with the R & D department?

Answer

They should definitely be put in the Marketing department.

Question

As to the cost and efficiency of R & D, can you make a comparison between companies that are only horizontally and those that are vertically organized? It would be interesting to hear some comments on this subject particularly in view of the recent acquisition by BASF of Fricks on one hand and the establishment of a new joint company with Freudenberg in the field of non-wovens.

Answer

As you know we at BASF still have a functional organization and we are trying to change this into a divisional one. So I can speak from past experience only. In the functional organization we still have at BASF you have to see to it that none of your activities is at a disadvantage in comparison with all your other activities. Now in some of the fields that BASF covers, research costs are really not justified anymore. A good example are fertilizers, every manufacturer of fertilizers is making losses. So we keep research costs in this field very low.
We spend more money on profitable product-lines and BASF still regards plastics as one of these. It is a more sophisticated product.
I must admit that BASF took over Fricks because their organization did fit into ours. We still run Fricks as a separate company, though we influence their policy together with the other proprietor: the Dow Chemical Company. The situation will be changed when we set up our new organization. Then we will have a fibre-division which will be responsible for running Fricks together with the Dow Company.
It is to early to comment on the results of the new company we started with Freudenberg. The idea behind it was that BASF wanted to enter this field together with a very experienced company like Freudenberg. We are sharing our know-how of products with their spinning experience. Ultimately the company will be taken over by Fricks and the joint venture will be between Fricks and Freudenberg. The present objective is to produce semi-final products that are sold to other firms which convert them into consumer goods.

Question

In my first question I asked whether it is possible to make a comparison for cost and efficiency of R & D between a company that is purely horizontally organized and one that is somewhat vertically organized. In my opinion the combination between BASF and Fricks and BASF and Freudenberg shows a certain tendency towards vertical organization.

Answer

We have a system for the assessment of the profitability of every product line and we try to distribute costs among the product-lines as realistically as possible. But that is very difficult, for in some cases it is not easy at all to control the efficiency of departments like R & D or marketing. BASF employs nearly 50.000 people, so we have rather high overhead costs and that makes it difficult to get a correct picture of the efficiency. We know from experience that we will be pushed out of a market very quickly if we stop to support most of our marketing activities with R & D. So we constantly have to distribute the cake between the needs of the various departments.
The situation at Fricks calls for another system, for here we are working together with an independent partner.

Question

In a previous question it was stressed that quite often people in research are not interested in the marketing side and that, on the other hand, marketing people don't have any notion of the difficulties of research. Now in most European industrial laboratories you will find scientists, engineers and technical people, but what you often miss are some people who know something about marketing. Would it not be good practice to place a few typical marketing men in every research laboratory with the specific task to act as a liaison officer between Research and Marketing.

Answer

In some respects I fully agree with you, it is absolutely necessary to bring people from various departments into very close contact. As far as I know this is done all the time in industry.

But in my opinion it is a dangerous practice to attach a marketing man to a research laboratory, just to act as a go-between. As you all know, especially in chemical industry, the market can change quite suddenly and so a marketing man has to keep in close touch with his market. If he is not, he is worthless as a liaison officer. But I fully agree that it is absolutely necessary to inform research people about marketing conditions. At BASF we have found the following solution for this problem: once every fortnight there is a meeting between people from the various departments, research, development, marketing and sales, and they talk about their respective problems.

Question

You stated that about 20 % of your research budget was not used for existing products or existing markets. What kind of research activities are financed out of that amount of money?

Answer

In the first place process-studies that cannot be allocated to a certain product line. A good example is ethylene, a chemical that is going into quite a lot of other products: polyetylene, polystyrene, ethylene-oxyde and so on. It is well nigh impossible to distribute costs among these product-lines, so we finance research on ethylene out of a special budget. About one tenth of the total amount of money is used for the development of fundamentally new things, which have nothing to do with the present activities of the company.

Question

Nowadays one hears and reads quite a lot about innovation for new products. Some companies create 'new-venture' divisions and here I am thinking of Dupont. What is your opinion about it? Does BASF have something like that?

Answer

Some ten years ago we asked ourselves: Are not we to far away from the consumer goods industry? We decided that we were and started to acquire other companies, like Fricks and so on. But the acquisition of other companies is not an end in itself, we only do it if it strengthens the parent company .

Question

To become somewhat more specific: Does BASF have a kind of 'new-venture' division like Dupont?

Answer

Yes, we have something like that.

Question

Can you tell us something more about your policy in this field?

Answer

No, for we might change our policy in the course of our reorganization.

Question

You stated that BASF uses the team-approach for solving the problem of interaction between R & D and Marketing. We discovered that one can do it with one man. He writes a report on the problem, which is submitted to the board. You should choose a

man with great experience, who knows enough about research, development and marketing. It takes him two or three months to write his report, but in our experience the results are excellent.

Answer

That, of course, is one way to solve this problem. We prefer to use the team-approach, and of course in such a team you must have a leader. But if you have people with the abilities for doing it alone, and if you are sure that this man does not ride hobby-horses, then your solution may be a very good one.

Case study I
Speaker : Dr. J. Brug
Subject : Duphalac - A Pharmaceutical Product

Ladies and gentlemen, Mr. Chairman,

To discuss immediately after a good lunch a pharmaceutical product which is prescribed in chronical obstipation might be somewhat unacceptable to you and to the cooks of Rotterdam Hilton. But I can't help that the properties of Duphalac, product of Philips-Duphar, are in this particular field of human disorders, so let us face the fact.

Philips-Duphar, one of the main industrial groups of Philips' Gloeilampen Fabrieken, started its activities in the nineteen thirties with the production and marketing of vitamin D, as a spin-off of the application of ultraviolet lamps. Steroids, isolated from molluscs were irradiated.
After world war II a diversification into other fields of products active on biological systems took place. Today there are industrial groups for pharmaceuticals, phyto-pharmaceuticals, veterinairy products, vitamins and isotopes.
Duphalac is a result of research and development in the pharmaceutical division.

The management of Philips-Duphar is in the hands of a group of three man, a general manager, a technical manager and a commercial manager. Research, development and manufacturing are the responsibility of the technical manager.
We do not make a big problem of organisational differences between research and development. Generally long term goals are in research, short term goals are in development and management decides what's what.
For each division a committee of a man of marketing, a man from manufacturing and a man from development is formed which advises management on the policy for their division. This committee also fixes the program of a product or a project and makes proposals on priorities.
This policy group not only covers new products but also improvement of existing products from the point of view of application.
It handles products originated within the companies own research and inventions of third parties which we bought or on which we obtained a license.
As part of its policy the pharmaceutical group tries from a market-orientated view point to realize new chemical entities as ethical drugs.
I am not in the position to give you an evaluation of different forms of organisation for a good interplay of R and D with marketing in the field of pharmaceuticals. In our relatively short history Philips-Duphar's has seen important changes and developments in the general field of products interfering with biological systems.
We have an organisation of which at the moment we think it is good. I can not say why this one is better than an other one.
The organisation should not be overemphasized, it is not a goal in itself, only a mean to get the optimal results and one must always be prepared to change it.

With vitamin D Philips-Duphar entered the field of marketing additives for the nutrition of man and animal. In this connection we had a special interest in research into food factors influencing the growth condition of your childeren. (vitamin D in rachitis.)
An Austrian group worked on so called bifidogenic factors. These are microfactors, small amounts of chemicals, which influence the bacterial flora of babies intestine.
The question whether babies fed on breast milk in the natural way have better survival chances than babies fed on a diet of cow's milk was subject of long discussions.
The Austrian group, headed by Dr. Petuely, and other famous scientists (Kuhn, Szent Györgi) found that for babies fed on breast milk a flora of Lactobacillus Bifidus governs colour and pH of the stool. It took several years of combined microbiological and biochemical work to conclude that not a microfactor but the presence of fairly large amounts of lactulose stimulated the growth of a good bacterial flora.
The close collaboration with the Austrian workers enabded Philips-Duphar to market lactulose in special dry forms (spray dried) as an additive for baby food.

Lactulose, the active ingredient of Duphalac, is a sugar. Sugar we normally eat is sacchorose. The chemical formula of lactulose slightly differs from that of saccharose. Lactulose is not a natural product. You can find it in small quantities in processed natural products (e.g. milkpowder) as a product of milk sugar (lactose) degradation. The chemical lactulose was known about 40 years before its potential value came to light.

The marketing of lactulose as a food supplement has not been a success. In a number of countries sales for food additive are still going on but volume is such that production would not be worth while for this application.
I still don't know if lactulose could have been a success but at least we in our organisation did not realize it.
In presenting case studies on products as this will be done today and tomorrow there is always a risk for you, as listeners, that you are confronted with successes and not with failures. Perhaps it would be better when I myself or one of the other lecturers should have told the story of a case which was not a success and to discuss with the panel the reasons why a particular project of development failed. There is always a risk in telling you a success story that the presentation is somewhat different from how it really took place inside the group.

Returning now to Duphalac. The biochemical and the clinical work in pediatric clinics indicated a side effect. Overdosage of childeren with lactulose caused diarrhoea.
This was at first simply interpreted as an unwanted result and a drawback for the product. However our medical research group reasoned that the mode of action of this side effect was in fact the same as the basic reason for adding the material to cow's milk in childeren's food. The hypothesis was launched that one perhaps could exploit the product in the treatment of obstipation. In deciding upon the further development of this possibility you had to realize that there were already quite a number of laxatives on the market. They can be obtained at the druggist's around the corner at fairly low price. Was there a real need for a new laxative? Close analysis of the clinical experience did show that possibly lactulose was not simple laxative but could regulate the bowel system to normal functioning.
If you want to convince a doctor that it is useful to prescribe a pharmaceutical you have to produce facts.
These only can be obtained from well organized clinical trials. Being not a medical doctor therefore running the risk to tell you something that is not quite true. I would like simply to state that full proof evidence of the pharmaceutical value was obtained.
Before you are in a position to start clinical investigation of a new pharmaceutical product much prepatory work has to be done. For pharmaceuticals you can't do the application study within your firm you need the coöperation of colleagues in hospitals.
It goes without saying that before a doctor will start experiments he must be convinced that he has a real chance that something new and worth while is at hand and not a simple imitation of an existing product.

The main items in development of a new pharmaceutical are :

1. Choice and realisation of a process to manufacture the desired quantities of a fully specified quality of the active ingredient at an optimal price.
   Lactulose is produced from lactose as a starting material.
   (Dutch chemical industry has a strong position in milk sugar.)

2. Choice of the form of the product and method of production of this form.
   Many presentations of pharmaceuticals are known: tablet, fluid for injection, oral liquid. Choice of the formulation is strongly related to the biological activity and therefore dosage form and set up of clinical study are strongly connected. Furthermore there is a direct relationship between the quality of the active ingredient and the choice and properties of the pharmaceutical formulation. Lactulose is formulated as an oral liquid, a 50% solution.

3. Development of registration.
   During development of Duphalac in the last six years there has been a lot of dis-

cussion all over the world about safety of drugs. We were not in a position to define six years ago exactly the work to be done : partly we did not know exactly what governemental authorities in each country would ask.
Programs for new pharmaceuticals who start now are in a better position. But even six years ago everybody knew that you had to do a lot of work on the safety of your material, about metabolism and fate, about the shelf-life of it, about knowing something about the side-effects, about giving exact instructions to the medical doctor under which conditions the product can be used and under which conditions it cannot be used.
You might get the impression that pharmaceutical industry takes the heavy involvement of government as a serious draw back for innovation. This is in a way true, because you are confronted with higher costs and higher risks for a new product. But on the other hand we are glad that these things are developing in such a form as they are developing nowadays.
The requirements put by your client for a new product are given by one particular client, the government, and it is a simple situation when one client speaks for all.

4. Clinical investigation aimed at instructions to the doctor when and how to prescribe your product for the patient.

This program for lactulose was a success. A factory was constructed, a formula was lounched, approval was obtained and the product with the brand name "Duphalac" is marketed.

I could end the story about "Duphalac" by saying that history was repeated. In medical practice the observation was made that the administration of substantial quantities of Duphalac to patients with severe cirihotic liver diseases gave a dramatic relief of comatic and precomatic conditions.
This observation initiated for the third time a development program. In itself it is a happy fact to get a chance for additional development. Such a new development asks for a complete set up of obtaining data for obtaining approval for this new application. For instance the continuous gift of large quantities asks for much broader data on safety and side-effects.
This is where Duphalac stands now. It is sure that if could restart development of Duphalac directly aimed at its present use we could save a lot of work, money and time, both in development, production and marketing. It is curious to note that each application in fact could have been predicted from the basic research into biochemistry and microbiology. Perhaps we could have done a better job in seeing at an earlier stage the possibilities for applied research.

I would like to add a few remarks about the impact of developing products like "Duphalac" on management.
1. You need at least about 15 different specialism's to do the work: Medical doctors, pharmacists, toxicologists, experts in biochemistry, analytical chemistry, proces engineers and so on. You must be able to do the job in your own firm or with easily available outside help in order to do it efficient. It goes without saying that only in case you handle more than one product at the time an efficient organisation can exist.

2. The time needed for the complete development of a product will be somewhere between 6 and 10 years from the initial result of research.

3. Costs of development are high. This in itself is not serious but the technical risk in developing products is big.

An example can be drawn from toxicology.
Two years feeding studies on two animal species and interpretation of results will take about 3 years and costs of about half a million. The results might be such that further development must be rescheduled or even stopt completely.

The impact of these aspects is that you have to synchronize all technical work and schedule it in such a way that one can say "no" to further development after investment of the least amount of money possible but on the other hand can say "yes" and spend the optimal amount in the shortest time.
This strategy is not particular for pharmaceutical industry. In this business perhaps the risk is higher and as a consequences the penalty for wrong decisions might be substantial. The toxicological example only underlines the importance of good organized work and of the planning of assistance from specialized techniques.
The planning in itself is of utmost importance. It can only be done by integration of estimates in time and work given by the specialists themselves and not by the project-leader. His task is to ask the right questions, to integrate the answers into a complete plan and last but not least to check the progress.
This task is difficult in practice. A scientist hates to give straight answers to questions whether he will succeed or not in a given time schedule. But right motivation of the purpose of the question allowing for statistical chances for success is of great help. Perhaps the most important aspect of good planning of the execution of a program is that highly specialized collaborators realize in a better way the interdependence of different disciplines.
It illustrates and stimulates the task of the whole team.
But a good project planning for a particular product or process is not enough. You are working on more than one project at a time. Each project competes for the skill and the volume of work available from the same experts. Each project has high technical risks.
To tackle this problem of efficiency in research and development, management needs a staff group to organize work-load and resource-allocation based on available capacity and on priorities given by management. Re-scheduling of the work will be necessary very frequently.
It goes without saying that marketing and manufacturing must know at the earliest possible time whether the progress of development is on schedule or not. Their preparatory work for a new product and processes is strongly interwoven with development. In this connection I can refer to the policy-group from marketing, manufacturing and development which defines the policy and program for innovation. For each project within the program a masterplan based potential profitability of the product is made. The masterplan apart from forecasts on marketing and forecasts on capital investment for production gives the actual development work foreseen in terms of duration, load of laboratories using money as a language.
Masterplans are reëvaluated periodically but also after relevant deviations from original technical expectations. The masterplan also has the function as a tool of management to set priorities. Heavy attention to forecasts and planning has a tendency to frustrate your scientific coworkers. You ask from them creative work and attention for the unexpected. In an atmosphere of planning you might have to pay a price for restricted freedom.
Furthermore profitable technical results very often do come from exploitation of the unexpected observation. Within your technical organisation a good climate for the unexpected result has to exist.
Both management and scientific worker however have to keep in mind that the best climate for application of the unexpected is well organized and well defined technical work. Execution of programs as efficient as possible saves time and money and therefore also creates room for the less directed work.

It is obvious that a close contact between marketing and development is essential for successful short term innovation.
It is my feeling that the same close collaboration is a must for basic and applied research.
Research should know that marketing has a direct interest in the running investigations. Marketing should realize that technological and scientific progress can be translated by research into profitable products and services which are beyond the scope of the actual market. The interplay of those two aspects, keeping in mind that the time-lag between start of research and marketing of a result of research easily can take 10 years is essential for long term company success. What you are spending

today is in fact what you expect to get paid back in ten years from now. Therefore firms active in pharmaceuticals should pay very much attention to long term planning and make a very well considered choice of actual research work. There is no firm in the world which has unrestricted resources fôr R and D. Always a choice has to be made, but making a choice is also familiar to the scientist. He does the same in his own work every day.

The close collaboration between research and marketing cannot mask completely a basic conflict. Sales people want cheap, unique products tomorrow and research has more or less a wait and see attitude.

The progress of the science of market research in the last 10 to 15 years has apart from its benefits directly for marketing, created a sphere of better mutual understanding.

Both marketing and R and D don't know sure, both hope that the answers given today will appear to be realistic tomorrow.

Polyisoprene

G.W. Atkinson
Marketing Manager of Elastomers Division
Shell International Chemical Company
London
Great Britain,
and
Dr. Ir. J.M. Goppel
Director of Koninklijke Shell Plastics Laboratory
Delft
The Netherlands

1. Review of the situation early 1960 (GWA)

My colleague, Dr. Goppel, and I are going to speak today about the European development of a new rubber polymer, Polyisoprene, made just a few miles down the river from here and sold in every country in Europe and many overseas countries as well. Only four grades are available now after years of experimentation and selection. We shall be discussing in detail the Research and Development interaction with Marketing later in this paper, but to bigin with we thought it would be helpful to our audience to draw a thumb-nail sketch of the world rubber industry as we saw it in 1960 and the developments both commercial and technical which have followed in the ensuing 10 years. Since we shall be discussing our work essentially against a West European background we have split out the relevant figures relating to this part of the world; see figures 1 and 2.

fig. 1 - World rubber consumption 1950 - 1970
fig. 2 - West European rubber consumption 1950 - 1970

The important point to note is that up to 1955 natural rubber was almost the only polymer used by the rubber industry here in Europe. (Some specialities were used but in low volumes at that time).
The industry had been founded on natural rubber and all techniques, technology and specifications were based on this raw material. The machinery of the rubber-using industry was designed to handle the natural product and the whole educational background of the industry was based on this agricultural material.

The war in the Pacific around 1942 resulted in the supplies of NR from the Far East being cut-off and therefore the USA was forced to bring to full development a synthetic polymer which could be used in the place of NR. This was accomplished in a relatively short time and was the foundation of a new industry. The early products were not the materials we know today and much difficulty was experienced both in use and performance. However, under the pressure of wartime conditions and without choice the adaption was made.

Following the war period the demand by the world automotive industry and others increased dramatically and the longterm forecasts indicated that the post-war NR industry in the Far East and Africa would be unable to satisfy the needs of the voracious rubber consumer in the years ahead. What had started as a wartime strategic development now became a peacetime necessity if the great industries of the world were to be supplied with base materials.

In the mid-fifties the U.S. Government sold all its wartime rubber plants to private companies and from this point there followed another great technical and market surge resulting from the peacetime application of R & D effort by many companies in an expanding market with competitive conditions. I believe a little background information on the technical aspects of this era would be of value.

2. Styrene butadiene rubber versus natural rubber (JMG)

Indeed, to get the IR developments better in perspective, we have to keep in mind that in 1955 the only synthetic rubber suitable for tyres was SBR. A number of copolymers of styrene and butadiene, both straight and oil-extended became available. For comparison the molecular structure of SBR and IR are presented in fig. 3 (molecular structure of SBR and IR). The copolymer lacks the selfreinforcing effect brought about by stereo regular crystallisation and acquire their strength only in so-called reinforced mixtures with carbon black. For good interaction with the reinforcing black the styrene units are important, as well as the type of carbon black.

In its presentation SBR offered the advantage of synthetic rubber in packaging and handling (film wrapped 75 lb. bales) and also it showed better purity and was more consistent in quality. In processing, however, it required not only changes in formulation - such as a different ratio of sulphur-accelerator and a preference for the furnace blacks over the channel blacks - but the manufacturing processes had to be adjusted due to a different behaviour in mixing and extruding. These industrial problems were readily solved, both by increasing experience with these types of rubbers and also by improving the rubber itself, e.g. by improved manufacturing techniques. As an example the so-called "cold rubber" can be mentioned, obtained at polymerisation temperature of e.g. 0-5^{o}C by use of the very effective redox catalysation systems. In this period the experience available from the U.S.A. was important and facilitated the introduction of the SBR type of synthetic rubber. In tyre applications SBR showed a greater resistance to abrasion than NR, but the presence of the styrene units causes hysteresis losses and the corresponding heat generation under dynamic conditions was so much greater than NR that SBR could not replace NR in the larger size of tyres, viz. truck tyres, either in carcass or tread and this is still the position today.

