3

# Contribution to renovation of a camera factory by intelligent production technology

*Sir John H. Noble* — *Kamera Werke Noble GmbH Dresden*
*Prof. Dr. Kochan* — *SFM GmbH Dresden*

## Abstract

The new technologies for the direct generation of a geometrical object of any complexity, based on 3 D-CAD-Data, are of general importance of the technical progress. Broadly-based and applied in leading industries like airplane and automotive factories, these technologies, named Solid Freeform Manufacturing, Layer Manufacturing, Rapid Prototyping and otherwise, are playing more and more an essential role in small and medium-sized companies.
The following paper presents experiences of product development and manufacturing technologies, also in a small enterprize.

## Keywords

Solid Freeform Manufacturing, Rapid Prototyping, Concurrent Engineering

## 1 INTRODUCTION

The competitiveness of small and medium sized companies depends on the ability for utilization of advanced manufacturing technologies.
The new technologies for the direct generation of geometrical objects, of any complexity based on 3 D-CAD-data (named Solid Freeform Manufacturing, Rapid Prototyping or otherwise) plays an important role in Leading companies of the

Q. Sun et al. (eds.), *Computer Applications in Production Engineering*

airplane and automotive industries. These state of the art technologies are also of increased importance for small and medium sized enterprizes. Because of the high investment cost, new types of innovative service centers and specific kinds of workdivision are requested.

The Noble Camera factory is a midsized corporation of the high tech-optical electronic industry. One of the main product-lines is the NOBLEX-Panorama camera for professional photographers and demanding amateurs.
Based on the international well-known professional panorama camera NOBLEX PRO for roll-film with a rotating lens (picture angle 146°), the goal was formulated in 1993 for the development of a 35 mm panorama camera with a rotating lens (picture angle 136°) and also high functionality.
For the development of the overall housing and mechanical components, a cooperation with the new-founded small company for fast manufacturing. of models incorp. was started. This high-tech company (in german: SFM-Gesellschaft zur schnellen Fertigung von Modellen) deals with all engineering tasks along the process chain for Solid Freeform Manufacturing, especially

- fast digitizing, scanning and reverse engineering
- 3 D-Modelling
- SFM-building processes
- follow up processes, like vacuum casting, investment casting a.o.

The following paper demonstrates the remarkable advantages by using the new technologies for the accellerated product development and manufacturing.

## 2 CHARACTERISTIC of the new SFM-technologies

The very general principle is shown in Fig. 1, which demonstrates the following points.

1. The essential prerequisite of 3-D Data models
2. The application of specific materials such as fluids, powder, wire or laminates. This is currently different from traditional manufacturing processes, a decisive restriction
3. The use of newly developed highly sophisticated equipment employing different physical principles
4. The physical objects are currently limited in size depending on the working ranges at the SFM equipment, but without restrictions concerning complexity and geometrical features.

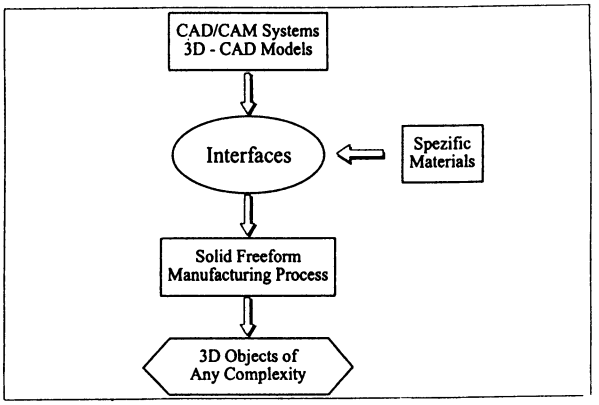



Fig. 1: Simplified Principle of Solid Freeform Manufacturing

A subdivision of the commercially available system, from the application point of view, is possible based on the usable materials and the used physical effects. (see Fig. 2) The stereolithography process is currently the most industrially applied principle and in a leading position on accuracy requirements.
For more detailed explanations, some specific literature is available / 1, 2, 3 /

