

# Manufacturing for profit

*Knowledge systems and technological innovations  
are at the heart of Rapid Prototyping,  
Rapid Tooling and Rapid Manufacturing*

TNO Industrial Technology

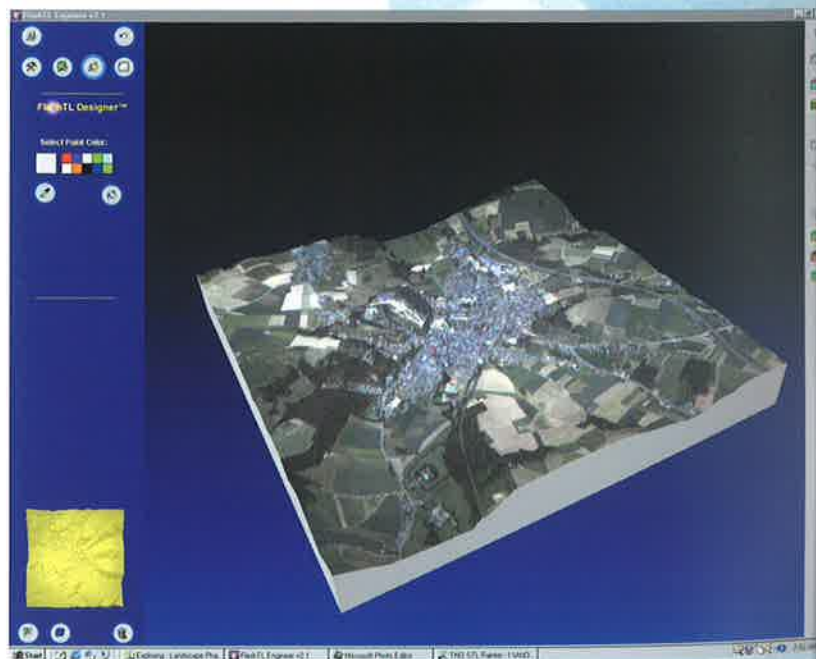




# Manufacturing for profit

The key to a company's competitiveness, and therefore to its profitability, is its ability to move rapidly from idea to production. Of course, this must not be to the cost of the product's quality, either in terms of design or functionality. In addition, both development and production costs have to be kept within reasonable bounds. Otherwise, there is nothing to be gained from the rapid introduction of new and innovative products.

But practice has shown that accelerating time-to-market is no simple matter; the various stages involved in developing a product don't always fit together well. Unfortunately, this is something that tends only to become clear during production. There is still a lot of truth in the statement that 80 per cent of the cost of a product is determined by design choices. So it is vital that design and production knowledge are integrated. This is something that TNO Industrial Prototyping, a department of TNO Industrial Technology, has recognised. By using knowledge systems and technological innovation – in Rapid Prototyping, Rapid Tooling and Rapid Manufacturing – this integration has now come within reach.



*3D colour printing may still be in its infancy but TNO Industrial Prototyping has already developed a 3D colour printer with the software to position the colours and materials in any given spot. This technique may have a lot to offer in respect of product development and production.*