3. Arrival of polybutadiene and polyisoprene (GWA)

In figures 1 and 2 are shown the market demands as we saw them in 1960 indicating clearly that synthetic products had to be developed to fill the forecastable gap between supply and demand of NR. We have seen that the pressure of war forced the U.S. and Canada into SBR production. What was to follow? Was SBR the only major synthetic rubber suitable for this growing business?
As so frequently happens the answer to a particular industry requirement arises out of work elsewhere. We were very fortunate that brilliant work on catalyst systems was undertaken in Europe in the early 50's thus enabling the development of new rubber polymers to be embarked upon. The ready availability of butadiene led to the production of two or three types of polybutadiene and the simultaneous evolution of isoprene monomer processes gave us two types of polyisoprene. As might be expected the first commercial development of both BR and IR took place in the U.S. but the know-how was quickly transplanted to Europe.
At this time (the end of the 50's) our Group of Companies began to undertake the development of polybutadiene (in Europe) and polyisoprene (first in the U.S. and later in Europe). Today we are discussing the IR work and to begin this section it is perhaps useful to examine the synthesis of this material.

4. Isoprene monomer and polymerisation routes (JMG)

Because of the unique properties of NR, being a stereoregular polyisoprene, the possibilities for a similar synthetic polyisoprene looked very good, in particular for use in the truck tyre field where heat generation ruled out SBR. Consequently, many efforts have been made to develop an economic route to obtain the isoprene monomer. Examples of processes are given in figures 4, 5 and 6.

fig. 4 - I.F.P. route to isoprene monomer
fig. 5 - Goodyear route to isoprene monomer
fig. 6 - ANIC route to isoprene monomer

We thought, however, that a special synthesis would be relatively expensive and we searched for more economical routes based on C_5 refinery streams. A dehydrogenation process with a feed of tertiary amylenes turned out to be particularly interesting, see fig. 7.

fig. 7 - Shell route to isoprene monomer

Some possibilities of polymerising the isoprene units into the rubber chain molecule are illustrated in figures 8 and 9.

fig. 8 - 1,4 and 3,4 polymerisation
fig. 9 - Cis- and trans-configuration

As far as the polymerisation process is concerned, the stereoregular polymerisation of the isoprene can in principle be obtained by two different catalyst systems, i.e. the Ziegler-Natta type and the lithium-alkyl type. The lithium process is more economical but results in a slightly less regular structure (92 vs 96% cis content, referring to the stereoregular configuration of the polymer chain molecule). Extensive product work showed that this small structural difference is not very important for the large-scale application of polyisoprene rubber. The rubber is obtained as a clear solution, the working up of which - in the absence of corrosive catalyst remnants - is simple and leads to an extremely pure and consistent product. This could lead to very interesting results, although not identical to NR.

5. New polymers require adaptation of compounding techniques (GWA)

Alas, so many users would insist on treating the product as if it were NR and, of course, there were some disappointments. We had to try to establish this material as a polymer with its own properties and pecularities and this took a great combined effort of our sales and technical people. We were conscious that a natural material like NR with its many advantages and weaknesses could not be imitated and indeed our research effort started in the U.S.A. in the mid-fifties did not have this as an objective.

6. Competition for time, from the new solution polymer BR as well as from new developments in the tyre field (JMG)

Obviously it was tried to fill the gap between demand and supply also with the other synthetic rubbers - SBR and the more recent BR. With SBR it was found possible to reduce the heat build-up in tyres by using naphthenic oil-extended grades (instead of the conventional aromatic oil) and penetration into the semi-large tyres (for vans, etc. up to size 7.50 x 20) became feasible. BR at first seemed to offer in one package a better abrasion resistance (than SBR) and a lower heat build-up (than even NR) but in actual practice the latter could not be substantiated and, furthermore, the use of BR in tyre treads is limited by roadholding properties. Nevertheless, it was found by extensive compounding and tyre testing that with BR as an important constituent an attractive balance in passenger tread performance could be obtained and it will be clear that by the time our polyisoprene developments had advanced sufficiently to approach the tyre industry, the industry was already heavily involved in the testing and evaluation of a wide variety of materials. Moreover, at the same time a major new development in the construction of the tyre itself took place, i.e. the radial tyre, which appeared to require different processing characteristics for the rubber in the carcass, tread and sidewall manufacture, along with the problems of cord adhesion (metal) and the new concept of the building of the tyre. See figures 10, 11 and 12.

fig. 10 - Composition of a cross-ply tyre
fig. 11 - Composition of a radial tyre
fig. 12 - Cross-ply versus radial principle

This meant again that entirely new formulations for carcass, tread and sidewall had to be developed, not only with respect to curing system and rubber black-oil ratio but also

with respect to the selection of the rubber base material. It goes without saying that all this meant a very strong demand on the available technical ingenuity, manpower and research in the tyre industry and in view of the resulting competition for time and allocation this was hardly the ideal time for the introduction of a new polymer.

7. Credibility gap to be closed (GWA)

You could say we should have arrived on the scene earlier when life would have been easier. Unfortunately inventions cannot be regulated in such an ordered manner so we had to buckle down to the job with the maximum of applied industrial skill and the best possible coordination between our international sales force and our multinational R & D and TS groups in Amsterdam and Delft. We hear much about credibility gaps these days - well I suppose we too had one in 1964 and our target was to close it completely. First of all we had to establish that like all polymers this one had its own characteristics and properties. It was not natural rubber and had to be treated differently. If we could get this message over then our progress was assured.

8. Approach to the tyre industry (JMG)

Our synthetic polyisoprene by virtue of being a synthetic rubber had already the advantages of purity, light colour, consistent quality and good packing and handling. However, as mentioned before the product appeared in its processing and properties to be not exactly identical to NR and this situation forced us to develop a great deal of technical information to introduce this material into the rubber manufacturing industry. Modification of the conventional mastication and compounding procedures were found to be essential to bring out the good properties of our material. This is perhaps best clarified by a short extract of a film we made on the subject.

(An extract of the film "CARIFLEX isoprene rubber" was shown.)

Apart from concentrating in the laboratory on physical and mechanical properties and abrasion studies in relation to the chemical structure of the polymer, other R & D programmes were directed to actual road testing comprising cars and trucks in extensive experimentals on racing circuits and motorways. (see fig. 13 - Tyre road test truck). However, in view of the interest in truck tyre application even more accurate and specific data were required. Therefore, we turned to our fleet of road tankers which are employed in various countries under a wide variety of climatic and road conditions. (See fig. 14 - Shell road tanker). Careful study of truck tyre performance, particularly with respect to the wheel positions (cornering front wheels, driven and trailing axles, etc.) provided a wealth of information and it maight be said that after completion of these studies a fleet of road tankers can now be used as a particularly sensitive and reliable instrument for assessing polymer performance in tyres. In the tyre industry, which by nature of its product is very much aware of safety considerations, introduction of a new polymer is never made at one stroke, but usually by a gradual phasing in by the use of blends with the conventional rubbers. It was found that already at minor amounts the new polymer by virtue of its good flow improves the processing behaviour in the plant, while at higher amounts improved vulcanisate properties e.g. lower heat build-up, become apparent. The dependence of heat build-up from tyre size and tyre composition is illustrated in fig. 15.

fig. 15 - Average running temperature, influence of construction and size

Tyre testing was further used in order to establish optimum formulations not only with respect to rubber blends but also in relation to the curing system (sulphur and accelerator) as well as plasticiser and filler contents along with modifications in mastication-, mixing-, and extrusion procedures. In view of the many variables involved use was made of the computer to design statistically significant programmes and to interpret the experimental results obtained (see fig. 16 - Hardness resp. heat build-up as a function of oil and black loading). The final results were then used for discus-

sion with the tyre industry and as suggestions for their own evaluation.
Also factory trials with prospective consumers were organised to determine large scale optimum processing conditions. In some cases these results led to further product improvement work but on the other hand in many cases they underlined the basic results obtained in the preceding stages of laboratory work and road testing.

9. Marketing required a major information job (GWA)

Our capacity in 1964 was 25,000 t/a at Pernis and we wished to place this quantity in a West-European market of more than 1.45 million tons of which 740,000 tons was natural rubber. It is obvious from these figures that our objective was not to achieve broadly a 100% replacement of NR but to find applications where the premium properties of our new polymer would make a positive contribution to blends with natural and other rubbers. Of course there were (and still are) applications where the material is used alone and in particular those outlets where colour, clarity, cleanliness and consistency are so important. Our rubbers had qualities of an original character which needed to be put over to the industry and with persistence and skill this was done. We found that many potential consumers were rather more ambitious than we ourselves and our salesmen being in the market to sell considered our advice erred a little on the side of cuation. We had an information job to do both inside and outside the Company.

10. Approach to the non-tyre industry (JMG)

Certainly our approach was not made only in connection with tyre applications! The penetration of our product in the non-tyre field was facilitated by properties inherent to synthetic elastomers, namely its consistency, purity and light colour. Apart from these, the new product showed significant advantages in the manufacturing of a large variety of articles. Due to the absence of polar groups or gel and perhaps also in connection with the slightly lower ciscontent of our polymer, the rheological properties of IR and NR are substantially different. Under high rates of shear NR tends to crystallise, which suddenly raises the apparent viscosity to extremely high values, which phenomenon does not occur with the synthetic product; this is illustrated in figure 17. (- Apparent viscosity of polyisoprene and natural rubber as a function of shear stress). The good flow of compounds containing IR allows for faster production speeds, closer tolerance in calendering and avoidance of blisters. In fact, the flow of IR is so much superior compared with the other synthetic elastomers, that it enabled the application of the injection moulding process to rubber. This labour saving mass production technique is commonly used in the plastic industry; due to the fact that in the Delft laboratory the required injection moulding equipment and plastics technological skill were available in one and the same organisation, the merits of our polyisoprene in the field of injection moulding could be rapidly established. The purity of the polymer, more in particular the absence of nonhydrocarbon constituents, results in compounds of considerably higher processing (scorch) safety, which reduces the scrap factor. The absence of colour provides for the production of brilliantly coloured and light coloured articles, while again the purity but also the absence of smell of any kind make the synthetic polyisoprene an attractive polymer for surgical and food-packaging applications.

Finally, its purity is the main reason why this polymer is so widely used for the synthesis of chlorinated, hydrochlorinated and cyclized polyisoprene. Particularly in chemical conversions under influence of acidic catalysis, the absence of basic compounds, which neutralize part of the catalyst and thereby necessitate excessive amounts of it, has been found very attractive. Many non-tyre rubber manufacturers, require that the rubber can be very easily processed on the mill. For this purpose a special type of polyisoprene has been developed, which by virtue of its special molecular weight distribution can directly be processed without prior mastication and which can easily be blended with every type of general purpose rubber. For the production of articles in the economy type of price brackets, a special, light coloured oilextended polyisoprene is produced, which by virtue of its considerably higher average molecular weight gives very attractive properties. This type of polyisoprene is extensively used in the pro-

duction of solid, microcellular and sponge footwear soling. This field of application is so important that a special section of footwear-specialists was created in our Delft laboratory to study the requirements for this industry from the viewpoint of raw materials and processing.

11. Communication system between R & D and Marketing (GWA)

Dr. Goppel has outlined the properties which indicated that a future market might lie in the area of injection moulding. Success here means the coordination of suitable machinery, the right polymer compositions and also the correct operating conditions. In other words it needs the ideal cooperation between the rubber product manufacturer, the machinery designer and the polymer producer.

In the early days of our entry into the market we had the opportunity to bring the three parties together under ideal conditions. At our invitation all the major injection moulding machinery companies brought a machine into a large hall in our Delft laboratory and there for a week we were able to bring together the three above forces which allowed us to treat the subject in a completely professional way. Unlike the many public exhibitions this was a really live working period which was of great help to our marketing and technical people. It was organised by our techno/commercial people for the benefit of their counterparts in the consumer indutry and almost every rubber company in Europe joined in.

At the time we were attacking these problems relating to polyisoprene we were also involved in similar exercises with other synthetic rubbers. Our marketing headquarters were centred in London and our research and technical development laboratories were in Holland. We felt we had to streamline the two way communications system between the field and the centres of R & D. The problems were coming thick and fast since we were operating as far as Japan and South America.

To facilitate the exchange we placed a senior marketing man in the laboratory at Delft with a reporting relationship back to the Head of Marketing and gave him the freedom to communicate world-wide with our sales managers in the field of technical matters. This gave us the best of both worlds and made a bridge between the various functional and national units. By this means we ensured that the field problems were known to the development groups and also that improvements coming from new laboratory work were conveyed to the field force with the minimum delay. We involved our laboratory people in the salesman's difficulties from the very beginning and I believe we created a relationship between both groups which we are still benefiting from.

As is our usual custom we gave courses in the technology of these new products such that any of our sales representatives was capable of taking off his coat and operating a mill in a rubber plant. Happily, they were rarely invited to do so.

12. Organisation of the liaison (JMG)

As Mr. Atkinson pointed out, for the rapid introduction of a new material into the rubber manufacturing industry, a good liaison between the various people in the field is of vital importance, not only in the R & D field itself (between polymerisation and product research) or between R & D, Manufacturing and Marketing, but in particular between Product Research and the technical commercial staff. In this respect the proximity of R & D and Marketing support activities in one location is indeed an organisational feature that should be mentioned. It offers the possibility of providing marketing support of a high quality, and on the other hand resulted in first hand briefing of the R & D staff with regard to important market trends, so that R & D programmes could be adjusted accordingly. It was recognised that exploitation of R & D results, often one of the difficult bottlenecks, would be greatly enhanced by improved coordination between commercial and research activities. In addition to the firm liaison established between the commercial and research functions, crosspostings of young graduates were found to be most effective from this point of view. These not only make for better under-

standing and communication between the various functions in a large enterprise, but I also believe that it contributes directly to the quality of the work. I think that international teams provide more challenge and stimulation to the research worker and in the research laboratory we have in addition often seen synergistic effects. A German chemist tends to show a different approach to problems than his English colleague, a French engineer again differs from his Dutch counterpart. I am convinced that such motivational and complementary aspects have strongly contributed to the efficiency of our research in the synthetic rubber field. In view of the heavy expenditure required in the R & D field for the launching of a new synthetic rubber - we spent more than $ 20 million - the importance of increasing efficiency can hardly be overestimated.

13. Experience gained and growth forecast (GWA)

The last ten years was a period of revolution for an old industry - the rubber consuming industry. It was subjected to the availability of new polymers requiring new techniques and itself began to develop new construction methods involving the new materials. Added to this, the decade was a period of unprecedented growth. The fact that all this has been achieved says much for the technology in depth which is such an integral part of the rubber consuming industry. A would-be supplier needs to be aware that to make a successful entry with new products requires a subtle blend of technology and marketing persuasion. If one adds to this list the problem of safety, which is of such paramount importance these days, particularly in the tyre industry, then it is apparent that every step of the way in the introduction of a new material must be measured carefully by both supplier and consumer.

As Dr. Goppel has said our R & D expenditure to establish a new polymer over a period of about 10 years has exceeded $ 20 million - and what of the future? If we take a look at 1980 now we see a continuing development.
(see figure 18 - Growth forecast for natural and synthetic rubber 1970 - 1980).

- The synthetics continue to grow and one must ask what will come from R & D.

14. Outlook into the seventies (JMG)

You have seen from the last figures the impressive growth figures amounting to an annual increase of 7% for synthetics from 1970 to 1980. In view of what has been said of the properties of synthetic polyisoprene its growth potential should be even greater than this!

As polyisoprene is for about 70% used in tyre applications, its future is much related to the expansion of the tyre industry. With most European tyre manufacturers the synthetic polymer is now used already for some 20% of the rubber component in the carcass and tread of large-size tyres. The properties of polyisoprene are such that the ultimate levels have not yet been achieved. A conservative forecast shows that the production capacity for isoprene rubber should at least be tripled in the next 10 years to fulfil the requirements of the tyre industry only. Virtually the IR growth may well be limited by monomer supply at an economic price and for this the integrated oil-petrochemical industry is very well placed.

Apart from efforts required to realise the increased production of synthetic IR, which should be the objectives of R & D to develop the product itself further?
Reduction in skilled labour potential and higher wages brings the need for further automation in the rubber industry. This means that in the field of synthetic rubber, hence also with IR, products are required which enable processing with the least possible attention. With our knowledge about polymerisation techniques, the influence of molecular weight and its distribution as well as the effect of branching on rheological properties such tailor-made polymers can be developed. For example, the move of tyre manufacture into the radial carcass construction (by 1980 almost every tyre in Europe will have a radial carcass) requires improved green strength. We have a modified polyisoprene with considerably increased green strength already well on the way to

commercial introduction.

It can also be expected that the auxiliary materials which are used in the rubber compounding will also be further adapted to bring out the best performance of the new polymers. As there have been developed special and superior reinforcing carbon blacks for SBR, similar specific developments will come for polyisoprene rubber and polybutadiene rubber. Also in the field of vulcanisation accelerators and stabilisers there is room for a better performance at higher temperatures.

It has been calculated that the investment required in the future in the rubber processing industry is considerable and may well amount to more than five times that required for the manufacture of the base material. Consequently, there will be an increased need for easy and fast processing grades of rubber. In this respect the absence of scorchy constituents in synthetic polyisoprene has already facilitated the use of higher processing temperatures, and it is to be expected that this particular property, coupled with the excellent flow, will be the starting point for spectacular developments in the years to come.

In connection with the increased need for faster processing elastomers the recent development towards so-called thermoplastic rubber should be mentioned. With this material vulcanisation is avoided altogether and the required network structure is obtained in a reversible way by associating polystyrene blocks in the molecule. Some of these new polymers are based on polybutadiene rubber and others on isoprene rubber. Whichever will be the preferred material for a given application, it goes without saying that in the further development of these revolutionary new materials we will exploit all our resources in the way as described for the polyisoprene venture.

In taking full advantage of the experience in approaches, techniques and cooperation obtained in that field, we will be able to continue contributing to the fascinating developments in the world of synthetic elastomers.

15. Acknowledgement

The authors wish to acknowledge the highly appreciated cooperation from the part of the experts in the European tyre industry and they also wish to thank their colleagues in the Research, Manufacturing and Marketing Functions for their wholehearted cooperation and important contributions throughout the development of the polyisoprene project.