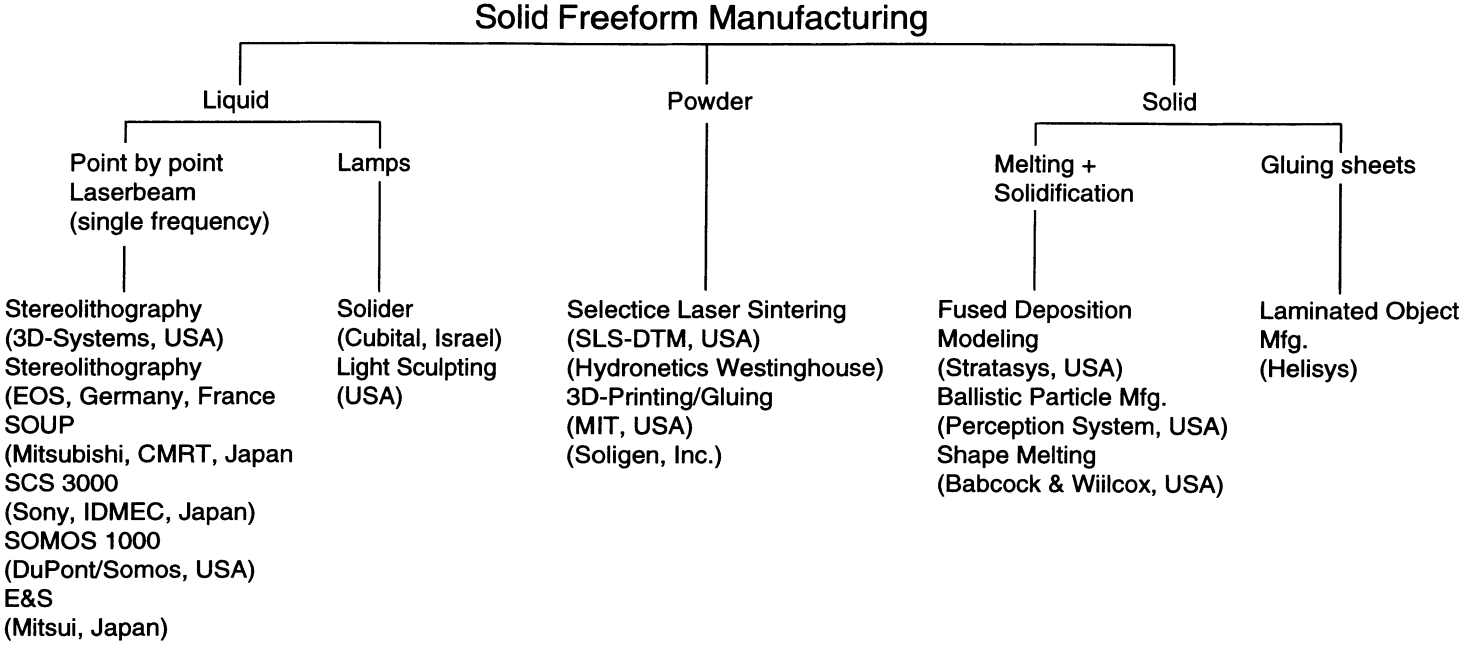

Solid Freeform Manufacturing
Liquid
Powder
Solid
Point by point Laserbeam (single frequency)
Lamps
Melting + Solidification
Gluing sheets
Stereolithography (3D-Systems, USA)
Stereolithography (EOS, Germany, France
SOUP (Mitsubishi, CMRT, Japan
SCS 3000 (Sony, IDMEC, Japan)
SOMOS 1000 (DuPont/Somos, USA)
E&S (Mitsui, Japan)
Solider (Cubital, Israel)
Light Sculpting (USA)
Selectice Laser Sintering (SLS-DTM, USA)
(Hydronetics Westinghouse)
3D-Printing/Gluing (MIT, USA)
(Soligen, Inc.)
Fused Deposition Modeling (Stratasys, USA)
Ballistic Particle Mfg. (Perception System, USA)
Shape Melting (Babcock & Wiilcox, USA)
Laminated Object Mfg. (Helisys)

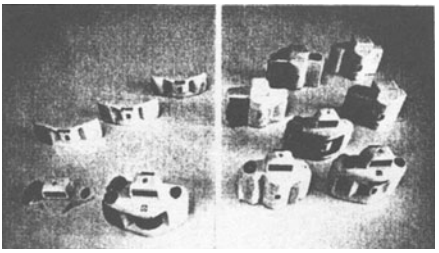
Fig. 2

# 3 Product development and manufacturing by utilization of advanced manufacturing technology.

The new technologies are not only procedures which allow to replace traditional processes, the SFM-process chain is becoming an increasingly valuable tool in the Integrated Product and Process Development environment.
The advantages and effects can be utilized starting from the product design up to the different follow-up processes depending on the requested number of parts.

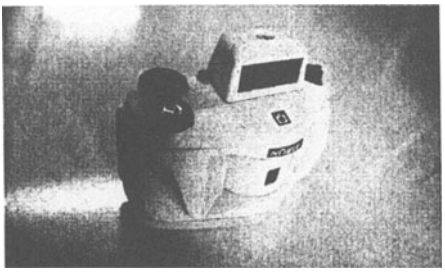
## 3.1 Design and decision-Making of design variants

The market success of a new product is decisively influenced by the quality of the design. Normally some design variants in foam material will be prepared.
Some examples for the new panorama camera are shown in figure 3.