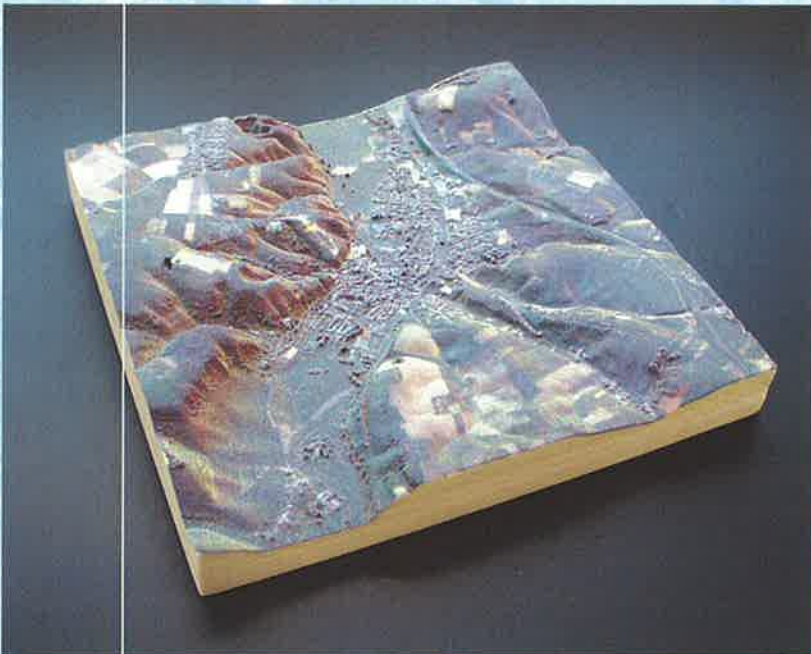
## Working towards results

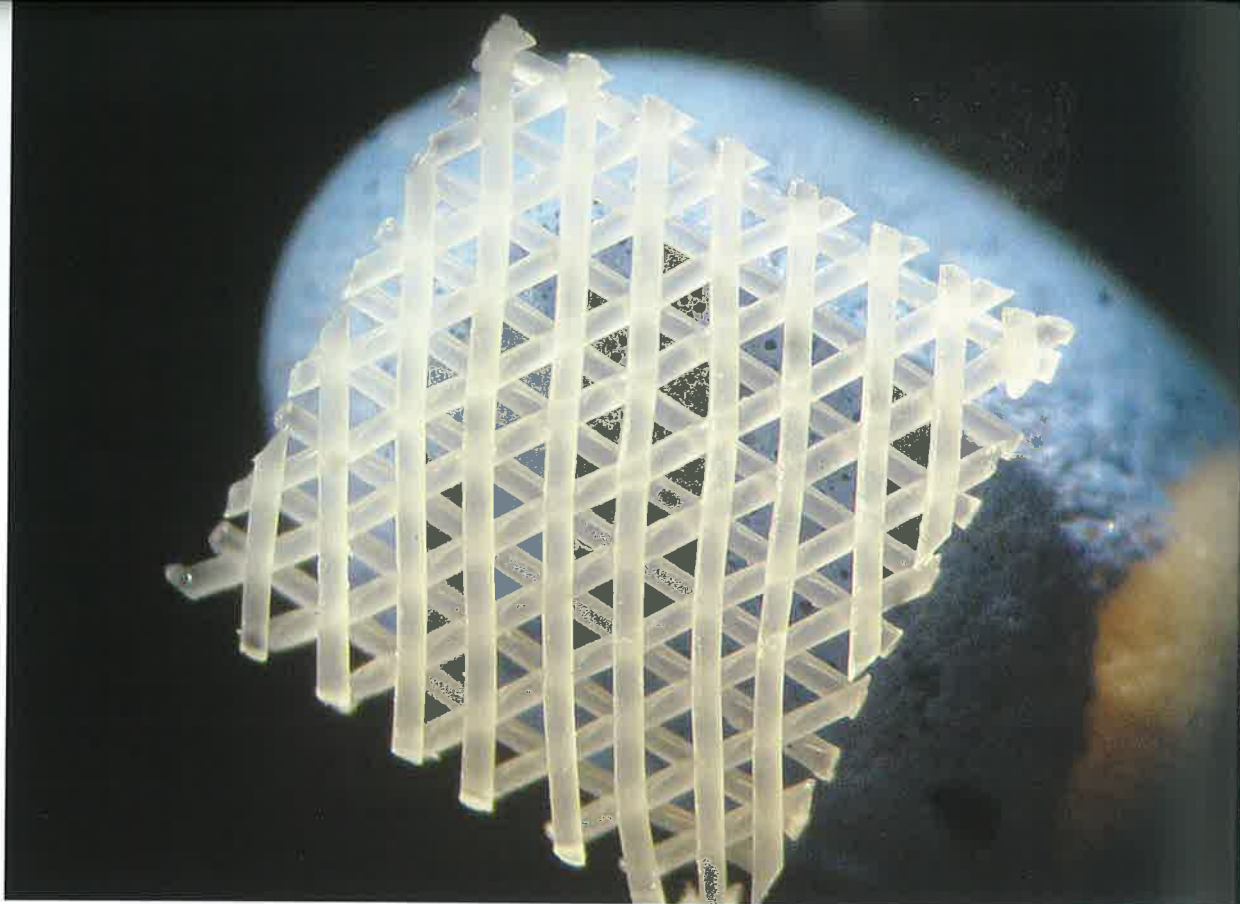
- research
- development
- realisation
- advice
- knowledge transfer

The expertise at TNO Industrial Prototyping is based on the very latest technological advances and on resourceful professionals who know how to use this knowledge to solve your practical problems. Experts who look at things from a different angle, who work towards results and keep to the schedule and the budget. In a form of cooperation that ensures that you will be able to manufacture for profit.

This cooperation can be expressed in a variety of ways – through **research, development, realisation, advice** and **knowledge transfer**. Of course, first of all a proposal will be drawn up with a plan for a phased approach that limits the development risks, the costs and a schedule.

What's more, access to TNO Industrial Prototyping means access to the entire TNO network and the international networks in which TNO participates. In short, a gateway to a treasure chest of applicable knowledge.





*Prototyping techniques now enable complex support structures to be generated for tissue formation in medical applications.*

## Technological innovation

Right from the outset TNO Industrial Prototyping focuses on how Rapid Prototyping can optimise the manufacture of complex products. Nowadays TNO Industrial Prototyping concentrates on Rapid Tooling and Rapid Manufacturing because both techniques can also make manufacturing profitable.

Current and future market needs as well as its own experience of various new materials and production techniques are the driving forces behind the conscious choices that TNO Industrial Prototyping has made in focusing on technologies that offer together or in combination with the development of new materials the greatest potency for innovation in Rapid Prototyping, Rapid Tooling and Rapid Manufacturing. These can be divided into:

- additive technologies: products (end products, components, moulds and dies) constructed layer by layer;
- subtractive technologies: products created by the removal of material layer by layer;
- technology knowledge systems (IT systems that reduce the need for human intervention).

Additive techniques involve among other things multi-material manufacturing, the combined processing of various materials into a single product whereby local specific mechanical and/or physical properties can be attributed, like electrical conductivity, varying heat conductors and additional strength or durability.