LIST OF FIGURES

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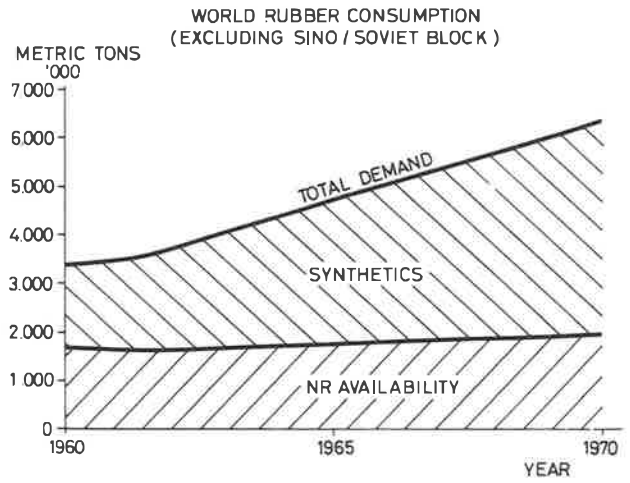
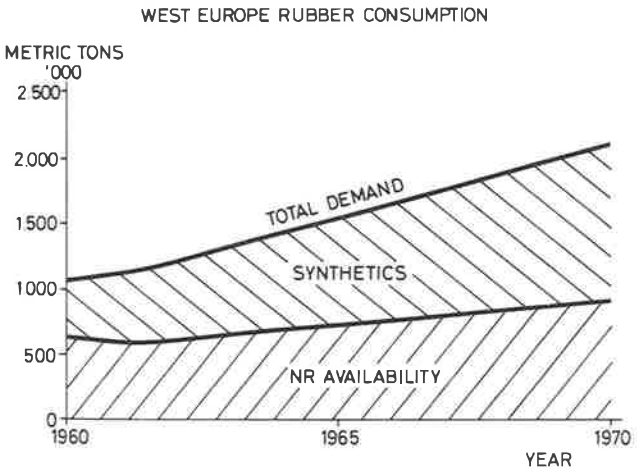
1) J.M. Tilton, Compounding for the radial tyre - ACS div. Rubber Chem. 24.4.1968

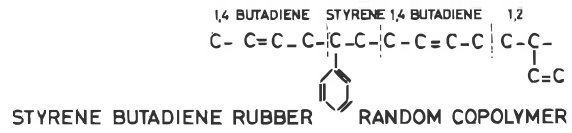
2) T. French, Pneumatic tyres, Science Journal 1969, Nov. p. 37

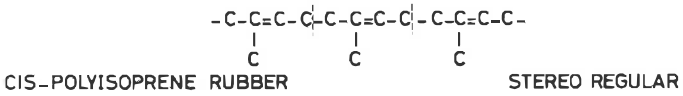


World rubber consumption 1950 - 1970

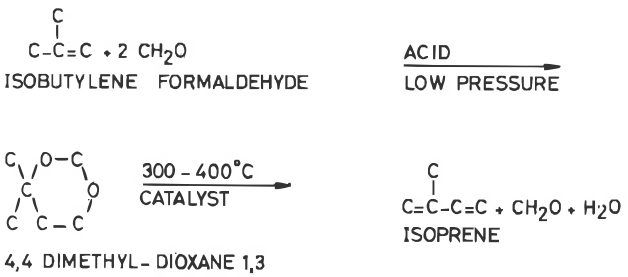


West European rubber consumption 1950 - 1970



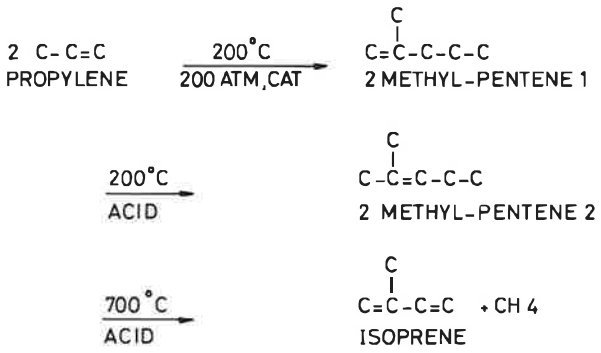


Molecular structure of styrene butadiene and polyisoprene rubber

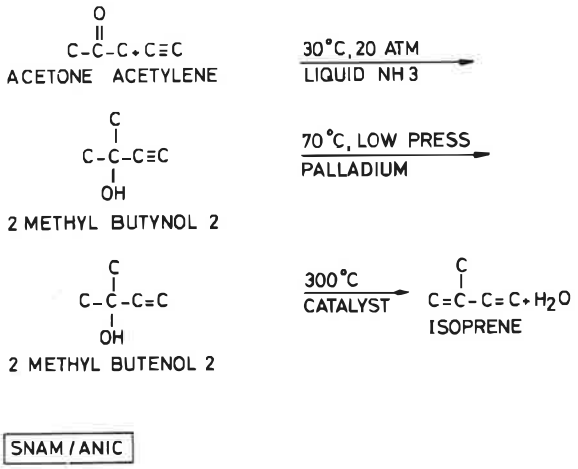


INST. FRANÇAIS PETROLE

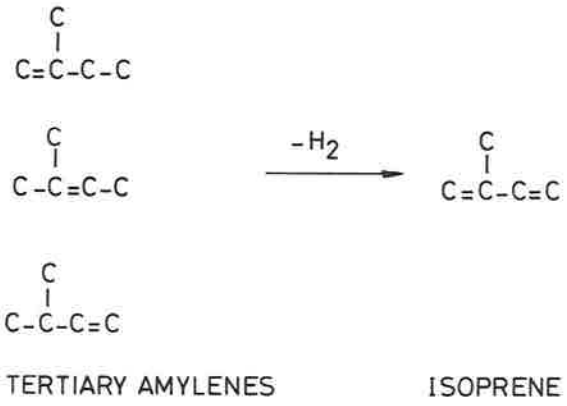
I.F.P. route to isoprene monomer



Goodyear route to isoprene monomer



ANIC route to isoprene monomer

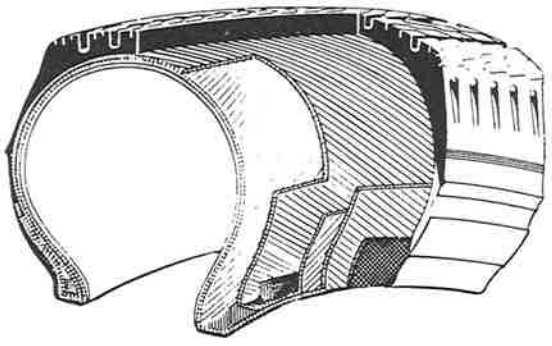


Shell route to isoprene monomer

1,4 and 3,4 polymerisation

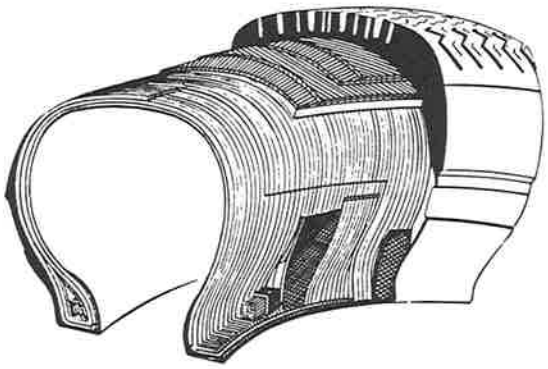
CIS TRANS

cis- and trans-configuration



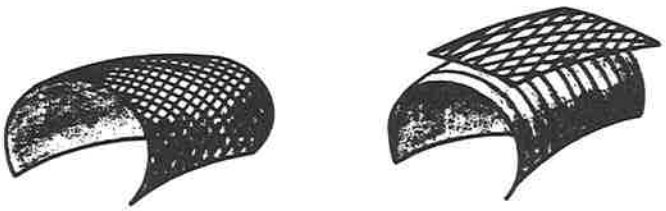
CROSS PLY

composition of a cross-ply tyre



RADIAL

composition of a radial tyre

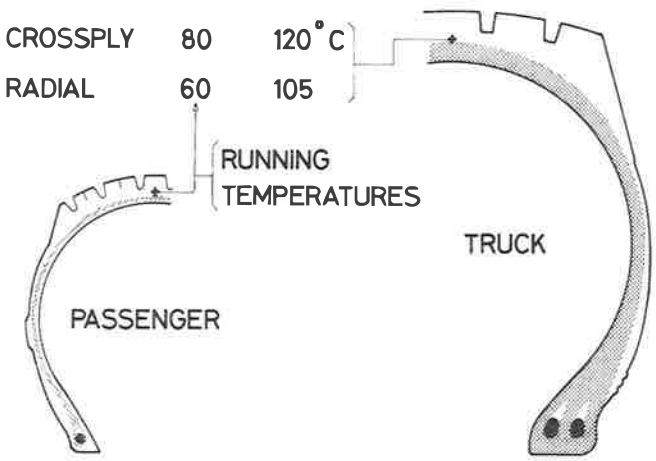


CROSS PLY RADIAL

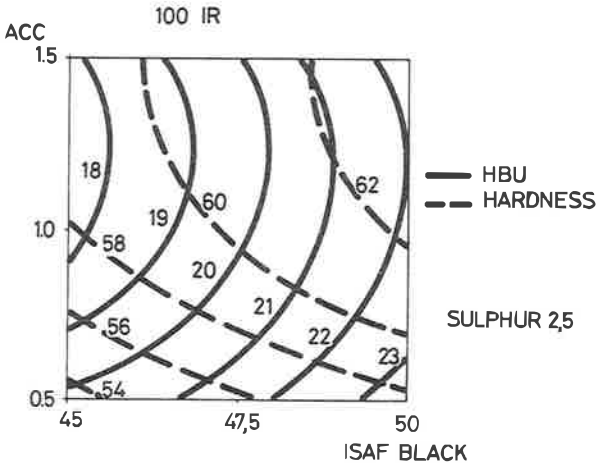
cross-ply versus radial principle

tyre road test truck

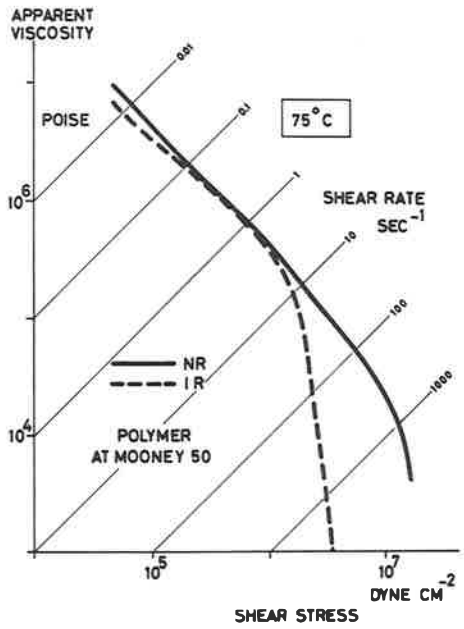
Shell road tanker



Average running temperatures; influence of construction and size

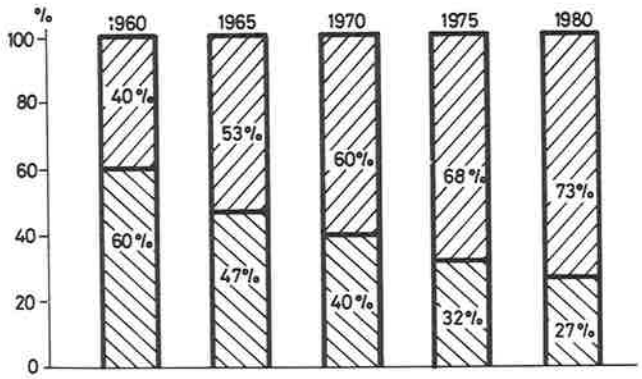


Hardness, resp. heat build-up as function of oil and black loading



Apparent viscosity of polyisoprene and natural rubber as a function of shear stress

SYNTHETIC RUBBER AS A PERCENTAGE OF
TOTAL RUBBER CONSUMPTION-WEST EUROPE



Growth forecast for natural and synthetic rubber 1970 - 1980

PANEL DISCUSSION

Panel:

Chairman : E.J.G. Toxopeus, Shell Internationale Research Maatschappij
Members : G.W. Atkinson, Shell International Chemical Company
J. Brug, Philips-Duphar
J.M. Goppel, Shell Plastics Laboratory
G.G.H. Hamm, D.S.M.

Question

What kind of background people in marketing should have? How many people with academic training do you need? Which disciplines do you prefer, scientists, economists, engineers or what else?

Answer

(Atkinson) Of course that depends on the type of industry. Here I can only tell something about our point of view. A salesman, joining our Company and destined for the polymer field, spends the first two years in the laboratory in Delft. After that he is appointed, either to London or to one of our selling companies, where he will probably be assistant to a sales manager. Then he makes his way up the marketing ladder. Of course, it usually means that such a man is a scientist of some discipline, but that is not always true. But he must be capable of absorbing the technical knowledge about a sophisticated outfit like a polymer laboratory. In our particular case we have a high proportion of graduates and they nearly all, in one way or another, passed through the hands of Dr. Goppel's people. As a result not only they do have a broad understanding of the technology, but there also is the sort of thing that comes out of working together in a laboratory with other people: the personal relationships. There is a personal relationship between the technical service groups and the laboratory. The sales manager in South America may have been the assistant to the technical service manager when he was a youngster at the laboratory. In our experience this is important.

(Toxopeus) Mr. Atkinson is of course dealing with a product that is very much in the performance type of field. Would another member of the panel like to add something?

(Brug) Yes. If a product is to be sold in the pure consumer field, I would not insist on a technical background. But in the case of pharmaceutical products that have to be sold to doctors or of products sold in the professional applications sector where they are converted into final products by the customer, the situation is different. Here, depending on the product you are selling, a scientific or a technical background is nearly always a necessity. If, as may happen, the marketing manager does not have this specialized knowledge, he should have as his senior assistant a man with the necessary scientific or technical background.

(Toxopeus) To sum up: It all depends on the product you are selling. In general a salesman should be at the same level as his counterparts from the customer.

Question

May I ask Dr. Goppel a few questions? It was quite intrigueing to see that two polymers that are chemically nearly identical, behave physically so differently. What is the cause of that?
Secondly, we have here a problem nearly every development man is confronted with at some or other time. Research gives us a new product that is nearly identical with an existing product. Then we can do two things. We can try to change the new product till it has exactly the same properties as the existing product. On the other hand, we can try to convince our customers that it is worthwhile for them to adapt their processing machinery to the new product. Why did you choose for the second possibility?

Answer

(Goppel) As to your first question, I think that the explanation is fairly straightforward. Natural rubber contains a certain amount of gel and it also contains a certain amount of polar groups, acid groups for instance. There is considerable intermolecular cohesion, which has a very pronounced effect on the rheological properties. Also, molecular distribution differs between the two polymers. The interesting point is that two polymers, though basically similar, can show a pronouncedly different behaviour. Your second question concerns the marketing and R & D approach which should be followed. You are quite right, there are two possibilities: You can try to adapt the product or you can try to adapt the customer. In our case we did not try to imitate natural rubber, we wanted to fill the demand for a product with good mechanical properties, and particularly for tyres with a low heat build up. Secondly we wanted to use a cheap monomer and a rather unexpensive route of synthesis.
It is perhaps possible to modify the synthetic polyisoprenes till they have the same properties as natural rubber, but there was no obvious reason for this. At any rate it would add to the costs and it would lengthen the time spend on research. In this particular case our choice was fairly simple, we decided to work with the new polymer and to accept that it was a challenge for marketing and R & D to make it go.

Question

In his paper Mr. Atkinson made a very interesting remark. He said: If we would have been earlier it would have been much easier to introduce the synthetic polyisoprenes. Could he enlarge on that?

Answer

(Atkinson) My point was this. In the period we were reviewing - from 1960 to 1970 - the rubber consuming industry underwent a technical revolution. It was not only faced with pressure from people like us, bringing new ideas, but in an engineering way it was undergoing a technical revolution also. Secondly, the rubber consuming industry had an enormous growth rate in those years. I wanted to convey that the introduction of a new polymer is always difficult in a period when there is tremendous competition for technical skill. It will be somewhat easier perhaps in a time of quiescence.

Question

This morning Dr. Freiensehner stated that the technical service laboratories definitely belong to the marketing organisation. Now in their exposé Mr. Atkinson and Dr. Goppel seem to argue that in their view these laboratories ought to be very close to the research function.

Answer

(Freiensehner) Working for a company that sells more than 6000 products, it is very difficult for me to be dogmatic on this. In my opinion it all depends on the product you are selling. If you sell adhesives to the wood industry, you have to visit your customers frequently, if only to inform them about the improvements of existing adhesives or to show them new adhesives. This only can be done from a place that is very close to the market. But for other products the situation may be wholly different. So you have to be pragmatic and you have to judge each case on its own merits.

(Toxopeus) Perhaps I may add that in an organisation like Shell, there are many sales technical service laboratories all around the world on oil products. They are part of the local marketing organisation. I am sure that Dr. Goppel will reiterate that, as far as the products he is concerned with, proximity to a research establishment is very useful.

(Goppel) Yes, for two reasons I think. In the first place, the quality of the technical

service can be much better if it is close to research. The flow-back to the research function can be very good and this is almost vital with the sort of product we have discussed. Secondly, you have to take into account that the need for technical service cannot be predicted exactly. For instance in a certain period the requests for technical service may remain below the expected amount. Then there is the risk that the separate technical service laboratory starts some R & D on its own, which, because it is isolated, tends to be of a lower quality than you would like to see. Conversely, there can crop up quite suddenly a difficult technical problem that should be solved as quickly as possible. If you have marketing support and R & D under one roof, there is at least the possibility that you can meet that demand for marketing support, be it at the cost of a temporary reduction in R & D effort. You would not do that readily, but at least the possibility is there. The integration of R & D and technical service gives you great flexibility.

(Hamm) It seems to me that in your marketing plan you have to consider the amount of technical assistance you are prepared to give to marketing. So technical assistance is part of your marketing plan and should belong to the marketing organisation. The actual execution of the technical service is, in my opinion, best based in the technical organisation itself, but it should immediately available on the request of marketing.

Question

When we are speaking about the interaction between marketing and R & D, we must keep in mind that there is a conflict. If we accept the scheme Dr. Freiensehner has sketched, R & D people are like an advanced task group, that works very closely with the customer and tries to get results as quickly as possible. The marketing man, on the other hand, wants to enlarge his share of the market. It seems to me that these two things can be in conflict. Should management not express its own priorities, saying: In this case the R & D relation with the customer gets priority and in another case: The marketing side gets priority?
Secondly, I learned today that there is a time-lag of ten years between the start of R & D work and the moment it will begin making profits. Does that mean that, with ten percent interest, every $ 100 invested now, has to yield $ 240 in ten years time before you start making profits?

Answer

(Goppel) In my opinion quite often there is no conflict at all. For if you want to enlarge your share of the market, you must have quite a lot of information about your product. In this respect information about the difficulties your customers are having with your product, is absolutely vital. It is only after you have gathered all pertinent information about your product that you can start a marketing drive. I can cite the polyisoprenes again. But we have had no difficulty when discussing this with our colleagues in marketing. We always found it easy to agree on a certain strategy and we never had the feeling that there was a conflict.

(Atkinson) As to your second question, you are right, but it is a somewhat unusual approach. How you account for your R & D costs depends of course on the system you have in your company, but I don't think that there is any company that actually adds all sums spend on a certain project and then asks for the total interest in the end. You always have to keep in mind that, if you have come to the end of your development and could restart, you would do the same work in less time and for less money. Reports are written as if people knew from the beginning where they would end, but in reality R & D is full of dead ends and full of things that looked promising but did not live up to expectations. Another point is that, when you have to decide between stopping a certain project or going on with it, you mostly cannot retrieve the sums already spend. So you look at the amount of money necessary to bring the project to a successful end and you base your decision on that.

Question

The case study on polyisoprene was very interesting as it was a clear case where adequate direction could be given to both R & D and marketing. Has the panel any idea how one could give direction in the far more difficult case of exploratory research and marketing? Exploratory research lies at the very beginning of a R & D effort and that, in my opinion, makes good co-ordination with marketing very difficult.

Answer

(Brug) Dr. Freiensehner told us that you have to divide your R & D budget in three main groups: exploratory research, development of results of research and research aimed at taking care of existing products. In the last two groups the situation is fairly straightforward as you can plan reasonably accurately the resources in men and money you will need. In the case of exploratory research however, the situation is far more difficult. Even in this case it still is possible to plan. There exist modern methods which give you a fairly good idea of the sums and resources you have invest to be able in a few years time to put on the market one or two new products a year. Secondly, I think you should ask the scientists involved how they judge their own chances of success.

(Toxopeus) But in your speech you said that you hated to direct your exploratory scientists too much and that you would like to give them at least some leeway to follow their own leads.

(Brug) That is true, but I don't see any contradiction. To ask a man for his honest opinion and to listen to him, is one of the roots of freedom.

(Goppel) I believe that exploratory research means just what it says: it is exploratory. You simply cannot know in what direction it will go. Therefore I think that co-ordination between this kind of research and marketing - or perhaps better a specific and well defined marketing objective - is hardly possible. But of course suggestions from the marketing side will be very wellcome and may be very useful.

(Toxopeus) I am sure that on this particular subject you cannot lay down the law. Every company will have its own approach. So I would like to ask Dr. Freiensehner for his comments.

(Freiensehner) Apparently I have not been fully understood this morning. I wanted to convey that we make use of development groups which are set up on an 'ad hoc' basis. Each group consists of a number of scientific and technical experts and a marketing man. He should be picked from the central sales department, as routine salesmen cannot handle this. They simply don't have time for it. When the development group has finished its task, it is dissolved.
But I wonder whether Dr. Copisarow could comment on this point: The relation between marketing and exploratory research.

(Toxopeus) The attempt to direct and to get the maximum efficiency from exploratory research groups is a very important subject. I think that a careful consideration of the marketing side is essential. In the United States firms make a growing use of so called 'think tank' sessions with both technical and marketing people. I wonder whether this approach could be a solution for the problem we are discussing.

(Copisarow) The brief answer to this question is: Yes, it may be useful. The advantage of a 'think tank' session is the association of ideas which brings to the surface new information which is really known, but which otherwise would not be presented. By bringing together research and marketing people in a brain storming session one may get a clearer picture which allows a better analysis of the problem. But I don't think that the techniques which have been evolved are fundamentally different from those that are used, perhaps in a small way by many sophisticated industries of the present time.

(Atkinson) I think that probably the last thing that marketing would want to do, is to get its fingers in the field of exploratory research. Once a year we meet our exploratory research people and we just talk about the business we are in and where we are going, and we discuss the miracles necessary to get where we would like to be. That sort of exchange of ideas is very useful. But it would be completely absurd for marketing to go back to a scientist and say: How are you going on with that idea I left you last week.

Question

We have talked about the interaction of marketing and R & D when a development is on stream. But how could marketing be of assistance when the development people have to select new processes or new subjects which are waiting to be turned into a production process. Has marketing to have the most important voice in the decision, or is that the responsibility of R & D? What would be the best procedure in this case?

Answer

Oh, this is a very tricky question!

(Toxopeus) As far as exploratory research is concerned, it seems to me that the research people have the last say, it is their responsibility. But if they don't listen to the advices of the marketing side, they are just fools.

Question

We have discussed extensively the management of the interplay between marketing and R & D. Some say that this must be managed by marketing, others would like to organise that somewhat differently. Now, could this not be handled by a R & D planning department?

Answer

(Toxopeus) Could you please explain what you mean by a R & D planning department?

The member of the board of a company, who is responsible for R & D, must have a R & D planning department, I think.

(Goppel) In my opinion this depends very strongly on the organisation you have in your company. Furthermore I want to mention a point that has not been made yet. You can have on paper the best organisation scheme in the world, but if you must work with people who do not know how to co-operate, you still are nowhere. The reverse can also happen. You may have an organisation scheme that does not look very efficient on paper, but works excellently because everybody does his utmost to make it work. So I doubt very much whether a question like this can be answered in a general way. The answer would probably differ for various companies and various circumstances, and, in my opinion, it depends strongly on the personalities involved as well.

(Hamm) I fully agree with Dr. Goppel. I would like to add that there are companies that employ co-ordinators or planners for research. They mostly are research men themselves and they belong to the R & D department. It is their task to maintain contact with the marketing department. But it seems to me that the way you organise this is a secondary problem. Of course you must have an organisation scheme that is adapted to the structure and to the needs of your company. The first thing is the realisation that there must be good communication between R & D and marketing.

Question

We have heard a great deal about basic research, but our company is involved in another kind of research. We have to react to problems of our customers that can involve

modification of a product at high speed. We do not maintain a basic research unit, we rely on the information passed to us by a basic research unit situated elsewhere. Do you in your organisations differentiate between these two kinds of research? In other words, do you have a basic research unit working on new products and do you have another research unit which can react at high speed to certain problems of your customers?

Answer

(Brug) Do you mean a technical service department prepared to tackle problems that go a bit beyond day to day problems?

No, that is not exactly what I meant. In technical service you send a man to your customer and he advises to change the speed of a certain machine, or something like that. I am thinking of, for example, a fibre finish for nylon used by one of our customers. He wants to use the finish for polyester and discovers that is does not work. Or a customer has used the finish for nylon from one supplier. He changes his supplier and suddenly gets results that are quite unacceptable. In both cases the product must be modified very quickly. We maintain a separate research unit for that kind of work. My problem is that our basic research organisation is 3000 miles away and that distance is difficult to cross quickly.

(Brug) Our company does not have such a separate research unit.

(Toxopeus) It seems to me that the solution you choose, depends on the situation. With your basic research laboratory in another continent you must have a separate research unit near at hand to solve the pressing problems you mentioned as examples. But if it were possible, then personally I would prefer to have the basic research laboratory, the special research unit you mentioned and the technical service department under one roof, because their respective fields of activity fade into each other.

Question

What does the panel think about the interaction between R & D and marketing when an important part of your research is carried out by an independent laboratory, like TNO in the Netherlands?

Answer

(Toxopeus) Could someone from TNO comment on this question?

(Prof. Dr. A.J. Staverman) Of course the gap between the research man and the salesman is a problem for an Organisation like TNO. But we have all heard this morning that the problem also exists in a company which does its own research, because there always is a gap whether you like it or not. In a company that does its own R & D this gap may be bridged somewhat easier by management than when you farm out your research, but in going from fundamental research to applications you always have to cross a number of boundaries. In our experience the problem mentioned always can be resolved provided that the sponsor realises that with farmed-out research the information flow requires special attention. Then it is always possible to work out a method which ensures that both parties receive the relevant information as quickly as possible.

(Brug) Companies with their own research laboratories regularly farm out part of their research. If you foresee that you will need a special technique only once, you should not try to carry out that part of your research program under your own roof. Then it is good policy to contact an independent laboratory that has the special skills and facilities available. In that case you can have the same efficiency as in your own company. It is only necessary to specify very carefully your wishes to the laboratory that does the research for you.

Organising for New Products

Dr. R.M. Lodge
Research Director of ICI Fibres Ltd.
Harrogate
Great Britain

In a conference such as this where we are to talk about the relationship between Marketing and Research & Development, the fact that we are here and are all from the chemical industry makes it quite clear that the chemical industry has moved a very long way from the days when it was a supplier of industrial chemicals like sulphuric acid or aniline or soda and the like. Chemistry used to be a leading élite science, but people are beginning to realise that it lost that status quite some time ago, so that chemistry today is what we must now call an "enabling science". It enables things to happen; it does not necessarily reach the final result. In other words chemistry must be regarded as necessary but not sufficient. This perhaps is the reason why speakers at this conference recognise, as Mr. Geldens did, that our products have a lifecycle (unlike sulphuric acid) or, as Mr. Valerio will, that this chemical industry of ours now does not sell only industrial chemicals; it also sells two more things which are more important: these are the effects and systems which modern civilisation needs.

The effects we sell are pretty varied - pharmacological, agricultural, decorative, convenient, energetic, protective. The systems we sell are beginning to be just as varied - fibres, fabrics, substitutes for almost anything (e.g. metals, leather, glass, paper, plaster), heating systems, photographic systems, sound and television reproductiun systems, packaging, housing; the list is almost endless.

Note how Dr. Freiensehner said that post war BASF decided that they ought to be in the consumer goods industry. This was no rationalisation; I believe this was indeed a conscious decision. The speakers from McKinsey made reference to the need to decide which business area one should operate in, and most of you will know that famous paper by Levitt in Harvard Business Review called 'Marketing Myopia' which makes it quite clear that it is extremely necessary for all of us to know what our proper business area is. The business area of the chemical industry needs to be defined for, if it is a business area that is not just sulphuric acid or something like that, then it needs to be kept up to date.

The innovatory process is vitally important. It is an economic law that, as products become established, so the profit margins fall. We are here to consider the relationship of Research & Development and Marketing against the background of this innovatory process. I have had the benefit of listening yesterday and now believe that we were in danger of making ourselves unwarrantably happy by saying that the relationship between Research & Development on the one hand and Marketing on the other is a simple, cosy one. I don't believe it is simple and I know it is not cosy; and you know it is not cosy too.

I believe the relationship is in fact a conflict and a battle, and I think it should be so. The marketing side of the business looks at the current products and it says: "Their quality is deficient; we are having difficulty in selling; kindly improve them." And they are right! The Research & Development side of the business says: "Here are some nice, brand new, pristine, exciting products; kindly receive them and sell them at full rate instantly." And they are right! And neither happens; from these two situations develops a perfectly natural conflict which I suppose, we as managers, are expected to resolve. I have to admit that often the duties of managers involve resolving conflicts, but I suggest that there are some areas where conflict can be a good thing and should not be resolved. And I believe that in the R. & D. versus marketing situation, we have such a situation, namely a conflict that we should not resolve.

There is always resistance to change; the established order is production, which should be even, level, calm, and undisturbed. Innovation is something which is difficult to introduce, demands extra efforts from people and most certainly needs a champion. Any particular innovation is bound to fail unless there is at least one person who is determined to see that it succeeds. Innovation quite clearly upsets even production and therefore there is resistance against it from the production side. By the same token, innovation also causes upsets in marketing who have their problems of trying to forecast what is going to happen with something new; and let us face it, that is a big problem.

I think the implication of this must be that on the production side, just as one pays people to do nothing else but keep production going, one should also pay other people so that their exclusive job is to keep production developing. There are after all three main functions, and only three functions, which any business has to do: it has to produce, it has to sell and it has to develop. I don't mean it has to develop products or processes, but rather that the business has to develop itself. In other words, the business must grow and develop in different ways at different times. All the other functions are quite subservient to these three mains ones: Development must go right through the business and not just be the perquisite of one or two departments. There is no reason therefore why there should not be development in production and development in marketing as well.

I am not being original here at all, and perhaps if at the end of my talk you feel, like the Bourgois Gentilhomme, that you too have been talking prose all your life, then I should be happy.

Mr. Bagnall when managing director of British Nylon Spinners posed us a question and it has taken me 20 years to discover its answer. The question was: "What are we here for; are we here to make what we can sell or are we here to sell what we can make?" There were endless arguments on this, but in actual fact the solution is very simple - we sell what we can make to the extent that we have plants that are obsolescent, some of them are even obsolete. We sell the product from them, because that is all they can make, and we have got to sell what they make. The other part of the question, "Should we make what we can sell?" is to do not with the past nor with the plants that we have, but is to do with the furture and what manufacturing plants we should have. It is perfectly reasonable to take steps to ensure that what we make is sellable.

We are dealing with futures today and not pasts. Research & Development on the one hand, Marketing on the other, are busy fighting with both.

And so I come to my title which is 'Organising for new products'. I think the best introduction I can give you to this is a failure story, not really just because Dr. Brug wanted it but because it is a failure story with a moral. In about 1958 my colleagues and I were getting very depressed about the future of the nylon industry, because we were mistakenly arrogant enough to believe that we had begun to come to the end of the recognition process for worthwhile problems. For this reason we decided that we would of necessity have to generate a new man-made fibre to work on. We got together therefore a new polymer group of about 25 organic and physical chemists and gave them the objective quite clearly of "Please make new fibre-forming polymers." And they did so; in their prime they were making about a hundred new fibre-forming polymers a year. Then, of course, the awful realisation dawned that we were rejecting these polymers at the same rate as we were synthesising them. In other words, we had given them their orders and they had obeyed; and we had never stopped to ask ourselves the question: "What are we going to do about it when they have achieved their objective?" Of course, when we reconsidered the situation and realised that synthetic fibres have appeared randomly in space and time, we realised too that we had bitten off a lot more than we could chew and we were about 1.4 million pounds sterling the poorer and we had a lot of small samples of novel polymers that were of no use at all; but we had a moral too; that moral is: if you ask a scientist today to achieve an objective, it is most likely that he will do so.

Truly, this was not so 20 years ago, when we all went into our laboratories and were quite happy to do things that were interesting to us; we would discover things that were exciting and every now and then some of those exciting new things we discovered were actually of use to the company paying us; this was called "Research" and everybody was delighted. In the twenty years that have passed, there has been a very big revolution which has meant that the chances of success against an agreed objective have been enormously enhanced. This is not really a statement made in arrogance: it is a statement made in humility in the face of the enormous amount of knowledge that has been acquired in those 20 years and has been recorded and is available.

So, the moral of my failure story is, that objectives are now assuming today an importance as never before; as a sort corollary of this, one finds that one can truly command invention. After all there is an expression in English, which describes a near impossibility or an impossibility - "It is like trying to jump over the moon." Well even that today has been done; it was less than 10 years ago that President Kennedy said that is what they were going to do and the Americans did it.

I don't say that always the technical solutions that are arrived at are commercial solutions too; they can fail for economic reasons. But even that situation is improving, because obviously if one has a greater chance of technical succes, then there is correspondingly certain increase in the chance of a commercial succes. I have to admit that, having failed, we disbanded the new polymer research group and regrouped to form a pioneering group. Of course it was at about that time that Levitt's paper had appeared and we recognised the importance of not suffering from "Marketing Myopia" and we questioned ourselves about our proper business areas. We very soon realised that the last thing we should be doing was to be making synthetic fibres more and more efficiently and of better and better quality and variety. It might be that one day somebody would come along and obsolesce the textile industry. And if they did that, where would we be? As Levitt had pointed it out in his paper, this is what really happened to most of the railways in the world. Hardly any of them are working at a profit, because they decided their business area was "running railways" and not something much more wide like "transportation business". They would have done differently if they had so realised. So, we considered our objectives and we tought that if anybody is going to obsolesce the textile industry, it had better be us. And also we did in fact formulate that our business area was concerned with barriers - barriers against heat, against light, and against wet and we added that our business is in part power transmission as well. So, (and this is not a rationalisation at all) we set up a pioneering group whose job it was to do some very, very specific things. One of them was to see whether there were other ways of making fabrics than the traditional ones of knitting and weaving and felting. I don't want to bother you with the details of that, except to say that we found it possible to use bicomponent fibres. In other words, we made individual filaments which had two different polymers in them arranged either in a side by side configuration or in a sheath and core configuration. The sheath for example was made from the polymer with the lower melting point and one could make a random array of such fibres and then heat this up to a temperature between the melting points of the two polymers and so arrive at a fabric like structure without having had recourse to either of those two tedious processes, knitting or weaving. We call this process "melding" - a combination of melting and welding.

I am not suggesting that we have obsolesced the textile industry, but at least it led to a new method of making fabrics which is certainly going to compete for the growth market with both knitting and weaving. But my point is not to talk about this at all; my point is to indicate that this was indeed a literal commanding of invention.

It has been important to take you through that stage, but I now want to turn to the chance we had to reorganise our internal arrangements as a company to encourage and catalyse the flow of new products to our production lines - about 60 new products a year, mostly yarns. The times between conception and production were anything from, at the lowest, 6 weeks; at the longest, about 8 years, with the average perhaps about a year and a half

to two years. You will recognise that, since I am talking about a homogeneous group of new yarn products, some of those development times were really far too long and we were quite dissatisifed with them. There were too many projects in the system, there were too few coming out, and they were coming out in entirely the wrong order of priority. By the time some of them came out, they were not even wanted and the whole proceeding was far too casual and really unorganised. All that was needed was in fact someone to organise it. So a team set about doing just this. Obviously if we were going to make what we could sell, we had to listen to those who were going to sell, so we came to precisely the same solution as BASF and we gave to the sales managers of the various product areas responsibility for defining their marketing objectives and they were helped by the research, textile development, accounts and production functions, (one man from each function) and they were all asked as a New Product Trade Committee to face the market and to decide the policy for their own particular area. Now, this sounds like setting up a rather large number of committees. And it is, but we were able to abolish more. These committees were there to commit the functions; they were not there to talk. The discussion all goes on outside the committees and the committee structure is there in order that this committal is in fact properly done and nothing is left out.

So objectives came to be defined to the business. But how was the business going to react to these? We felt that it was necessary to seperate the definition to the business of what the objectives might be from the reaction by the business to the suggestions. Obviously, when we came to think about it, it was essential to put some sort of a filter in between. Someone had to check that scarce resources were available, recources such as manpower, revenue money and capital money, space and equipment. Someone had to check whether the pattern of new product objectives that was being developed by this team of sales managers, supported by their New Product Trade Committees, was compatible with the strategy of the business. Someone had to check whether things were feasible and someone had to allocate priorities. So we created a small group or department, a new product department, 5 or 6 senior people, who acted as a secretariat for all these groups of people meeting together, discussing and refining objectives. One of the senior men in the New Product Department always acted as a continuity man and secretary, recording what was going on.

Because our two main fibres are polyamide and polyester, we had additionally to have two separate Technical Progress Committees, in order to progress the work that was being done to carry out the suggestions that had come up from the New Product Trade Committees under the sales managers. And as a result of this, since a demand might start by being: "We want a knitting yarn", and would need translation by the new product department (non-executive, not a filter, unless everybody agreed that it should act as a filter), this request for a knitting yarn might for example be translated into: "Should it be a polyester one or a polyamide one?"

There could be situations where doubts were unresolved and conflicts remained; what should we do with that sort of situation? So we created yet one more committee; this was a committee of board members representing the involved functions and we called it 'the New Product Conference' and arranged that it would meet only when required by the New Product Department to do so, in order to develop strategy and resolve hitherto unresolved conflicts. The dangers that have arisen from this - and this is a system which has now been working for nearly two years - are perhaps fairly self-evident but worthwhile noting. If sales managers are put in charge of developing new product requirements, they are likely to give too short a term view for comfort and we have found that the New Product Conference has to meet from time to time and persuade the New Product Trade Committees into thinking much, much further ahead. The situation is getting better and it is worthwhile being patient about it.

There is a danger of asking for the wrong sort of objective. Three months ago I had the unpleasant task of stopping some research which has cost us over a million pounds on a leather substitute material, but I learned a lesson from it: you may ask for an object

with a density of 2.1234 and most of us would answer: "yes, we will make you an object with a density of 2.12 by this evening. The next two decimal places are a bit more difficult, but if you define the temperature, in about a week we will be able to provide it." There is absolutely no doubt whatsoever that such an object is attainable and achievable, within any stated degree of accuracy that is reasonable. But is you ask for a product which is going to be suitable for men's shoe uppers and acceptable to the shoe manufacturers' buyers and it is to have the properties (as yet unstated) of natural shoe-leather, then it is a very different sort of objective, since it depends upon subjective situations extremely difficult to assess. This is the same for all of us who have been trying in the synthetic leather area. One gets 95% of the way very, very quickly and the next 5% is extremely hard to come by and one gets no marks for closeness. The jack-pot is yours only if you get there. So you need to be careful that the objectives that are set, if they are of the latter type, are recognised for the dangerous things they are.

Don't let them ask for too little; and don't let them ask for too many things at once; make sure that the objectives are going to last not only for as long as it takes you to develop them, but also as long as it takes to recoup back the expenses incurred in their development. That is a point that is very frequently missed and one which our New Product Department is constantly pointing out to us to our infinite good.

I can see that my job as a research man in industry is to apply science to my industry; I only really should have recourse to research when I have to; in other words, if I can go and look it up in a book, then it is cheaper to do so. For this reason it is always necessary to cosset those people who are fertile and do have new ideas.

Meanwhile, the battle between Research & Development and Marketing goes on, but it goes on in a very clandestine sort of way, because I think we all realise that at the end of the day each of the protagonists in this battle realises quite well that he is useless without his enemy.

DISCUSSION

Question

How are the new product conferences constituted? Who is there from R & D, marketing and other departments?

Answer

The chairman of the new product conference is the deputy chairman of the company, who is responsible for commercial matters. The technical deputy chairman is there as well, together with research, textile development, production and engineering and the two marketing directors. The head of the new product department is the secretary of that conference.

Question

Your remarks about the necessity and desirability of conflict call, perhaps, for a small comment. It seems to me that there are two types of conflict. The first, the 'yes' and 'no' conflict, is absolutely useless and sometimes very dangerous. The other type can be a source of challenge and inspiration, and that is very desirable. But I think that the last type of conflict is not limited to the confrontation or R & D and marketing. You find it in each of these functions, in marketing and in R & D, and there too it is desirable. I think that you simply cannot do without it. In that sense the necessity of conflict is nothing unusual, it is a necessary constituent of our society.

Answer

I fully agree. When resolving a conflict you must always bear in mind the possibility that a decision may be taken on limited knowledge, and such a decision can be parochial and therefore very dangerous. This must be avoided at all costs, all the difficulties must be dragged out into the open and seen for what they are.

Question

I understood that the new products department is handling all new projects in the company. Its members have non-executive status, they act as a filter, they have to check resources, feasabilities and so on. But it is a rather small group. How many new projects can they handle?

Answer

Usually, about fifty or sixty are running through at any one time, including about ten major ones. The group is non-executive only in the sense that its members are not allowed to take the final decision. That must be done in public. The group can recommend to turn down a suggestion of one of the new product trade committees. If anyone objects, the problem goes up to the new product conference for final decision. That decision is taken right at the top.

Question

We are talking about the conflict between R & D and marketing in our European situation. Anyone acquainted with plants of affiliated companies in the United States knows that the conflict, although existent there too, is of a different nature. The cause seems to be that our colleagues in the US are far more market-oriented. This does not only apply to people in research, it applies to all people in the company. It seems to me that we in Europe should become far more market-oriented than we are at the moment. Will the new organisation you build up in ICI work towards that goal? Did you notice that the company got more oriented to the market, rather than looking at things from the production side?

Answer

Yes, we think so, but it is to early to draw definite conclusions. We have been running the new system for three years now and we must have a few years more before we can judge whether it is a success. Certainly there have been less mistakes made and we have obtained some very good results. On the other hand we might have achieved that anyhow.

Question

You mentioned that any invention requires a champion. Is there room for a champion in this complex system of committees and conferences?

Answer

Yes, it does, and that is absolutely vital. The system is not used to crush initiative, but to get our priorities right and to make sure that we develop only those things that are going to be profitable.

Enzymatic Detergents

Dr. Ir. L. H. Ruiter
Director of Unilever Research Laboratory
Vlaardingen
The Netherlands

Introduction

The tremendous growth of the chemical industry in the past decades can perhaps be best explained by the successful conversion of the results of Research and Development into products which had either superior properties - a superior performance - at an acceptable price compared with existing ones, or were cheaper and at least as good. I would like to stress here performance and cost. Of any new product coming on the market it is the "market", that is to say the sum-total of the potential customers, which will eventually decide whether that product is successful and has come up to the promised performance at a certain cost. This implies, of course, that if a "science-based" industry, like the chemical industry in general, wants to be succesful in a competitive market, it must not only have an excellent knowledge of that market, but there must also be a very lively and efficient interaction between Marketing and Research and Development. This is necessary to ensure that on the one hand marketing opportunities are not lost and on the other new scientific discoveries and inventions, whenever possible, are turned into marketable products.