An example of a subtractive technique for complex products is high-speed milling. The aim is to introduce a knowledge system so that the geometrical information of the product to be manufactured suffices for the machine to come into action.

These are just a few examples of areas where TNO Industrial Prototyping constantly invests with companies in research, development, realisation, advice and knowledge transfer.

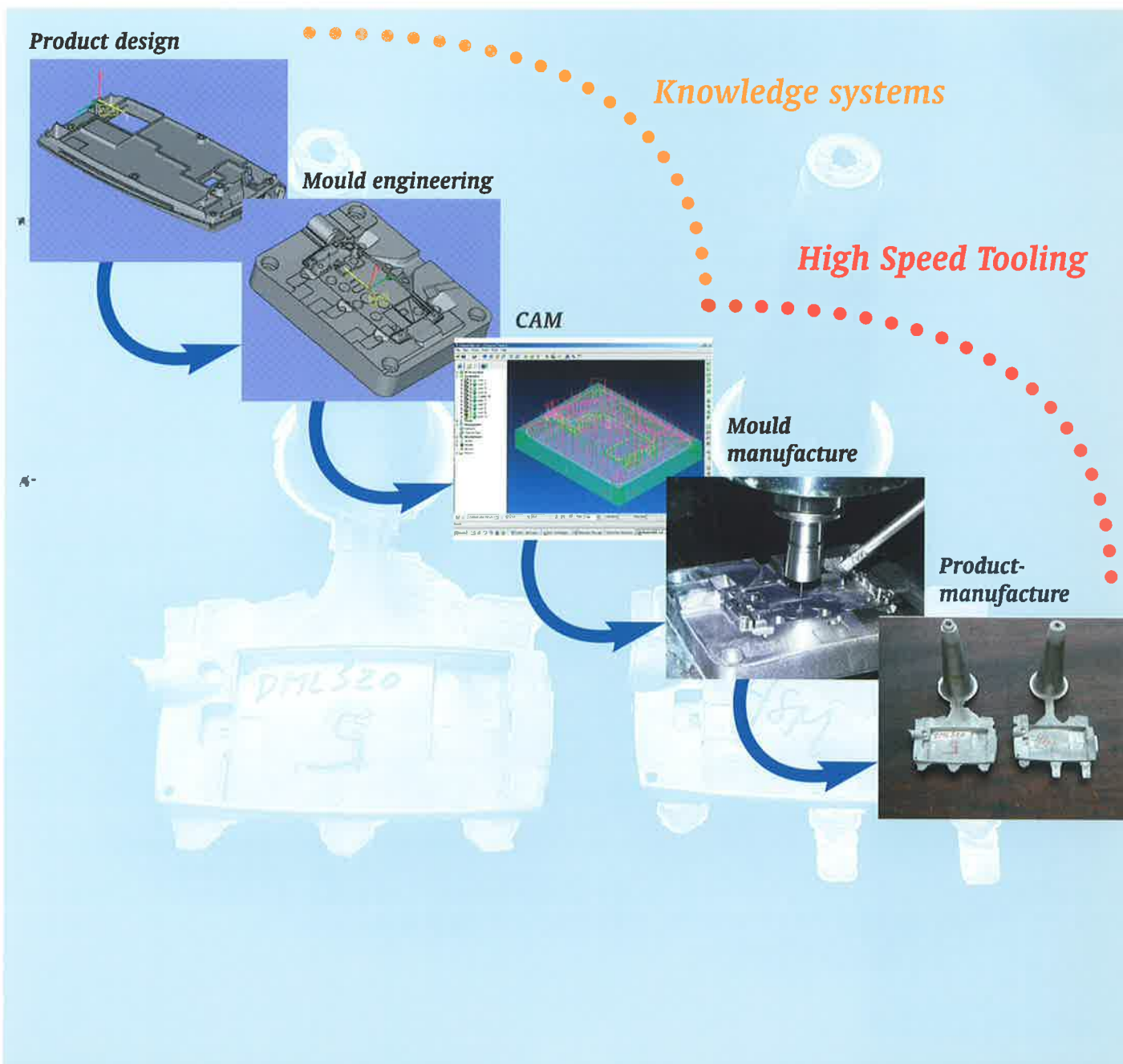
## Knowledge application as a driving force

TNO Industrial Prototyping contributes to the competitiveness of businesses by equipping companies with the knowledge that enables them to manufacture new and existing products in the most profitable way.

This knowledge comes from the work that TNO does and from companies themselves. Experience suggests that the knowledge within companies tends to be available in a fragmented way, largely within the heads of a small number of employees. The downside of this is that the knowledge is not accessible for everyone, and in the absence of a particular person, progress can be seriously delayed. And that makes a company highly vulnerable.

By developing a knowledge system TNO Industrial Prototyping removes such problems; the knowledge becomes available to everyone all the time. The systems are always constructed along modular lines, which fosters a gradual introduction and allows companies to build up their knowledge system at their own speed and without endangering continuity. Once this 'lifeline' is running through the company, then even more traditional techniques can produce faster and more reliably.

The knowledge systems of TNO Industrial Prototyping will make it possible in future to generate, for instance, a mould design fully automatically on the basis of the CAD files of the product design and the production parameters. Product mould cavities required for a mould can already be realised without the need for human intervention. And this reduces the CAM phase from several hours to just a few minutes!