As this is exactly the subject of this Symposium, I would like to point out one difference between the chemical industry proper and an industry like Unilever. In general, the chemical industry proper produces products in bulk, and intermediate products that are utilised as raw materials by other industries, whereas an industry like Unilever produces consumer goods that are used by millions of individuals throughout the world. In principle there is no difference between these two types of industry as regards the interaction of Marketing and R & D., but the gap to be spanned is bigger. An intermediate product manufactured by the chemical industry can only be sold and should be sold by explaining and discussing its technical performance and economy to and with the experts of the buying industry. The individual buying consumer goods is usually not a technical expert. He has to rely on his experience and on the trust he has in the message which he receives from the producer. In other words, he has primarily to trust the advertising through any of the modern mass-media and he can then judge whether the promise made is fulfilled by comparing the new product with the old one in actual experience. If the promise is not fulfilled, the trust in the message and, therefore, in the producer breaks down.

I shall now explain to you the structure of Unilever before describing the interaction between Marketing and R & D in my Company.

The structure of Unilever

The organization of Unilever is, as far as relevant, shown in figures 1, 2 and 3.

From figure 1 it is apparent that Unilever is divided into Product Groups. These groups are headed by Product Group Co-ordinators, almost all of whom are Members of the Board. They are responsible for the profits and the operations in their allotted spheres of interests. There are, however, also quite a number of centralised Service Departments. To name only a few: Marketing Division, Engineering Division, Research Division, Central Accounts, Finance, Patents, etc.

Figure 2 explains in more detail the organization and responsibilities of a Product Group Co-ordination. The operating Companies are selfcontained in so far as Accounts, Production, Marketing and Product and Process Development for local needs are concerned. They report either directly or functionally to their Co-ordinator. The size of

the Factory Development Unit depends to a large extent on the size and importance of the Operating Company and on the location. I have clearly indicated the Marketing Department and the Factory Development Unit, because I will refer to them later.

The organization of Research Division is shown in figure 3. As I said before, Research is a centralized Service Department for the whole of Unilever. In general, at least two laboratories carry out research for one particular Product Group, e.g. Port Sunlight and Vlaardingen/Duiven for Detergents, Vlaardingen/Duiven, Colworth/Welwyn and Hamburg for Foods I (the fatty foods Product Group), and Isleworth and St. Denis for Toilet Preparations. The U.S. laboratories serve in particular the U.S. companies: Lever Brothers and Lipton. Bombay is catering in particular for Hindustan Lever, the Indian Company. There is free and intensive exchange of technical information among the laboratories to facilitate the picking-up of scientific discoveries and inventions and of new products and processes. Close liaison between Research and the Product Group Co-ordinations is maintaned in order to ensure that Research is fully informed about the policy of the Product Group Co-ordinations and to enable Research to respond quickly to any queries and request by Co-ordinations.

Briefing of Research

Science-based industries need, of course, a fair amount of continuous long-term Research to ensure their economic health in future. I don't want to dwell on the size of effort to be spent on this type of research, as it varies greatly from industry to industry. To-day I will restrict myself to that part of Research which is close to the coal face, the part that is engaged on research work aimed at putting new products on the market in the near future. It is obvious that information from the market is essential. The marketing people should know which opportunities exist in terms of product attributes. On the other hand, they should be fed continuously with information about the possibilities which newly developed technologies can offer. The company that has solved the problem of effective communication and co-operation between Marketing and Research most efficiently, has the best chance of being successful, under otherwise equal conditions.

How do we go about it in Unilever? In figure 4 I have shown how we arrive at a Research Brief. The Operating Companies are asked to submit their long-term marketing plans to their Product Group Co-ordination. These plans, indicating the new products required in the years ahead, are digested by Co-ordination. Each of the proposed new products is assessed on its potential commercial value and considered in the light of overall strategy.

The result is a document which is discussed with Research in order to eliminate those requests which can easily be solved by existing technical know-how and in order to obtain comments of a more general nature. The eventual Research Brief lists in some detail the concern objectives, the desired technical properties of the new products, the geopgaphical areas for which they are intended and their potential commercial value. Thus the Brief clearly indicates the overall needs and the commercial priorities, but only in terms of known concepts. It is not a Research Programme, although certainly a large part of the Research Programme is based on the requirements spelled out in the Brief.

Research has also the added, and, in my opinion, even more important responsibility of creating completely new products (and processes) which cannot be adequately expressed in known terms and which nobody has thought of before.

The information about the development of any new product emerging either as a consequence of a Brief-related research project or as a result of the autonomous thinking and work of a creative scientist is passed on as quickly as possible to the relevant Product Group Co-ordination. Further action is now required!

Interplay between Marketing and Research

The next stage - bringing the new product on the market - is the crucial one. The problem is to do it effectively and efficiently, and yet carefully. Companies and consultants have come up with numerous suggestions to solve this problem. I believe that there is no single solution. How one does go about it depends on the particular situation; the historical background of the company, its organisation and the circumstances under which it operates. Conditions and circumstances change in time, and therefore, the method which seems to be the best one now may not be so in a few years time. Furthermore, the method to be used may depend on the type of product to be brought on the market.

For the introduction of an enzymatic heavy-duty detergent we have chosen a method the principle of which I will now describe in general terms. We had to enter in a product area which required a new technology and a new marketing approach. Moreover we had to move fast because of possible competitive action. Concentration of resources was, therefore, an absolute necessity. The obvious thing to do was to form a project team.

First of all the Product Group Co-ordination had to select the country in which they wanted to test the new product and in which the marketing and factory development resources were sufficiently large.

Secondly Research Division had to nominate the laboratory where the expertise and experience were available to provide the strongest support for the operation.

The two combined resulted in the formation of a project team burdened with a considerable amount of responsibility and freedom of action. The principle is shown in figure 5. It is obvious that the formation of such a team only makes sense when Research has shown that the new product can, in principle, be produced and meets the required performance, and that Marketing has shown that there is a definite consumer need to be fulfilled.

In figure 6 I have listed the responsibilities of the project team in order to meet the objectives (the terms of reference), as laid down by the Product Group Co-ordination and Research Division. I will pay more detailed attention to this later.

The real interplay between Marketing and Research becomes apparent in such a team. There must be a very good understanding between the team members, each of them must appreciate the point of view of the others and be prepared to comment. The two cultures (C. P. Snow) must meet and interact, otherwise the outcome is not nearly as successful as it could be.

Now I would like to get into greater detail.

History of enzymatic detergents

Let me first set the scene, and tell you something about the history of enzymatic detergents.
The suggestion to use enzymes in detergent products to aid in the removal of stains that strongly adhere to the fabric is very old indeed; it was already made many decades ago. In old patents mention is made of all sorts of enzymes, amongst them the proteases, which are enzymes that split protein molecules. Many stains contain proteins: blood, egg, cocoa, gravy, human excrements, etc. Since there is no reason to assume that these stains occur more frequently nowadays, nor that our parents and grandparents couldn't be bothered about a clean wash, why then did we have to wait until about 7 years ago before proteolytic enzymes became a regular ingredient in detergents?
Several reasons can be mentioned. First of all the availability of the enzymes. They are produced by growing micro-organisms under suitable conditions in fermentation vessels, and are subsequently isolated from the culture broth, a step which requires

a fair degree of know-how. Some 10 years ago there were only a few companies in the world which produced proteolytic enzymes, mainly for use in the leather industry. There was no production capacity to cope with large-scale use of enzymes in detergent products. Secondly the price of the enzymes. In order to have any noticeable effect in a detergent product, they had to be added in such a quantity that the raw material cost would be at least 30% higher than that of the same detergent without enzymes. In a period in which it was generally believed that the consumer was not prepared to pay a significant premium for a detergent product, even when the product was improved noticeably, the high cost of the enzyme was discouraging.
Thirdly the properties of the enzymes. The proteolytic enzymes had their maximum effect in the pH range of 6-8, whereas the detergent solution usually had a pH between 9 and 10. Furthermore, many of the proteolytic enzymes were at least partly inhibited by many of the surface-active agents in the detergent and by builders, which are substances that increase the cleansing action, such as sodium triphosphate. Moreover it was believed that the proteolytic enzymes could only work sufficiently when the contact time was long enough, several hours at least and, of course, the temperature did not exceed 50°C. And when, finally, one thought of adding enzymes to a heavy-duty detergent containing sodium perborate (the most common detergent product in Europe), the problem of incompatibility seemed almost insurmountable.
All this implied that the enzymes could only be used in soakers, a market which was steadily declining and of no interest to the large detergent manufacturers.
Fourthly the appearance and smell of the enzymes. Ten years ago, the enzymes were of a brown to darkbrown colour and had an awful smell. Not an ingredient which one would add readily to a product with the strong connotations of making soiled fabrics clean, white and pleasant-smelling.
I don't know which one of these reasons was the most important. In fact, it is easy to list a number of reasons why something has happened or not after the event has taken place. The combination of the reasons I have mentioned is powerful enough to explain the situation in the early sixties. I believe that it was the selling-drive of an enzyme producer (Novo Industries in Copenhagen) combined with the daring entrepeneurship of a small company (Kortman & Schulte, Rotterdam) that brought about the break-through. There still existed a fairly extensive soaker-market in the Netherlands, and Kortman & Schulte were right in it; the housewives, even the Dutch ones, were prepared to pay a premium for a detergent product with an exceptional performance. The outcome was astonishing, even to the initiators I suppose. Selling about 1700 tons of Biotex, a detergent soaker, in 1964, Kortman & Schulte succeeded in selling more than 10,000 tons of Biotex in 1966: an outstanding achievement.
It became the biggest single detergent brand sold in the Netherlands in 1966, including the heavy-duty detergents. The counter-offensive of the leading detergent manufacturers in the Netherlands, who were taken aback by the phenomal success of Biotex and who launched enzymatic soakers in 1965 and 1966, wasn't very successful. Biotex was very firmly established. The performance of the product must have enthused the housewives to a considerable extent. The use of Biotex for all sorts of cleaning jobs was widely advocated by individuals, even for those jobs where one would certainly say: What has the enzyme to do with it? The large detergent manufacturers learnt their lesson, albeit a bit late. The most important lesson was: the consumer is prepared to pay a premium for a detergent product which performs significantly better than those on the market. The second lesson was: the soaking habit can be revived when a good performance cannot be achieved otherwise.
Ever since, the enzyme detergent battle has been waging on an international front and by the international detergent companies. A most fascinating development, in itself, and for the major producers of proteolytic enzymes!

The introduction of an enzymatic heavy-duty detergent

The scene is set. The enzymatic detergent soaker is firmly entrenched in one country and is spreading to neighbouring countries. The next, and obvious step, is the development and introduction of the enzymatic heavy-duty detergent. This product should combine tha advantages of the proteolytic enzyme in a soaker with the robust action of the perborate-containing heavy-duty detergent. In the meantime much had happened. The

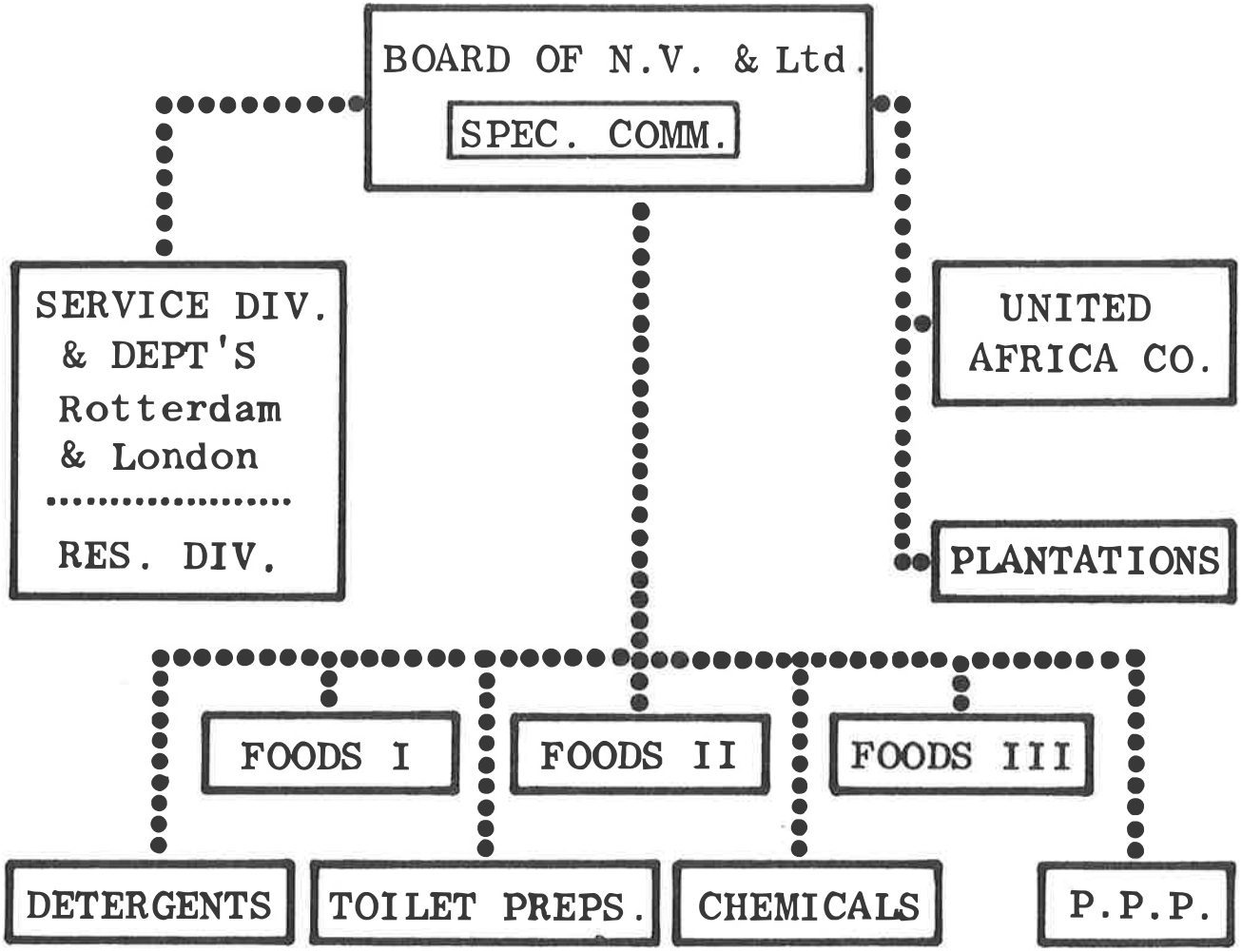
price of the proteolytic enzymes had gone down considerably. This is clearly shown in figure 7. The index of 100 is set for the average price of proteolytic enzymes at a certain enzymatic activity in 1966. As you may expect, the production of enzymes in tons per year has gone substantially. Figure 8 does not leave any doubts. The index of 100 is again set at 1966.
Not only had the price gone down and the production gone up, the quality had improved significantly too. Colour and smell had improved, stability against pH and detergent ingredients had become better.
Unilever installed the project team, mentioned earlier, to introduce an enzymatic heavy-duty detergent containing perborate. Their terms of reference were, in short, to introduce such a product as soon as possible on a test market in a certain country. There is no need to specify that country; the same would hold for quite a number of countries. Moreover, for this talk it is the general which is interesting and not the particular.
Now I must refer to figure 6 again, and let us take each of the listed items in succession.
In Research meanwhile, it had been shown that by suitable measures it is possible to protect enzymes against the usual detergent ingredients, amongst them sodium perborate, and that certain commercially available enzymes are not inactivated by conditions prevailing in ordinary washing conditions. Enzyme levels had been established, as well as time and temperature effects. The results had to be confirmed by more extensive tests under the conditions prevailing in the nominated country, a task to be performed by the Factory Development Unit. The market had to be surveyed; the new product not only had to suit the combination of consumer, type and frequency of stain, textile, washing machine, but also had to be positioned against any competitive or potentially competitive product on the market. In general, the question had to be answered: what are the chances of the new product?
The consumer test was scheduled to test the technical performance of the new product on laboratory scale against the judgment of the consumer on the performance of that product under practical conditions. A most important test which brought out the fine points, not only for the major effects, but also for the secondary product attributes.
And here we arrive at the attributes of the new product. In this case it not only had to be more efficient in removing proteinaceous soil, it also had to have the correct lathering level, it had to retain at least the general level of detergency, and it had to have the right bulk density, free-flowiness, appearance, the right perfume, etc. Moreover, it had to be clearly distinguishable from the ordinary products on the market.
Advertising came in at an early stage as well. The message of newness, improved performance, had to be conveyed effectively to the consumer. The only secure base is technical performance and the advertising agency had to have enough advance information to word and visualize the message with the introduction of the new product. The information from the market survey and the consumer tests determined the product attributes, and therefore the formulation of the product. The surfactants had to be chosen to suit lather height and overall detergency, taking into account compatibility with enzymes. The same applied to the other detergent ingredients, builders, fluorescers, and perfume.
Raw materials are always important. The team had to look into the availability, cost and quality of all necessary raw materials. The major issue, of course, was presented by the enzymes. The team had to contact the suppliers and potential suppliers in order to obtain an as precise as possible picture of the future. Especially in a rapidly changing situation, as was the case with the proteolytic enzymes for several years (see figures 7 and 8), a correct estimation is invaluable. Not only the pricing of the new detergent product depended upon it, but also the timely action to secure sufficient quantities of raw material. Quality specifications had to be laid down; not an easy matter with a new raw material.
As regards production of the new product, the project team, and here the representative of the Factory Development Unit plays an important rôle, had to ascertain that at the time of introducing the product in the test market, sufficient quantities could be produced in the factory. They also had to ensure that the production capacity was large enough to be able to cope with a national introduction in case of success in the test market.

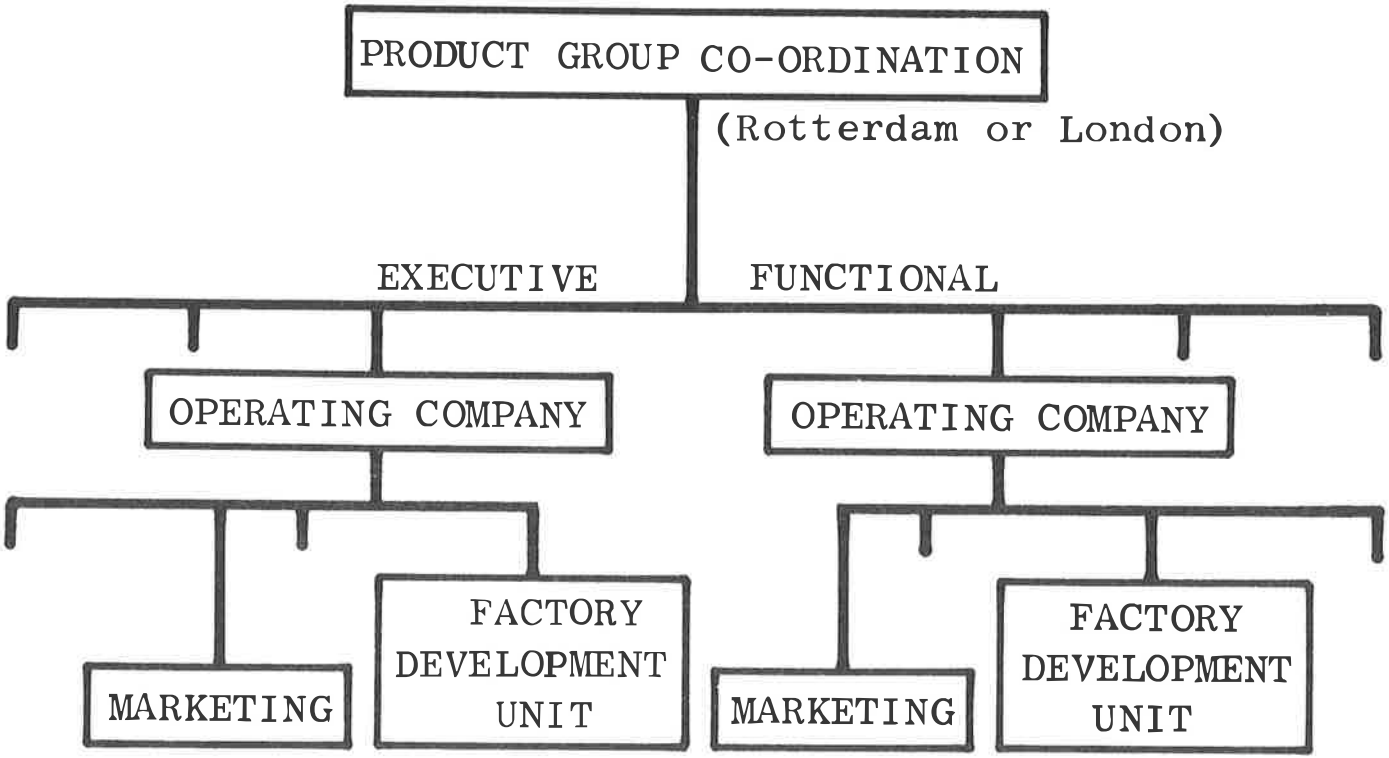
Research had come up with a new process to protect the proteolytic enzymes against attack by the other detergent ingredients. This had been proved by extensive experiments involving long-terms storage tests at various climatic conditions. The safe-handling of the enzymes required very special attention. The orders for new plant and equipment had to go out well in time to meet production demands later on. Packaging is not only important to attract the eye of the consumer, it also has a protective function. The former needs no further explanation, although it needed close attention by the Marketing member of the the team. The protective function required a detailed study by the technical members, because the enzymes in detergents are inactivated by high relative humidities.
The costing is very important; it determines the price of the new product, and was continuously in the minds of the team members. The formulation, the choice and level of raw materials, the production process, the packaging were decided upon in view of the costs.
The patent situation had to be checked with Patents Department. The project team was, of course, well informed about all Unilever patents in this area. They had, however, to ensure that Unilever would not infringe the patents of others.
Safety-clearance is a much more difficult issue. Whenever a Unilever company wants to introduce a new product, or to improve an existing product by adding new ingredients in the area of consumer goods, whether a foods product, a cosmetic article or a detergent, it has to have the approval of the Head of Research Division. He has, ultimately, to decide whether the new product will not represent any form of unusual hazard to the user. In the case of new ingredients, which have not been used on a large scale before, extensive biological testing is necessary. The fact that our products are used by so many millions of people requires us to carry this special responsibilty. This, of course, applies to any large-scale manufacturer of similar consumer goods. Coming back to the enzymatic heavy-duty detergent, the project team had the responsibility to request for the clearance of their product. They, therefore, had to initiate the contact with the specialists in the area of biological safety within Unilever, to provide samples and to wait for the outcome of the tests.
Finally the stage of the test market was reached. The Marketing member of the team became predominant and conducted the forces to win the decisive battle. In this case they were successful; you may have noticed that yourself!