- concept model
- functional model
- prototype
- 3D-imaging

*Concept models have enabled, for example, the wearability and user-friendliness of the body sensor to be examined. The body sensor is a system comprising a number of sensors on the body, a unit that temporarily stores data and shows information on-line as well as a PC for permanent data storage as well as data analysis and processing. Data that may relate to pulse, blood pressure and movement.*

## Rapid Prototyping

Developments concerning Rapid Prototyping are taking two routes. On the one hand, there is a need for extremely cheap models while, on the other hand, there is a need for hybrid prototypes, high-quality models that are composed of various materials.

In the first category are the **concept models** that allow you to check whether an idea has been properly translated into a product design at an early stage of the development process. A tangible model makes it much easier to make an assessment than a picture on screen or on paper and, what's more, it facilitates communication between the various parties involved. It also enables design variations to be assessed and roughly verify whether the various components of a device or a machine will fit the casing and, if so, whether they are logically positioned.

High quality models that are composed of various materials are particularly well suited as a **functional model**. This allows the mechanical, electronic, chemical and thermal properties of a new product to be tested.

In order to test the end product (in the market), a high quality model is necessary, a **prototype**. This very closely approximates the final product in terms of size, materials and properties. The main difference for you is that the prototype requires no investment in tools and so is much less of a risk financially. Prototypes can also be used for a final check on operation, measurement accuracy and tolerance as well as provide information on production and assembly properties.

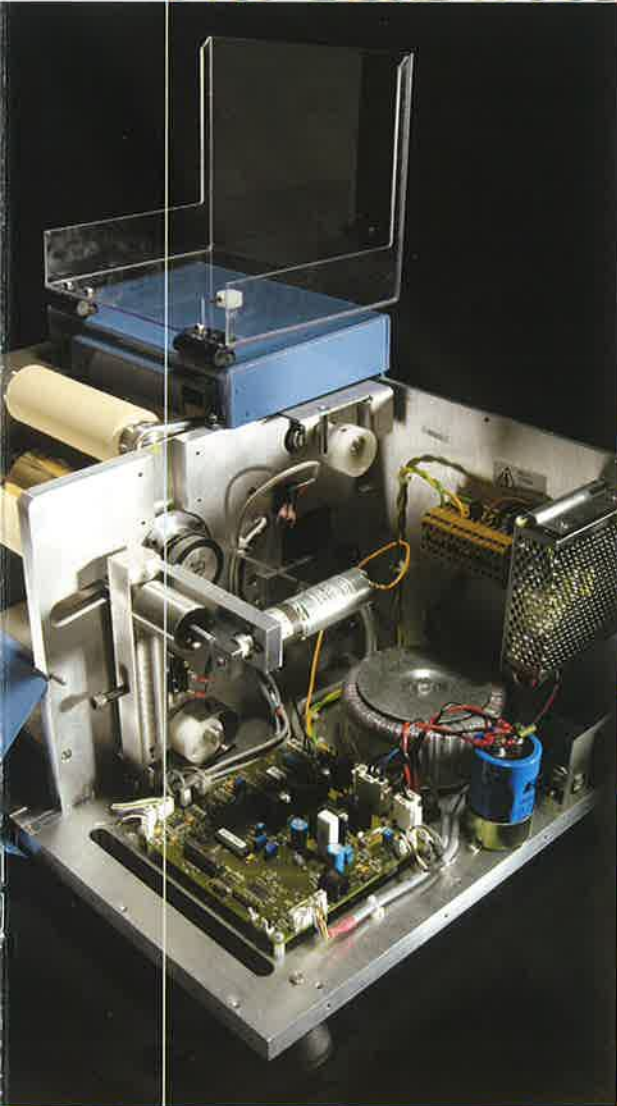
On the basis of the complexity and the measurements, TNO Industrial Prototyping can determine which technique or combination of (rapid and traditional) techniques is the most suitable. A 3D CAD file is the starting point for most techniques, whether you supply this file yourself or have it made for you. It is also possible to digitise a physical product or model with **3D imaging** techniques that make a 3D scan to produce a 3D point cloud. This can then be converted into information that you can use, as in FEA and Virtual Reality.

In addition, the point cloud can be compared with the original 3D CAD model, which enables you to see at a glance whether your products comply with quality requirements.

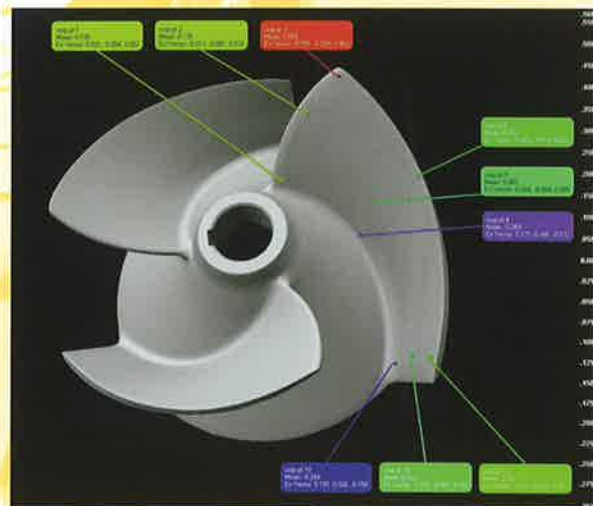




*A large number of technologies have been combined in this compact 'talking barcode scanner' for the blind and partially sighted. Concept models and a zero series were made during the development process.*