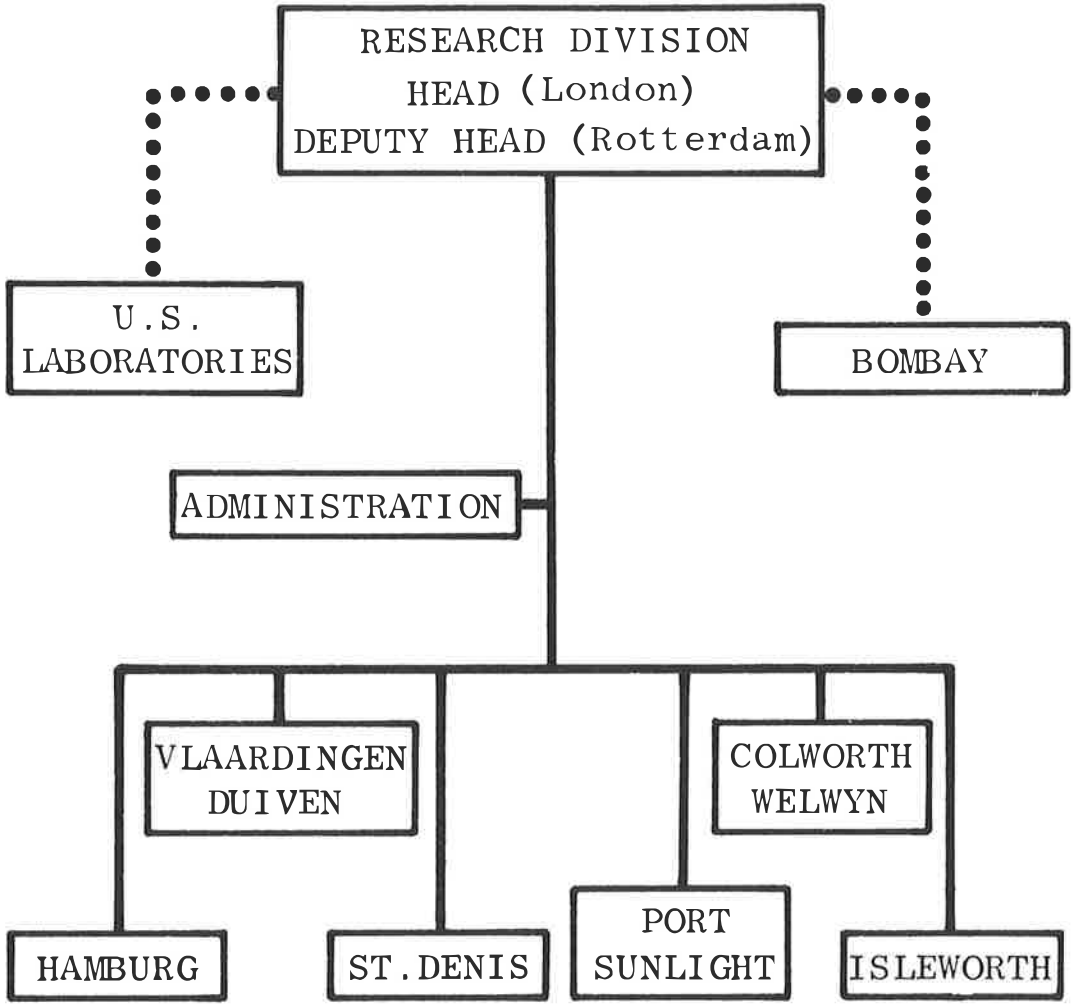
Conclusion

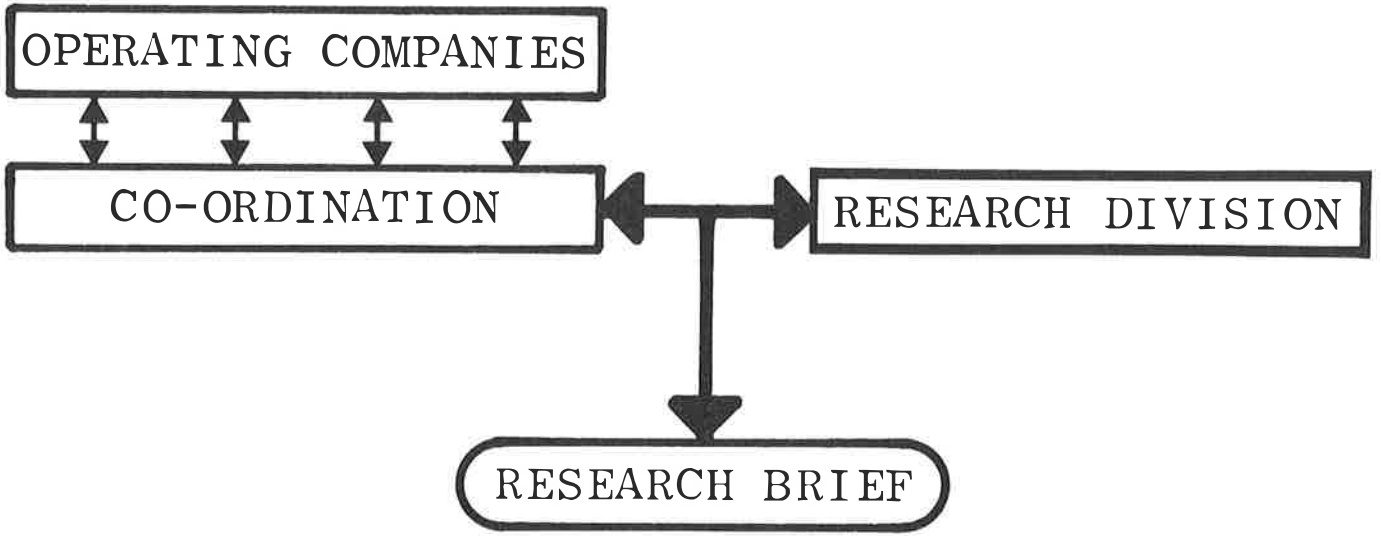
I have described how we, in Unilever, dealt with the problem of interplay between Research, Development and Marketing in a particular case. The result has been very encouraging. The method which we applied was a good one, but more importantly the people involved were of the right quality and possessed the required mentality. I should like to emphasize the latter; I know it is a platitude but still very true: Whatever the organization, it is the right people on the right spot which matters.

Finally I cannot resist the temptation to remark that with the introduction of proteolytic enzymes in detergent products, Europe was ahead of the United States. But have we exploited all opportunities?

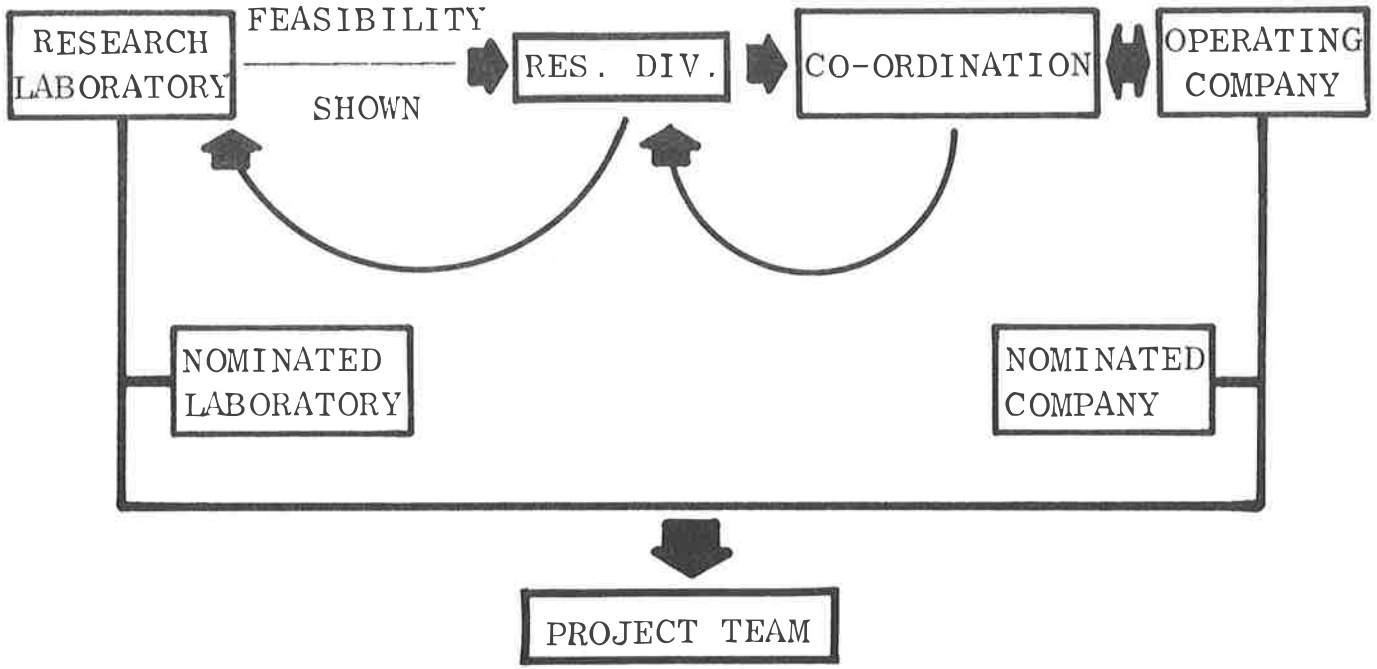

BOARD OF N.V. & Ltd.
SPEC. COMM.
SERVICE DIV. & DEPT'S Rotterdam & London
RES. DIV.
UNITED AFRICA CO.
PLANTATIONS
FOODS I
FOODS II
FOODS III
DETERGENTS
TOILET PREPS.
CHEMICALS
P.P.P.


PRODUCT GROUP CO-ORDINATION
(Rotterdam or London)
EXECUTIVE
FUNCTIONAL
OPERATING COMPANY
OPERATING COMPANY
MARKETING
FACTORY DEVELOPMENT UNIT
MARKETING
FACTORY DEVELOPMENT UNIT


RESEARCH DIVISION
HEAD (London)
DEPUTY HEAD (Rotterdam)
U.S.
LABORATORIES
BOMBAY
ADMINISTRATION
VLAARDINGEN
DUIVEN
COLWORTH
WELWYN
HAMBURG
ST. DENIS
PORT
SUNLIGHT
ISLEWORTH



CONCERN OBJECTIVES
PRODUCT PROPERTIES
VALUE
GEOGRAPHICAL AREAS - COUNTRIES


RESEARCH LABORATORY
FEASIBILITY
SHOWN
RES. DIV.
CO-ORDINATION
OPERATING COMPANY
NOMINATED LABORATORY
NOMINATED COMPANY
PROJECT TEAM

PROJECT TEAM

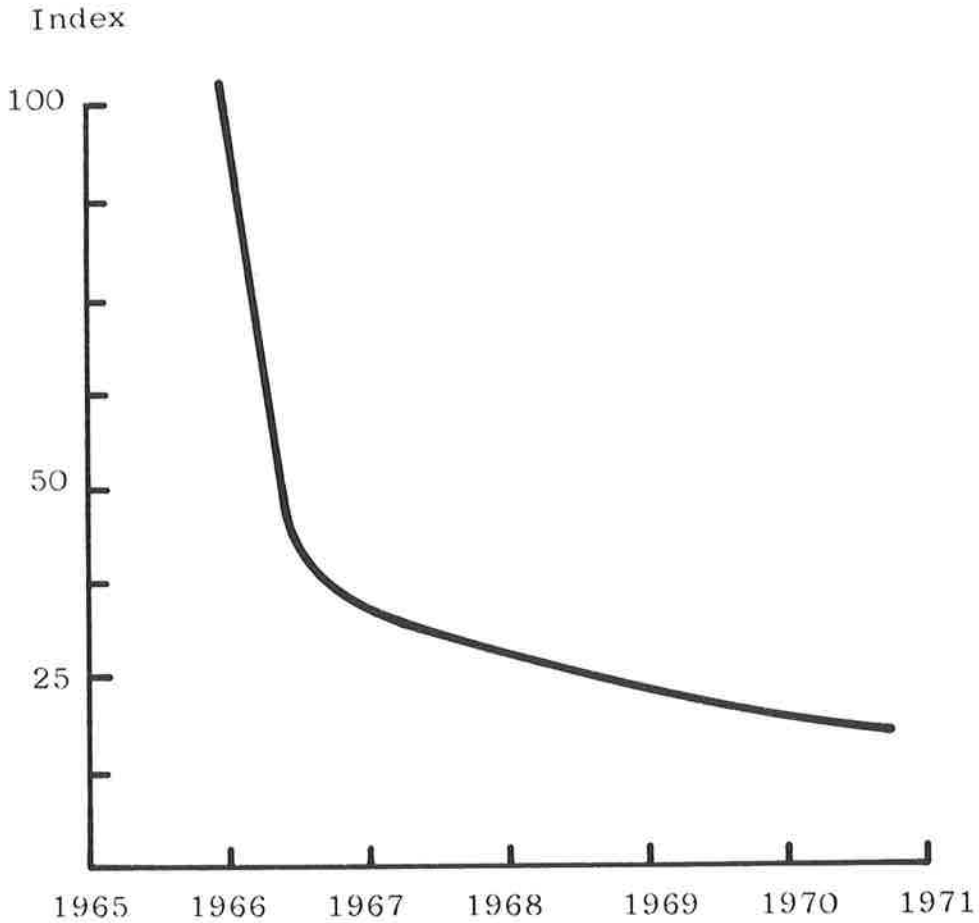
TERMS OF REFERENCE

(BY CO-ORDINATION AND RESEARCH DIVISION)

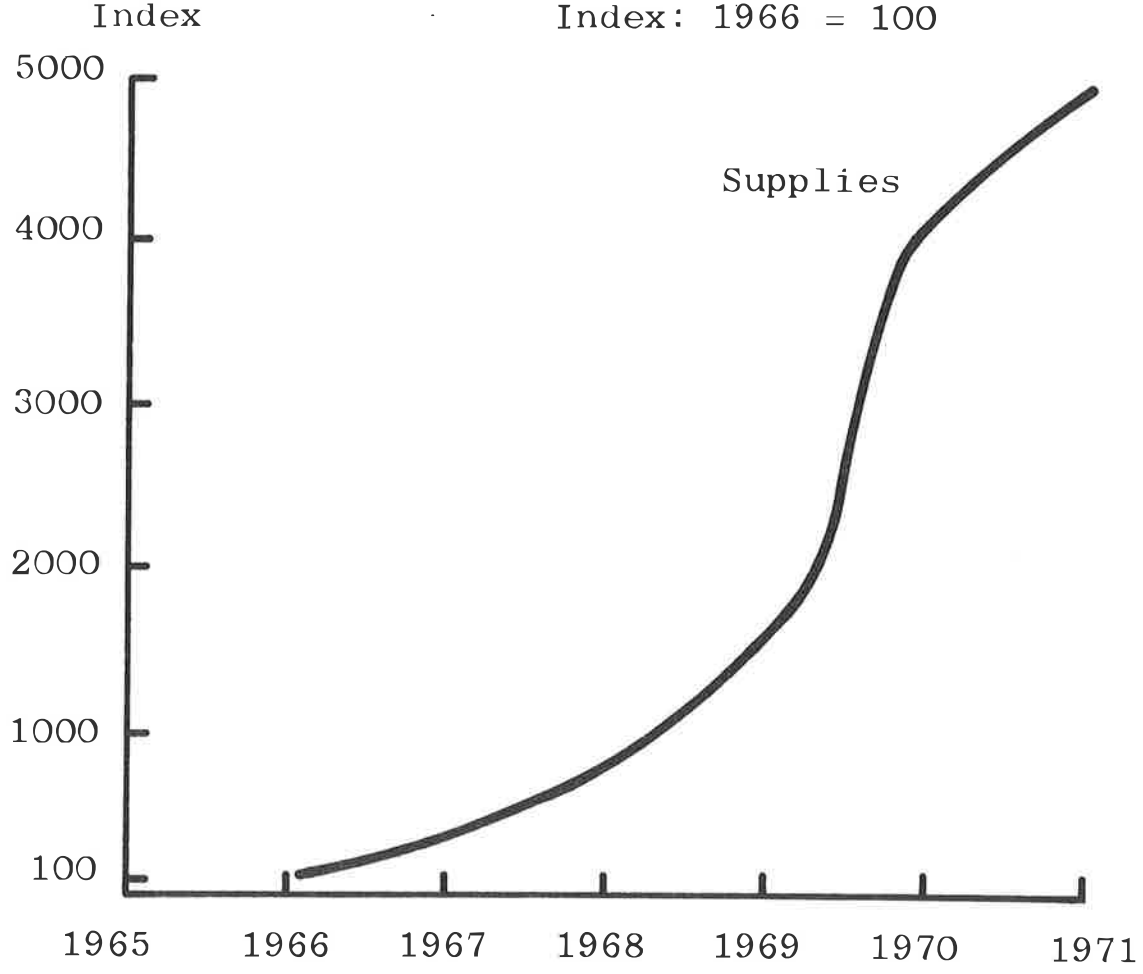
RESPONSIBILITIES

- CONFIRMANCE OF TECHNICAL FEASIBILITY
- MARKET SURVEY
- CONSUMER TESTING
- PRODUCT ATTRIBUTES
- ADVERTISING
- FORMULATION
- RAW MATERIALS
- PRODUCTION (PLANT)
- PACKAGING
- COSTING
- PATENTS
- SAFETY CLEARANCE
- TEST MARKET

Movement in price of proteolytic enzymes
for detergents
Index: 1966 = 100



Supply of proteolytic enzymes for detergents



The Multiple Applications of Thiabendazole
A Study of Marketing and R & D Interaction

R. G. Valerio
Vice President, Marketing
Merck, Sharp & Dohme International
New York
U. S. A.

I greatly appreciate this opportunity to be with you and to share in your exchange of views about the interrelationship between marketing and research. My impression is that - when international marketing and research are involved - one comes to Holland more to learn than to contribute.

My experience in marketing, and earlier in research, has been limited to one industry: the pharmaceutical industry. Our approach to competition is primarily through innovation, but obviously this is true for many industries that draw upon modern technology. Like other innovative industries, we try to anticipate the needs of the market, create new products that hopefully fill these needs, introduce them by explaining their merits and then await the verdict of the marketplace.