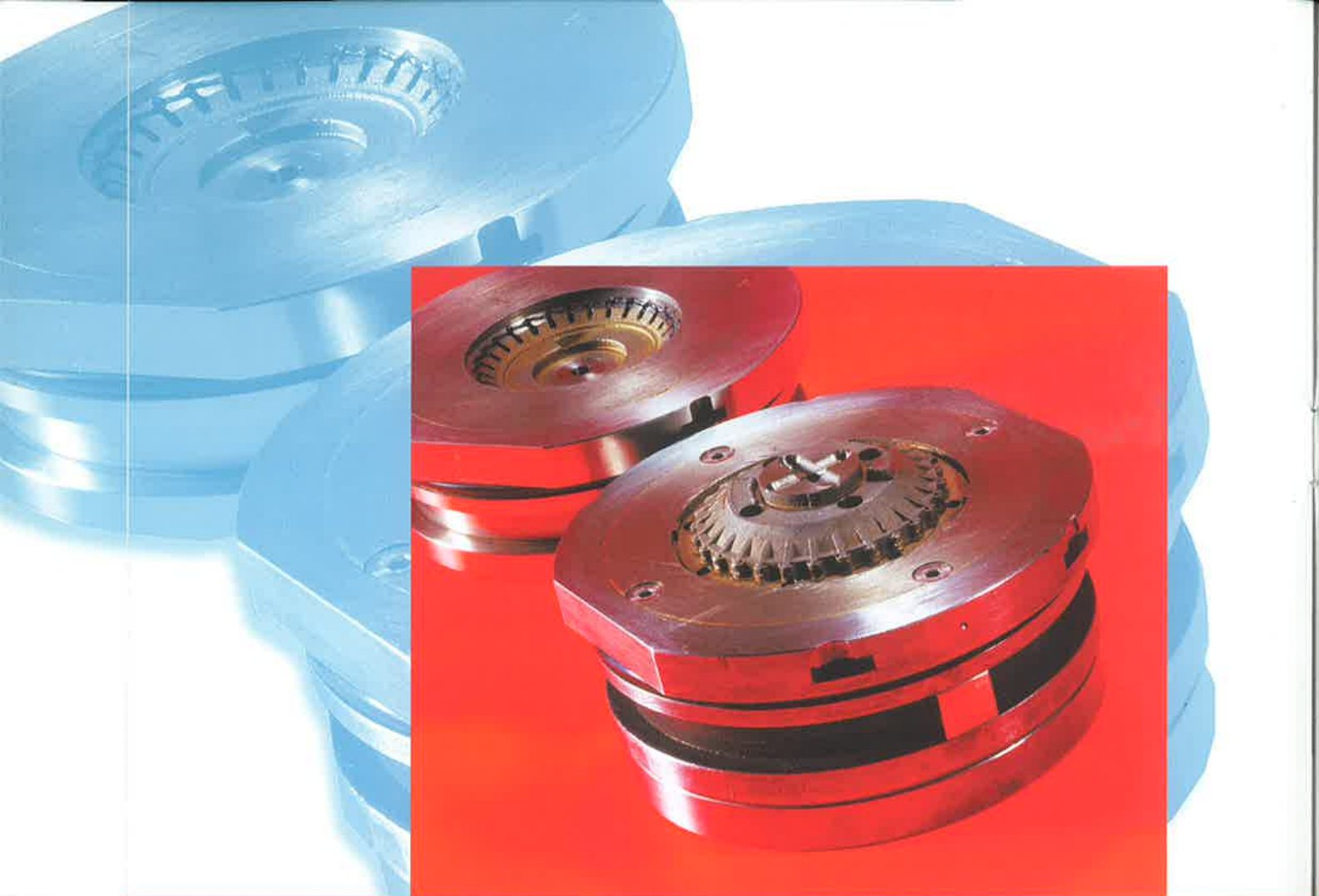
*This device is able to measure the adhesive strength of viscous liquids. TNO developed the machine, producing three of them for practical tests.*



*The point cloud of a scanned product is compared with the original CAD model. The points indicate specific measurements.*

*Coloured patterns reveal the course of the deviation in 3D.*





- LMT-tooling
- Conformal Cooling
- High Speed Milling
- Knowledge systems

## Rapid Tooling

Given the developments in Rapid Manufacturing (see page 10), it is expected that in the future tools will only be used for the manufacture of large quantities of multi-component products. And such tools will have to meet very stringent requirements in terms of surface quality, shape and positional precision, and durability. TNO Industrial Prototyping has extensive experience with direct and indirect rapid **tooling** based on **LMT** (Layer Manufacturing Technologies). There is a growing focus towards the use of **conformal cooling**. This can be achieved by the application of additive technologies in combination with **High Speed Milling**, whereby the milling finishing is controlled by 3D imaging. TNO Industrial Prototyping is also investigating the potential of *graded materials*, the local application of specific mechanical or physical properties through varying the materials used.