In some other aspects, however, the marketing of modern prescription medicines differs fundamentally from the marketing of other types of manufactured products. I'll mention only two ways. In the first place, the customer for our products - the patient - is seldom directly involved in their selection. The choice of product is delegated to a disinterested third party, the physician. This creates an atypical marketing situation. Adding to the abnormality, a drug manufacturer - unlike his counterpart in virtually every other industry - has both the moral and legal obligation to discuss in detail the shortcomings of his products, since health is at stake.

Because the marketing of prescription medicines differs so fundamentally from the selling patterns of most innovative industries, I've turned to another aspect of my company's business to find a more analogous field. I thought I would focus on the exchange between marketing and research in the development of a veterinary product group. With veterinary and animal-feed products, the research work is very similar and often identical to that involved in the creation of a prescription drug. In their marketing, however, the situation is entirely different and the straightforward economics of return on investment is all important.

The class of products whose evolution and current status I would like to discuss is the thiabendazole family. Thiabendazole is a compound with the capability of killing certain roundworm parasites, many of which are quite important to human and animal health and farm economics. It is a discovery of the Merck research organization. To place our discussion in context, let me first review briefly the history of Merck's involvement in research in the human and animal health fields, and the indirect route that led us to thiabendazole.

The commitment of the American pharmaceutical industry to research, as you know, is not one of particularly long standing. The tradition is far older in Europe. Though World War I gave the initial stimulus for such research, it was only in the decade before the second World War that a handful of leading American drug companies - Merck was one - began to take a really critical look at themselves in the context of the rapidly evolving new era of scientific medicine. Foreseeing rapid change with the escalating store of knowledge, they recognized research as their opportunity. So, with stars in their eyes and butterflies in their stomachs, they timidly began their courtship of scientific research, hitherto the province of the academic world.

When I mention Merck, I shall be referring - of course - to the American-based company with which I am affiliated. By the end of World War I, this company had become

completely independent of the German company of the same name. It was only in the mid-50's, with the merger between Merck & Co., Inc. and Sharp & Dohme, that MSD came into being.

Merck's entry into the field of research was through the route of the nutritional field by way of vitamins. Company chemists contributed importantly to the commercial development of vitamin B_1. This accomplishment, in 1936, made possible its broad use in human nutrition and later in animal nutrition Two years later, the company introduced niacin, the cure for pellagra and recognized by some as necessary for optimum nutrition of poultry and swine. Merck also devised the first commercial synthesis of riboflavin and introduced it for human and animal nutrition. In 1940, Merck chemists synthesized calcium pantothenate. The war years placed greater emphasis on questions of nutrition as America strove to supply its allies and all of these vitamins found a place in animal feeds, improving feed efficiency and producing more meat with less feed in a shorter time.

Building on this experience, Merck chemists and biologists pursued a more elusive target, the anti-anemia factor found in liver and later termed vitamin B_{12}. This vitamin, when it was isolated and produced in pure crystalline form in 1947, showed two properties of great value. First, it was life-saving for humans with pernicious anemia. But, it also possessed the so-called "animal protein factor" - APF - an essential in the diet of swine and poultry for their reproduction and growth.

While research was under way on vitamin B_{12}, biologists began to measure a growth response that went well beyond anything that could be accounted for by the vitamin itself. This was traced to antibiotic residues in the fermentation broth used to produce the vitamin. Thereafter, it became common practice to combine vitamins and antibiotics in feed supplements to speed the growth of poultry and swine. From this experience we had - through hard work - begun to develop an understanding of the feed manufacturing industry and animal husbandry practices in the United States in raising poultry and swine. We could comprehend their problems, and the opportunities for improvement.

Since Merck scientists are gentlemen, I think they would acknowledge that - with the "growth factor" and on several other important occasions - Lady Luck has smiled in their direction. The trick, of course, is to recognize a smile when you see one, and to be prepared psychologically to accept the invitation. We have learned - and, curiously, it does require some experience - to welcome serendipidy with open arms.

As with feed additives, good fortune played a role in initiating Merck's large-scale involvement in anti-parasitic compounds. While everything that we did seems logical in retrospect, the imperatives that first pushed us in this direction were as much strategic and political as scientific.

During World War II, the Japanese gained control of the traditional sources of quinine. The Allies, with their heavy troop commitment in the tropics, placed a high priority on finding a substitute for quinine as an anti-malarial agent.

Merck, which had created several medically important sulfa drugs, had high hopes for a member of this family, sulfaquinoxaline. In tests, the compound proved to be a potent anti-malarial agent. But its therapeutic index - the balance between benefits and risks in its use - was not high enough to permit its use as a human drug. It did, however, inhibit another type of parasite as well: coccidia. But how important was coccidiosis?

In economic terms, coccidiosis was highly important. To the poultry grower, the disease was a major barrier standing in the way of establishing a large-scale economic broiler industry. A severe outbreak of coccidiosis in a broiler flock could kill as high as 20% of infected birds and leave the remainder in unthrifty health. The control of this devastating disease permitted raising birds in very close quarters, with better management and feed efficiency. The number of pounds of feed needed to produce one pound

of broiler has fallen dramatically from more than four pounds to less than two pounds. With this decrease, the cost of production has fallen proportionately, with ultimately lower prices for poultry.

Today, with coccidiosis largely controlled, the annual sales of the broiler industry surpass 2.5 billion birds in the United States alone. Broiler raising obviously has become a major industry in many countries, including Holland. In this country, the estimated number of broilers raised increased from 34 million in 1960 to 177 million in 1967, and is well in excess of 250 million today.

The broiler industry - as an industry - only became possible through an agrieconomic chain. Other contributing factors were poultry genetics, which improved the quality of birds, research in nutrition that bettered the quality of feed, and mechanical improvements in feeders, waterers and ventilation systems, as well as improved storage and transportation methods.

All steps in the chain were encouraged by the emergence of effective coccidiostats - such as 'S.Q.', as sulfaquinoxaline was called. Such medication enabled the grower to reduce to less than two per cent the mortality within his flock attributed to coccidiosis. At this level, the concept of the broiler industry - which today permits a single farm to grow as many as one million birds at a time - became feasible. Our company's experience as a supplier of vitamins and nutrients to the feed business enabled us to move expeditiously into the coccidiostat field. We knew what was needed in the way of formulations to properly mix and equally distribute drugs at levels as low as .01% in tons of feed, as well as what was needed in the way of drinking water formulations. We recognized and responded to the need for technical services to diagnose the disease rapidly, before it could get out of control.

'S.O.' was a major contribution to the poultry industry. But it wasn't the final answer to coccidiosis. The little coccidia have a very unfortunate trait of developing tolerance to drugs used to eradicate them. Our research and marketing people recognized this and continued the search for better products.

The next product in our series was 'NiCarb', a highly effective agent against coccidia, but one that left room for improvement in its adaptability to feed-mill technology at the time, since it was not recommended for feeds used for egg-laying hens. 'NiCarb' was followed by 'Glycamide' which, incidentally was tested on more than two million broilers on company farms before its introduction. For all of its initial promise, certain strains of coccidia developed resistance to 'Glycamide' rapidly, thereby challenging laboratories to create a more effective anti-coccidial agent.

By this time a tremendous amount of research had been done on the life cycle of coccidia and their nutritional and reproductive needs. The best hope for an improved coccidiostat, from a research point of view, seemed to lie in an antimetabolite. This would be a compound that chemically would deprive a parasite of something essential in its nutritive process, in the manner that sulfonamides were known to block a vital process in bacteria. In the search for a better coccidiostat, the company's pioneering work with sulfas provided important insights.

The compound which emerged, 'Amprol', bears a chemical resemblance to vitamin B_1. Coccidia do not seem to distinguish between the drug and the essential vitamin, and - as a consequence - are literally starved. Once this research route was determined, synthetic chemists created what seemed endless variations to achieve the compound that best met scientific requirements for strength and absence of toxicity as well as handling ease and production costs. I might mention that 'Amprol' was tested in the laboratory against 44 strains of seven different species of coccidia infecting chickens. Learning from our broad experience with the variable nature of this disease under different climatic conditions and with different strains of poultry, we also subjected the compound to field tests in the major broilerproducing areas of the United States. This was to assure that the product measured up to the challenge before we went to market.

The company's work in this area, incidentally, received some unwelcome attention. Some of our research records were stolen, our first experience of this sort. The episode evolved into a major case of theft of trade secrets when Merck discovered that not only was someone else reporting its findings at a scientific meeting but also applying for patents on the basis of the stolen information. Scientists who had done the original work for Merck had the unreal experience of sitting in courtrooms and hearing their work described by others as something they had done. The evidence of theft was conclusive, however, and courts in both the United States and Switzerland supported Merck. Because the stakes were high and the trial was well hidden and the details of the story were highly dramatic, the case attracted considerable attention, with articles in the newspapers and in several major magazines.

At this point, it may be well to place in some perspective the interdependence in the relationship between research and marketing. Initial research breakthrough on the vitamins, coupled with nutritional knowledge developed largely in academic institutions, gave marketing insights into needs that had to be filled. Marketing rapidly learned how best to distribute products and to sell their merits in terms of profits to such buyers as feed manufacturers, poultry raisers, and farmers with large herds of swine. As it made its way in these fields, the marketing force -- in turn -- became more aware of the differences in animal husbandry practices -- the nuances that caused practices in the field to differ from the theories and small-scale experiments of the laboratory. Marketing was soon providing research with the specific needs of the marketplace, and giving priorities in terms of potential sales. It became an important part of marketing's function to characterize an ideal product in terms of such properties as physical characteristics and performance standards. In other words, marketing detailed specific targets for applied research in the laboratories.

Paralleling their work to develop more effective coccidiostats, company scientists were pursuing, as another major target, a better agent against another type of parasite. This was a group of roundworms, especially important from an economic point of view -- the gastrointestinal parasites called helminths. I shall mention but one country -- and the problem is international: in the early 1960s, these parasites cost farmers in the United States alone an estimated $250 million annually in economic losses.

With its knowledge of the economics of the swine and poultry industries, the company set as its target an improved anthelmintic primarily for swine. Again, good fortune was at the company's elbow.

The compound created, thiabendazole, first proved its usefulness against roundworms in sheep and goats, neither of which would offer a market in the United States comparable to the swine market. But, fortunately, by the mid-50s our company had begun to expand its involvement in international markets. In countries such as New Zealand and Australia sheep raising is important to the point of being vital to their national economies, and the company recognized the opportunity this offered. New Zealand, for example, had 50 million sheep and an annual wool clip of more than 60 million pounds. It was with an eye to the major overseas markets that Merck launched thiabendazole - or 'Thibenzole', as the sheep and goat formulation was called. Events soon demonstrated that the company's first hopes for this product, while high, were under-estimated. 'Thibenzole' was a much-needed product - one that performed even more effectively under actual field conditions than under controlled research conditions.

Thiabendazole has since proved its utility in other animals. It also has demonstrated its use in man, a variation on the more familiar theme of first in humans and then in animals. Currently, thiabendazole is finding another use in agriculture as a fungicide. The broadening of the usefulness of thiabendazole has come about because of a highly efficient cross-feed between research and marketing. This is the interchange I would like to explore with you. To appreciate the interaction, however, we must first look briefly at the workings of the research laboratories and what is involved in the creation of a new animal health product.

No pharmaceutical industry laboratory could be described as "typical". Each has a distinctive character. But the Merck laboratories in some ways are unique, even in an industry in which all major companies look to research for a competitive edge.

Currently, about 1,000 technically-educated men and women - trained in some four dozen different scientific disciplines - are engaged in a number of coordinated projects. They are aided by almost 1,000 more technicians and service personnel. The total company investment in this research now exceeds $60 million annually. The scope of the effort, to a large degree, reflects the competence of the laboratories to undertake broad-scale research, since funds are allocated carefully after expert review. Competence, in turn, is the sum of experience and ability in an institution where repeated scientific accomplishment has attracted and held a high level of scientific talent.

Obviously - speaking in the most general of terms - ideas for new veterinary products come from one of two prime sources. When veterinarians or growers experience a real need, this if fed back through the company's marketing axis, and we now maintain field representatives in some 30 countries. Alternatively, the scientists themselves - in broadening their knowlegde - construct theories that suggest the possibility of better medicines or nutritional agents. These hypotheses are pursued with enthusiasm.

It seems highly likely that someday, with increased knowledge of the correlation between molecular configuration and biological activity, we will be able to design tailor-made medicines. That day, for most of our needs - both human and animal - is probably far in the future. But we are making progress. Last year's first synthesis of an enzyme, achieved independently at Rockefeller University and by a team in our own laboratories, opens up remarkable possibilities.

In today's laboratory, much is accomplished by a far more empirical method. Once a compound with a potentially useful activity is found - whether rationally or by accident - synthetic chemists begin to produce a great number of analogous compounds and to screen them to find the most promising candidates. A good screen must be specific, significant and have a high "through-put" capacity. Such screens are operated by experts in the company's major fields of research activity.

The challenge is to find the compound of the series with the best ratio of efficacy to toxicity or other unwanted side effects. With veterinary compounds, the testing would also include an initial investigation of how the agent is metabolized since tissue residues are a problem in animals raised for human consumption.

When the veterinarian, chemist and biologist are convinced that a compound with important activity has been found, they request management to begin the development process that transforms an invention from a laboratory curiosity to a commercial product.

This development process is complicated because it requires effective teamwork among many groups, some of which - in all probability - will be working simultaneously on other important projects.

In the case of a new veterinary product, these are some of the things that must be done. Material for clinical and field testing must be synthesized. Efficacy and safety must be established in the intended species in carefully controlled laboratory experiments and pen trials, and eventually under field conditions, since variations in field conditions can result in major variations in the results.

The metabolism of the agent must be worked out fully, and the metabolic residues in edible tissues identified. Practical and analytical procedures must be devised that will permit the determination of the drug in tissues and feeds with a sensitivity of fractional parts per million.

The general toxicity of the substance in laboratory animals must be determined, not

only at dosage levels but also in amounts far in excess of those that will be used in the field since human error in mixing feeds is always a possibility. Stable formulations must be developed, often in the face of complex problems of compatibility or solubility. Also, a chemical process must be developed for large-scale production, and this frequently is a difficult challenge. Finally, patent protection must be secured.

I am sure this brief description is not new to you. I have reviewed it only to make the point that there are innumerable turns on the developmental trach at which a promising candidate can plunge off the rails and into oblivion. In our own laboratories, from about 20,000 compounds entering the screens, only about ten emerge as product candidates. Of these, only one - on an average - emerges finally as a useful product. Then begins another complex chapter of obtaining governmental approval to market, creating literature and planning all that must be done in marketing area to introduce the new product to the eventual user and demonstrate its advantage in terms of agrieconomics - money returned for money invested.

Thiabendazole - the active ingredient in the product group that we will look at in some detail - was an example of a "need" generating a "search". In the mid-1950s, a company research veterinarian argued persuasively that there was a great need for a better agent to control roundworm infestation in farm animals. As a consequence, a screening program was established for roundworms, helminths. From some 5,000 candidates put into the screen, one emerged as having particularly interesting characteristics. Several hundred analogues of this compound were synthesized, and these were tested carefully against helminths. It was from this program, representing five years of work, that thiabendazole emerged.

When we embarked upon the search that led to thiabendazole, Merck was essentially an American company with few facilities abroad. Thiabendazole has helped Merck change in the direction of becoming more internationally oriented. This must seem surprising in Holland, which has always tended to regard the world as its market. But the magnet for our efforts, until very recent years, was primarily the large and readily available United States market, with less consideration than we might have paid to the different needs and different opportunities of other nations. There were many reasons for this, the first being that a rapidly growing company services its immediate market first. But today, we are coming to recognize and really to understand the opportunities that the world offers. For us, the thiabendazole products have been an education in international marketing.

By spring of 1961, the company was ready to announce its new wormer to the press, and to say that field tests were under way in Australia, New Zealand and South Africa, as well as the United States. The results of these tests, when extrapolated from scientific language into marketing terms, were highly encouraging. The compound was removing about 95 per cent of 13 species of roundworms in sheep.

In August 1961, the company broke ground for a manufacturing facility for thiabendazole, thereby committing itself to the compound as a product. Limited distribution began in New Zealand early the following year. It is now manufactured in the United States, the United Kingdom, Holland, Argentina and Australia.

For 'Thibenzole' to succeed in a competitive market, we needed more than scientific evidence that the agent was an effective wormer. We had to be able to demonstrate to the farmer that buying 'Thibenzole' was not an expense but an investment. First, we had to be able to show that it would put money into his pocket. Also, we had to prove it would work in fields like his, under like weather conditions, with the same types of sheep or goats as he had on his farm.

To answer the farmer's questions and our own, we turned to the demonstration and experimental farm. Our first farms of this type, outside of the United States, were in the great sheep-raising countries: New Zealand, Australia and the Union of South Africa. Here, under conditions in every way comparable to those of local farming, we demon-

strated what 'Thibenzole' would do. At the same time, we also installed scientific facilities to expand our knowledge about regional variations in parasite control.

To give but one example, through careful studies on our New Zealand demonstration farm we were able to show the New Zealand farmer what thiabendazole could mean to him in terms of return on his investment. The fragility of wool is a measurable quantity, and this decreased 47.1 per cent in treated animals. The so-called "wool style" is a second factor affecting wool quality, and this increased 41 per cent in treated animals. Both factors affect wool price. Moreover, the quantity of wool per sheep increased 29.5 per cent.

For the sheep farmer, weight gain is also important. The studies showed that treated animals gained an average of 12.1 pounds - or 52.5 per cent - more than the untreated controls. With such studies, we could document a return of better than 400 per cent on the original investment in drenching programs.

As the market grew for 'Thibenzole' as a sheep wormer, we intensified our studies as to its uses in a number of other animals, including horses, cattle and swine. With horses, our market research in the United States turned up a curious fact. While Department of Agriculture estimates placed the national horse population at about 3 million, our studies showed that there were more than twice this number. This counting system had gone wrong because it considered horses as primarily farm animals, rather than as recreational animals. We also found that veterinarians saw only a relative few horses. From this increased knowledge of the horse market grew an entire line of horse-care products, intended for the owner's use. These include a thiabendazole-based wormer, 'Equizole', as well as a vitamin-mineral conditioner, a shampoo, a hoof dressing, an insect repellent and a liniment.

With sheep, the economic blessings of 'Thibenzole' were readily demonstrable in the quantity and quality of meat and wool. With horses, the cost-profit ratio was not an important factor. Return on investment was pivotal, however, as we moved to cattle and swine. With cattle, it was broadly acknowledged that thiabendazole was effective, but it required relatively high doses in terms of an animal's body weight. It was thus relatively expensive, considerably more so than competitive but less efficacious products.

The challenge with both meat and dairy cattle, therefore, was to prove economic gain through better performance when compared with that of less costly products. For this purpose, studies that show increased weight gain of beef cattle and faster development of dairy cattle - translated in terms of income for the farmer - gave us the type of persuasive evidence we needed for entry into the field.

With swine - the original target of research - thiabendazole is a highly effective wormer against a number of important helminths, but it is not the best agent against one dramatic worm, ascarid. Here, a combination product was indicated and is on the market.

In developing additional veterinary uses of thiabendazole, our demonstration farms have been a major asset. In addition to the farms I mentioned previously, we now have farms in England and here, in Holland, at Nieuwer-Amstel. Their purpose is to show the farmer how he can reduce his cost and increase his protein yields using our veterinary products, with methods that conform to local agricultural practices.

I doubt whether anyone could construct an accurate picture of the potential world anthelmintic market. The starting point would have to be the world population of cattle and sheep, which is estimated at approximately 812.9 million cattle and 762.3 million sheep.

While not all animals are infected, the parasite-free animal is the rarity. In the United States, with its largely temperate climate, studies have shown that - on the average -

8 out of 10 healthy looking dairy cows carry roundworms. Obviously, on a world basis, economic considerations severely limit the potential market to something much smaller than the number of infected animals. My purpose in mentioning these figures was merely to point out that - if even only a small percentage of the animal population is reached - a high potential exists for products of this sort. In many world areas, more sophisticated grower have now learned that even mild infestation is costly and are continually monitoring their flocks and herds and treating regularly to prevent economic losses from helminthiasis.

I have not, incidentally, mentioned the more esoteric uses of thiabendazole. About every imaginable big animal in zoos or game perserves has had it. It has even been given to whales in the New York aquarium. It is of interest to sportsmen, since it controls gapeworms that kill pheasants and turkeys, and it helps check helminthiasis in deer population

Since man is also subject to roundworm infestations, thiabendazole also has found human applications as a prescription drug under the trademark 'Mintezole'. Moreover, it has been found effective as well in a rather rare subcutaneous infestation of larvae migrans, known as "creeping eruption", and holds good promise in treating human cases of trichinosis.

Thiabendazole is extraordinary in another sense - the breadth of its activity and potential applications. Recalling again the empirical screening programs mentioned earlier, in collaborative efforts with other laboratories, it was discovered that thiabendazole also possessed significant anti-fungal activity. Thiabendazole's uses as a fungicide in industrial and agricultural applications are just beginning to reach commercialization - but I would like to mention how a highly unusual veterinary use came to fruition through a close collaboration on the part of marketing and research.

On the rolling farms of New Zealand, a disease of sheep and cattle called facial eczema until recently posed a major problem for farmers. The disease results when a grazing animal ingests spores of a particular fungus from the fields. Toxin from the spores photosensitizes a certain percentage of the animals, resulting in a skin condition. But more important, the toxin attacks the liver, resulting in a high mortality in heavily infected areas. Thiabendazole, sprayed on the pastures, controls the fungus and checks the disease.

The antifungal activity was discovered in the early 1960s. But its significance was not immediately apparent, since the scope of the original outside screen was limited. As MSD scientists began to look at the compound more closely, however, they found it had great activity against a dozen important fungi. The challenge became one of finding areas where the harm caused by these particular fungi was economically important. In short, Merck had an answer in search of economic problems.

Market research moved to the center of the stage. While thiabendazole was highly effective against certain fungi, it was also relatively expensive in comparision with the well-known mercurials and carbamates ordinarily used as fungicides. So it obviously was more suited to be a specialty product than a broad-purpose fungicide.

If price was a disadvantage, thiabendazole had to its credit a list of properties that were definite assets. It is tasteless, a major advantage for use in products to be eaten by people or animals. It has a very low order of toxicity. It is thermostable, subliming rather than melting, a useful property for fumigation. It is highly insoluble, desirable for field retention on crops. And it shows no activity against yeast, important if it were to be used eventually for baked goods or on wine grapes.

Merck's experience in the agricultural chemicals field was limited. It had one compound, 'Gibrel' (gibberellic acid), used on grapes to enhance growth and sugar content and on citrus fruit to promote meat and pulp at the expense of rind. It also has an antibiotic product for use against fire blight in pears. With fungicides, however, the com-

pany recognized its inexperience. For this reason, marketing and research established a scale of possible uses, graded by the degree of difficulty we might expect in bringing a product to market. A product that would not need extensive governmental clearances was obviously an easier target than one that would. In short, we wanted to learn to walk before we found ourselves in a running race.

Some of the more important projected uses that we foresaw - by order of increasing difficulty - were on ornamental plant bulbs, tobacco, bananas, citrus fruits and sugar beets. Apart from agriculture, possibilities such as its use in paints and paper products are being investigated.

In the examples that follow, some of the uses are awaiting governmental clearances in several countries. This is inevitable since the uses are new and submission evaluations take time. However, rather than confuse you by giving a country-by-country accounting of where each of the following projects stands, I'll describe each as if it were in universal application today when this is not always the case.

With flower bulbs, mold causes rot in shipment with considerable economic loss to the shipper. Thiabendazole prevents this. Some of the points that had to be established were whether the compound would be safe for handlers and whether it would harm the ability of the bulbs to germinate. The safety question was easily resolved because of the extensive experience with the compound in the veterinary field. It was safe, and it didn't harm germination.

The tobacco question was next up on the scale of difficulty. With Cuba shut off as a source of cigar tobacco for United States producers, manufacturers were looking to reconstituted tobacco for cigar wrappers. Through this process, scraps of tobacco are worked into a sheet on a steel conveyer in a process much like that for paper making. These sheets of reconstituted tobacco are then cut for cigar wrappers. The problem was that the tobacco sheets had to be kept moist and were an easy prey for unsightly mold.

Thiabendazole, which was tasteless and stable to heat, appeared to our marketing people to be a choice candidate to try to prevent this mold. Research soon demonstrated that this could be done. With tobacco mold, it had to be established further that the thiabendazole traces in the smoke from the cigars were not harmful. This was done in the company laboratories with chronic inhalation studies at high concentrations.

Moving again upward on the scale to bananas, another dimension was added to the problem. Bananas are an edible crop, although their skins are discarded, and it had to be established to the satisfaction of governments that treated bananas would have residues very well below the limit set for human consumption of thiabendazole.

Thiabendazole arrived at a propitious moment for major bananagrowing corporations. A particularly important type of banana tree - the "Gros Michael" or "Big Mike" - was in trouble. The "Big Mike" had turned out te be particularly susceptible to Panama Disease, an illness of its vascular system caused by soil-borne fungus. To fight it, growers would sometimes even flood their fields, a lastditch, but rather ineffectual practice because the fungus could obtain enough oxygen to survive from the water itself.

Attention had then turned to more resistant trees, such as the "Valerie" and the "Giant Cavendish". The problem was that bananas from these trees could not be shipped in stems, as with fruit from the "Big Mike", but had to be shipped in smaller clusters or "hands". The extra cutting left the fruit vulnerable to a fungal disease known as "stem rot". Trials conducted in association with a major fruit company in Honduras demonstrated the ability of thiabendazole to control this wasting.

With citrus, the problem again was in long-distance transport. Two fungus diseases, "blue mold" and "green mold", were the culprits. A rotten orange that breaks open in transit can send its spores throughout the box, infecting the other fruit in the container.

With treated fruit, however, the damage will be restricted to the single rotten orange.

Previously, control had taken the form of pads saturated with a pungent fungicide that were placed between layers of fruit. Thiabendazole's lack of taste and odor, high order of fungicidal activity and low degree of toxicity make it a strong contender to satisfy this existing need of citrus shippers.

It might seem that citrus would be in the class of difficulty with bananas, since the outer covering of each is discarded when the interior is eaten. With oranges, however, oil is recovered from skins and the pulp is used for beef and dairy cattle feed. This necessitated obtaining additional residue data. No thiabendazole has been detected in either the meat or milk from animals fed pulp of oranges treated with thiabendazole.

For nations such as South Africa and Israel - both producers of high quality citrus, and both far from their major markets - thiabendazole can be of major utility. While governmental registration requirements vary, the wealth of information accumulated in testing thiabendazole as an animal anthelmintic has considerably facilitated the job of meeting clearance requirements.

The use of thiabendazole on sugar beets brought problems of a different order. Sugar, after all, was a product directly consumed by man, and the tops of the sugar beets are utilized in animal feeds.

The blight affecting sugar beets is a fungus disease, commonly called "leaf spot". The disease causes leaves to wither and die. The plant replaces these to maintain its photosynthesizing capacity, but in doing so decreases its sugar content. In controlling the disease, thiabendazole permits greater yield of sugar beets in terms of actual tonnage per acre and also in a higher-than-average percentage of sugar in the beet root.

Because thiabendazole was applied to a growing crop, additional data beyond the usual safety data was required. We had to establish that the compound would be degraded in the soil and that it would not have a harmful effect upon wild life.

We know that thiabendazole could be a useful agent against other crop diseases, for example, some of the fungus diseases in grains. When, however, the cost is high in relation to the economic value of the crop, the compound ceases to be interesting as a potential agricultural product. It has not met the measure of agrieconomics in terms of return on investment.

The common denominator in the cases of tobacco mold, banana stem rot, citrus molds and sugar beet leaf spot is the high order of activity of thiabendazole in combatting the fungus. As the activity level falls off, more thiabendazole is needed and the harsh facts of cost economics eliminate its potential use. In such a situation, less effective products can survive and prosper. We can, for example, demonstrate in a greenhouse environment that thiabendazole could improve a cotton farmer's yield per acre by about 5 per cent. This, however, is a great deal less than year-to-year crop variations, and farmers are understandably uninterested.

Equally stringent profit-to-cost criteria apply when thiabendazole is considered for industrial applications. As a rule of thumb, a return of three-to-one on investment would be considered highly interesting, while something in the area of one-and-a-half-to-one would be borderline. The paper industry, obviously, has problems with mold. Thus far, however, problems of cost have ruled out broad application of thiabendazole in this industry.

In the paint industry, another set of conditions prevails. Painted surfaces - especially those used outside in warm, moist climates or inside in high-humidity locations - are susceptible to fungus. Several species are involved. Thiabendazole has been shown in vitro to be highly effective against these, both in water-based and oil-based paints.

Paint, however, can be a very complex proposition. The formulas vary, and the ingredients tend to interact. Each maker, before committing himself, needs an opportunity to test thiabendazole in his formulations under field conditions for two or three years. He is interested in how it will react to sun, to rain, and to industrial and natural fumes. Always, it must prove out on a cost-to-return basis.

As the company has moved with thiabendazole from its introduction as a sheep wormer to agent for bananas and house paints, one major asset has facilitated marketing decisions. With each decision, manufacturing facilities were already in operation. This crucial bridge did not have to be crossed twice.

From the moment that the company decided to look for a better sheep wormer, marketing considerations have called the tune. The properties of thiabendazole - as reported by research - have challenged marketing to find areas where such properties could be put to good use. Research confirmed the feasibility or unfeasibility of the idea, first on the basis of performance and then on the basis of economics as compared with competitive products.

There will be other uses for this highly versatile compound. Some are under active consideration. With one exception - human medicine - the fate of each will depend on the company's ability to demonstrate solid economic benefit for the customer who buys thiabendazole.

PANEL DISCUSSION

Panel:

Chairman: H. Müller von Blumencron, Farbwerke Hoechst
Members: W. Th. J. L. Lier, Philips-Duphar
L. H. Ruiter, Unilever
A. Stikker, AKZO
R. G. Valerio, Merck, Sharp & Dohme Int.

Question

In the United States at least some suspect that detergents containing enzymes present a safety hazard, particularly in connection with skin irritation. Would Mr. Ruiter like to make a comment on this point?

Answer

(Ruiter) Yes, of course. We are fully aware of the discussion going on in the United States and some other countries, and the major detergent companies are discussing the facts with government authorities. We have, of course, to wait for the results of these discussions. But as I said in my lecture, the major detergent manufacturers have gone deeply into the effects that may be caused by the presence of enzymes in detergents. We have satisfied ourselves completely that there are no undue hazards in use.

Question

1970 is the European Conservation Year, and many companies are looking at pollution. Now here we have a new product with entirely new raw materials in it. Did you study the possible contamination of effluents as part of your research program?

Answer

(Ruiter) Yes, that was part of our efforts. We also studied the possibility that effluent waters might become contaminated to a large extent. We satisfied ourselves that this could not happen. These enzymes are unstable at elevated temperatures and they are easily inhibited by other components present in the effluent. So the risk is further contamination of effluent waters is very small indeed.

Question

Many companies are composed of divisions and as a result their marketing side often is quite decentralized. In these circumstances would it not be recommendable to decentralize R & D too, perhaps only to a certain extent? If you think that something like that should be done, the board of the company may have trouble with the planning and controlling of the total R & D effort. What would be your advice in that case?

Answer

(Valerio) It is a difficult question, but I'll have a crack at answering it. I may even be able to say something of value, for till about 1955 our firm was decentralized with regard to R & D. Secondly, we have a divisional build-up in our company; broadly we have in the US a chemical division and a pharmaceutical division, then we have the international division, covering our markets outside the US, and an environmental division, involved in problems of water and air pollution.
As I said, before 1955 we were decentralized with regard to R & D. Research was in the chemical division, while fundamental research was an entity on itself. In 1955 we centralized our whole R & D effort. That was quite a shock for our production departments, for they had to hand over their process development and technical service groups to the new R & D department.

In the question, control by the board of the company was mentioned; quite rightly, for with a decentralized set-up, control by top management is a big problem. Still, I think that it is one side of the coin and that the other side is called 'information flow'. In a centralized R & D department, like we have in our company, control by top management is not such a problem; but ensuring that R & D and management really know the needs and wishes regarding R & D of the various divisions is a big problem. To see to that we use a system that is very much alike to the one Dr. Lodge sketched this morning. We use committees for co-ordination of efforts and we too have a new products conference.
In the middle of each planning year - and we have been doing long range planning for more than ten years now - people from each marketing division have a full day session with the top people in research. They review our marketing needs and decide on a descending order of priority. They start to ask for the ideal product and then they say: If we cannot have the moon, we will take one step down and that is worth so much to us, and if we cannot have that, we can put our wishes on still a lower level, and if that is impossible, we could better forget it. After each marketing division has done this, they all meet to produce a preliminary research plan and a preliminary research budget. Both are presented to the board. Then top management may say: Sorry, your budget is to high, it must be slashed by, let us say, two million dollars. Then they have another round of sessions to decide where to cut back. In the end it results in the definite research plan and the definite research budget. Once the plan is put into effect, we use a number of formal committees where co-ordination takes place.
I realise that all generalizations are fraught with pitfalls, but I would like to make a general remark. In the discussion following the lecture of Dr. Lodge, a remark was made on the danger of the 'yes' and 'no' conflict. I fully agree with that, this is very dangerous. When you operate a rather complicated system like the one I tried to sketch just now, you must have trust and mutual respect between the people in the various functions. People from marketing must trust and respect their colleagues from research, development and production, and vice versa. For in their meetings they have to work out the best compromise possible between the needs and wishes of their departments. As soon as these people start to act like cats and dogs, management must act quickly, otherwise the company may go to the dogs.
To sum up: You can have a centralized or a decentralized organisation scheme, but when you come down to the plain facts, it is always people and not organisation which makes things work.

(Müller von Blumencron) Perhaps Mr. Stikker can say something for decentralization?

(Stikker) That is rather difficult, for in this field you cannot lay down hard and fast rules. I am neither for, nor against centralization or decentralization and it seems to me that each case and each company must be judged on its own merits. The decision to centralize will always depend on a number of factors and here the degree of diversification is very important. Mr. Valerio told us that his company has centralized R & D successfully and I suspect that this was possible because his field of research is almost wholly in organic chemistry. But if you have to cover various fields of scientific research, centralization may be almost impossible. The greater the amount of diversification in the company, the greater will be the need for decentralized interaction between marketing and R & D. Secondly, I want to emphasize another factor which has not had much attention till now: process costs. In some fields of activity, these costs can be very important, as they may influence your marketing strategy. If you organize for good interaction between R & D and marketing, you should try to design a scheme that gives you the possibility to involve processing people whenever it seems necessary. In general you should shun rigidity and plan for flexibility. In my opinion this means that you must not have too great a distance between the central planning department and the people who have to carry out its decisions.

Question

We have seen that industry is aware of the fact that there must be good interaction

between R & D and marketing. How does that affect the future position of independent research organisations like TNO?

Answer

(Ruiter) I can only speak about the situation in this country, and there, in my opinion, TNO has an important function to fulfil, especially for middle sized and small industries. Now the difficulty with farmed-out research always is that the results have to go through an interface between the independent laboratory and the sponsor. Secondly, on the side of the sponsor the man who maintains contact with TNO should be of sufficiently high level, as he has to interpret and to translate the results in terms of products and processes. When TNO is working for a big industrial concern, the necessary expertise is available on both sides, so there will be no difficulties in this respect. But when TNO is sponsored by a small or medium-sized firm, it can be a problem. It seems to me that in some cases the sponsor will have to submit to TNO on a trust basis not only his problems in the field of R & D, but also his other plans. I simply do not see any other way to ensure good interaction between marketing and R & D carried out by an independent laboratory. Perhaps the TNO Organisation still has a job to do in selling this point of view to small and medium-sized indutry.

Question

Till now we have treated consumer products and performance products and that is well within the scope of this Conference. But that is not the whole chemical industry, we also have specification products and basic chemicals. Can we extrapolate our conclusions to these products or do we have to use a different approach?
My second question is of a more philosophical nature. We all agree that the marketing aspect is very important and that we must adhere to the slogan that we must make what we can sell rather than sell what we can make. Now this is a big change, for twenty or thirty years ago we were trying to sell what we could make. I wonder whether we will see another change in the next twenty or thirty years. When we meet in twenty years time to discuss the same subject, will we then come to the same conclusions as today? Is the panel prepared to stick out its neck and say something on this?

Answer

(Lier) In your first question you made an important point. We have certainly been talking about a certain kind of products and not about the whole of chemical industry. Now I always like to make the distinction between consumer products and non-consumer products. Sometimes you have to divide the last field still further in basic materials, industrial products and professional equipment. Now I would not like to be quoted as saying that in the field of non-consumer products marketing is unimportant, but it is relatively less important, as technical assistance and technical service may take a large slice of your total effort. So if you want to extrapolate from the consumer products to the field of non-consumer products, you should be very careful. The markets differ and as a result your marketing approach may have to differ too.

(Müller von Blumencron) We have to keep in mind that in chemical industry advances in production often are the result of advances in technology. These advances mostly result from work done by the engineering firms who design and erect your new plants. Chemical industry does not do a lot of R & D in this field.

(Ruiter) In your second question I have been invited to stick out my neck and I'll do so with pleasure. In general my answer is negative, I don't think that there will be a big change. In twenty years time we still will have to sell our products on the market. As I said in my lecture, marketing can only look into the near future, whereas research is really catering for the future. From research you sometimes can look far ahead into the future, but that can only be done with succes if there is continuous exchange of information between the research department and all the other departments in the company. So I think that in twenty years time you still will have the problem of organising

for good interaction between R & D and marketing. Of course, the next twenty years may bring very important technological changes, but it seems to me that the main problems we have discussed here will still be with us then.

(Stikker) It is at least a possibility that in the next twenty years people from research, marketing and production will be interchanged more often than is the case at the moment. So in twenty years time you may have a Conference with participants who have been in all three sections. They might tackle the problems in a way that is wholly different from the way we have done it here.

Question

We have heard much about teams and co-operation, but we did not hear much about the role of the individual. Now in research it is often stated that results depend on the creativity and vision of one man. Now, when listening to all speakers I have got the impression that the vision of the creative individual does not play a large part anymore in modern industry. It seems to me that research is looked upon as the servant of the company and the handmaiden of marketing. Do the members of the panel agree with this? Has the creative individual still a function in modern industry, or is he just shown to the visitors and given permission to go congresses? And if he still has a function, what kind of vision such a creative individual should have, a scientific vision, a marketing vision or a commercial vision?

Answer

(Ruiter) If you have a research organisation headed by people without any vision, I would certainly advise to get rid of that organisation as quickly as possible. It is useless. It is essential that the top people in a research organisation have vision. Does that answer your question?

Well, not exactly. I meant people like Carrothers, Langmuir and their like.

(Valerio) If we have in our company a research man who has demonstrated outstanding creativity and exceptional ability, we don't ask whether he will make a good research manager. We pay him like one, we give him his own laboratory and we give him the opportunity to play his own game. We say to him: Now just start to follow your own ideas, we'll sit down and wait for your results. The total synthesis of ribonuclease I described in my lecture came from such a set-up. One of our scientists who had shown outstanding creativity wanted to pursue this and he was given the opportunity to do it, although we simply had not any idea where it would lead to.

Question

And this really is essential for your company?

Answer

(Valerio) It is absolutely vital. We are by necessity research oriented and as a company we would soon be in the doldrums if we stopped to give free rein to the creativity of our outstanding scientists.

Question

Most of us have grown up in a society where science was the driving force. Then marketing became an important element and with it many people trained in economics entered industry. Now we are living in a situation where a new class of experts is growing up: the sociologists. It is an important class of students, at one of the Dutch universities there are nearly as much people studying sociology as there are students in science. These are the people which soon will enter our companies. Has the panel any experience with their performance in industry? Having studies in behaviour of

human beings they might be an asset when it comes to bridging the gap between research, development and marketing.

Answer

(Stikker) I would like to add some general remarks. Students of sociology often are rather critical of industry and of the methods used in industry, but they are not the only young people who critize. We have had some discussion groups in our company with students and also with young graduates which had worked for a few years in industry. When you talk with these people, you discover that they have rather exaggerated ideas about the way things are being run in industry. On the other hand, you sometimes find out that the gap between their ideas and the ideas circulating in management is far smaller than you expected. These young people are certainly stimulating the type of organisation most large companies are developing, where the decision making process is not concentrated at the top any more, but spread over various levels lower down. To bridge the gap that exists between what is really happening in industry and what these young people think is happening, it would be perhaps a good thing if there were more interaction between universities and business. This should be not in the form of visits or plant inspections, but in the form of people from industry staying a year or more at a university. And it would perhaps be a good thing if students before graduating would not work in industry for only six or eight weeks, but could stay for something like one year. Such a scheme may suppress some of the silly ideas about industry current at the universities and it may rectify some of the wrong impressions about modern students current in industry.

(Lier) For me sociology is just another specialism which may be very important for management at all levels. Human relations in industry are rapidly altering, participation is a popular word and in my opinion a real need. I would not advice to place a sociologist at every level of management, but it seems to me that you need a group of sociologists to advice management at all levels on social and human affairs.

(Valerio) We have many sociologists in our organisation. We have seen that they easily pick up the technical and other knowledge they need in their job. These people can be placed nearly anywhere, exept of course in the research department.

Contents