All this experience is being incorporated in **knowledge systems** which enable the transformation from product geometry to production to be achieved rapidly.

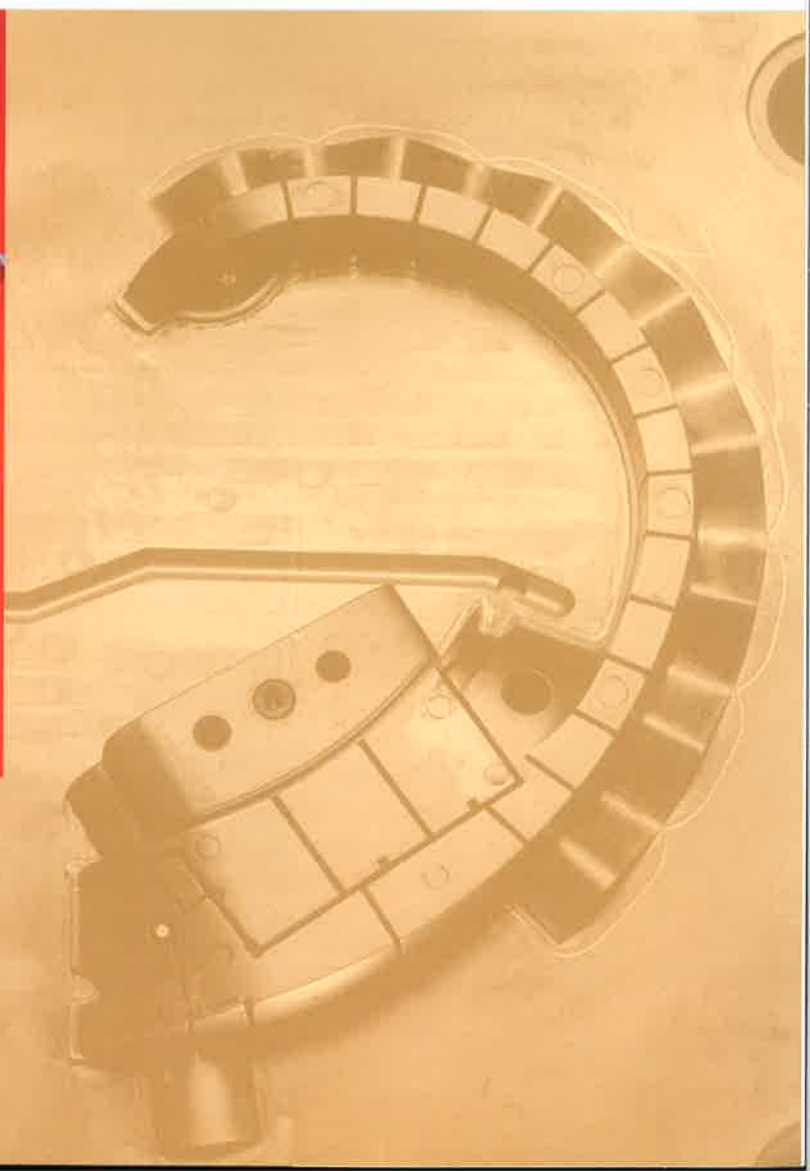


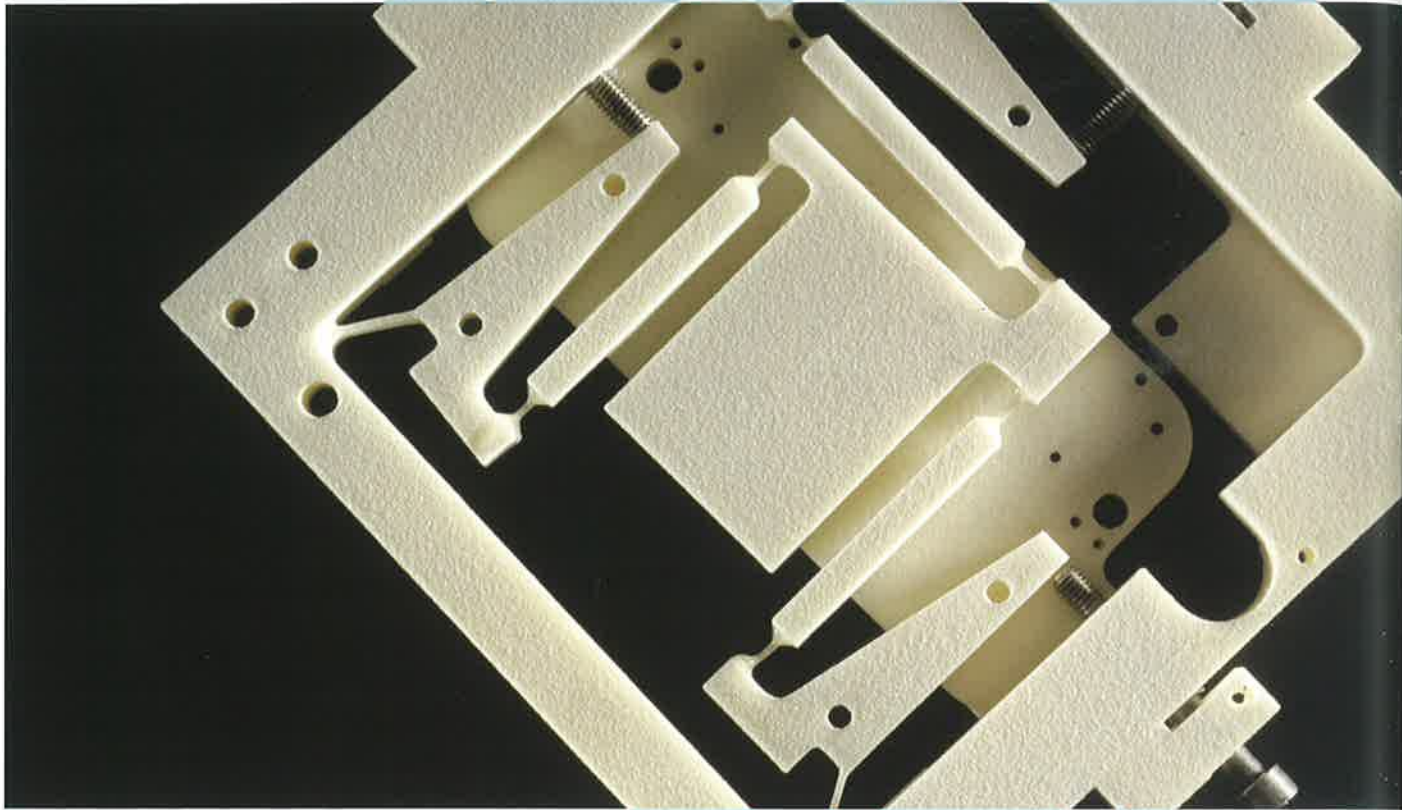


*TNO Industrial Technology has developed FlashMILL, a software package that is based on the digital geometry of the item to be manufactured and allows milling paths to be generated more or less automatically. Since the design and structure of FlashMILL is universal, a whole range of combinations between CAM packages, cutting equipment and machines is possible. Users can easily add their own experiences to the NC code, which is particularly relevant for critical elements like very deep and narrow slots/grooves. FlashMILL enables the professional to focus his knowledge and experience on this by allowing some 80 per cent of the labour-intensive work to be done at the touch of a button.*



*TNO Industrial Prototyping responded as an independent party to Ericsson Mobile Communication's request to investigate the possibilities offered by 13 different techniques to produce a mould directly from product design for the die-casting of magnesium frames. Up till now, knowledge of this technique had so far been limited to the manufacture of moulds for plastic products.*





## Rapid Manufacturing

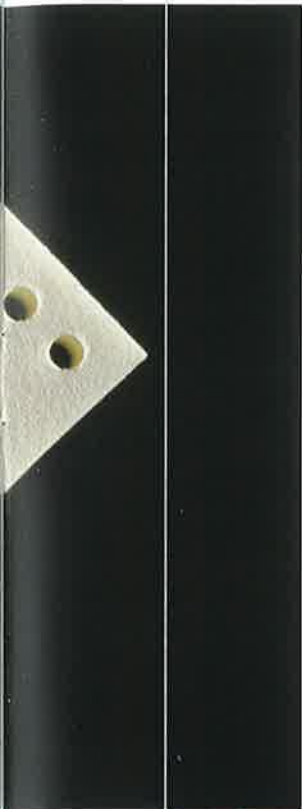
There may be times when you need only one or a just a limited number of a product or machine. Or maybe you want to adapt your products constantly to individual customer requirements. Rapid Manufacturing provides an attractive alternative to traditional manufacturing for a limited number of complex items and low volume series (up to several thousand). On top of that, Rapid Manufacturing lets you add more functions to the product than traditional production does.

Developments are charging ahead at incredible speed. What may not have been possible yesterday and today might be there tomorrow. TNO Industrial Prototyping is training the arrows of its research particularly on **micro-extrusion** and **3D printing (3DP)**. In due course these techniques will be particularly suitable for Rapid Manufacturing because they will enable products to be manufactured very accurately from various materials.

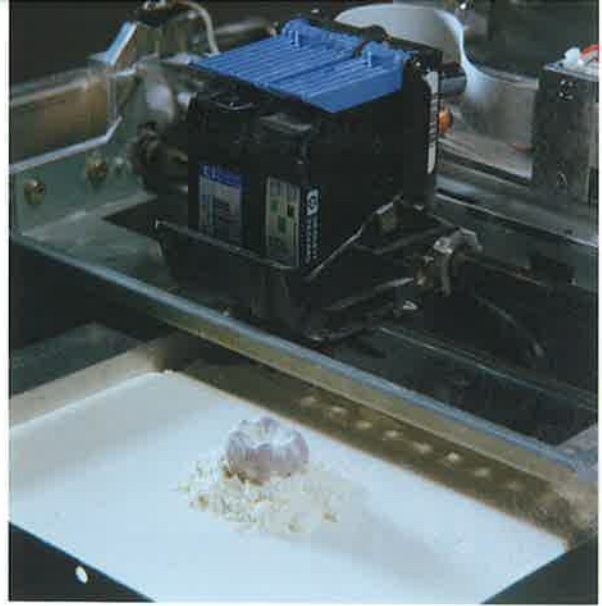
The nice thing about the new production techniques is that they give designers and engineers more freedom from a geometrical and functional perspective than traditional production techniques can. TNO Industrial Prototyping can tell you exactly what at this moment is the best production method for your end product and what this offers in terms of possibilities for your product design.



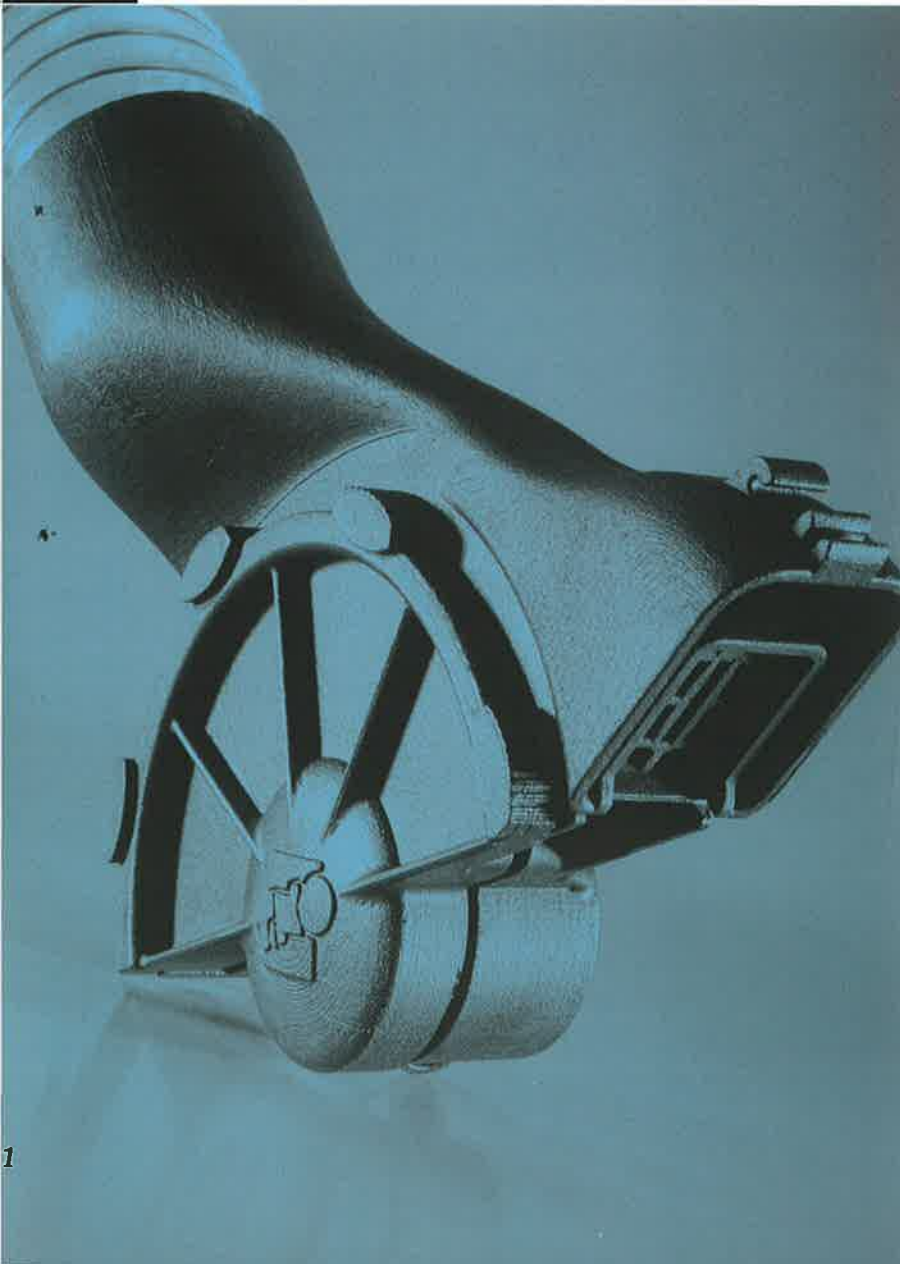
*Using Selective Laser Sintering (SLS) and Fused Deposition Modelling (FDM) functional components are made for various hand tools with dust extraction.*



*Rapid Manufacturing makes it possible to manufacture, with a great degree of freedom, complex adjustment mechanisms as a single component. This shortens the time and reduces the costs. TNO has made a number of examples of this mechanism direct from 3D CAD.*



*Making dental elements is still labour-intensive work involving a number of parties. Together with Q-Lab B.V. TNO Industrial Prototyping is developing a method whereby it is possible to provide a definitive dental element for someone in a single session. This method is based on the knowledge system and 3D imaging, the conversion of information on physical objects and environments into digital models.*



- **Micro-extrusion**
- **3D-printing**

## **TNO | Knowledge for business**

TNO Industrial Technology develops innovative products and processes by undertaking projects together with its clients and translating the knowledge that is generated in the field of product development, production processes and the application of materials into practical solutions. Which makes TNO Industrial Technology an attractive partner for industry.

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