In consideration to the utilization of new SFM-technologies, there was given no restriction concerning freeform shapes and other aestetically-shaped elements.

The result of the decision process by the management of the Noble camera factory is shown in fig. 4.



## 3.2 Fast digitizing

For some design patterns, the point net was digitized and by the principle of reverse engineering /4/ prepared for further computerized processing
Digitizing is only justified for some selected shape elements, e.g. the frontside of the camera. The other parts must be included into the general task for 3 D modeling.

## 3.3 3 D-Modeling

As it was emphasized before, the 3D-Modeling is an absolute "must" for the SFM-processes. In the case of the development of the panorama camera the closed cooperation between the constructor and 3D-modeling expert was most useful.
The camera is a very complicated technical device, which includes optical, mechanical and electronical components.

The startpoint for the construction was the functional principle of the camera, the structure, the measurement of the essential function elements and the design drafts for the outside form.

Therefore a closed cooperation between designer, constructor and 3D-Modeling expert was necessary. The 3D-Modeling of the outside shape was realized in consideration to the necessary subdivision of single parts related to functional requirements and manufacturing aspects. For the construction of the irregular single parts of the camera housing with many freeform shapes the utilization of the 3D-surface modeling system STRIM 100 (Cisigraph) was very useful.
Essential advantages are:

- multisided possibilities for the description of complicated shape elements.
- unification of surfaces to surface units by determination of different connection conditions between the single surfaces
- different and independent description of outside and inside contours of objects
- extensive systemsupport for the rounding of surface boundaries and the determination of lift out angles for casting procedures.
- simple and fast possibilities for the local and global changing of surface description.

After the successful construction and 3D-modeling, the CAD-data are available for the following processes.

## 3.4. SFM-building procedures

Additional to the 3D-CAD-modeling the availibility of real objects of all technical objects and components is very necessary. The real relationships and proportion in complex and complicated devices or assembly groups can not be simulated by computer support. Therefore the building of design or function pattern for many investigations is a compelling need. The rise of any product-development can be minimized if in an early stage test objects are available.
For this reason the SFM-procedure stereolithography was applied for all seven housing parts. The manufacturing of the models was realized with the stereolithography-system STEREOS 400. For the produced prototypes the following demands was requested

- checking of the design of the outside shape
- checking of the construction of the single parts related to productibility and functionality
- suitability as basic models for vacuum casting parts, which can be used for assembling of applicable test cameras
- suitability as basic model for manufacturing of forms for injection molding by metal spray procedures. This parts must be usable for midsize production (up to 5000 pieces).

Because of the necessity for parallelization of product-development tasks and preparation of the manufacturing processes several experimental samples of the camera has to be put ready. For the multiplication of single stereolithographic models into 20 plastic parts the vacuum casting procedure was successfully used.

## 3.5. Application of prototypes, testmodels and preparation of the medium sized production.

Without expensive tools it was possible to produce complete camera housing in an early developmental phase. So it was possible to make a lot of necessary corrections at the single parts without additional expenditures for the tool making for the midsize production. Two typical examples will be used for the explanation of the advantages. Selection of the suitable motor for this specific requirements.
Investigations concerning fitting and handlibility of the camera was possible with the parts, which was manufactured by vacuum casting. Additionally, it was possible to provide for the production of the packaging and the casing in an early stage for this specific construction and manufacturing tasks. Furthermore it was useful to prepare prospects by specific painted models. For the necessary marketing activities the prospects was available of the same time when the serial production starts.

The preparation of the serial production starts also simultaneously to the development and construction of the new camera.
The selection of suitable manufacturing procedures must be in agreement with the complexity and number of the part. In this relation has to be considered the relatively small number of parts.

That means it is necessary to apply manufacturing procedures which allow a low price level also for small and medium sized production.
An essential cost factor are the manufacturing cost for the injection molding tools. These manufacturing procedures for complicated freeform shapes requires multi-axis milling and EDM processes for the quality justified production. In this cases the NC-programming was possible direct based on the 3D-CAD-data.
This is also a opportunity for the reduced amount.

Some parts are suitable for the new metal-spray procedure. This procedure reduces the cost up to 20% in comparision with the traditional NC-manufacturing.
The tools, manufactured by the metall-spray procedure, can be used up to 5000 injection moulding parts.

## 4. Economical effects and results

The application of the described innovative methods and procedures for the product development and manufacturing of the new panorama camera leads to a lot of effects. Currently the exact qualification is not easy, because there doesn`t exist analogues traditional processes for such complicated parts. Most important is the drastical reduction of the development time for the camerahousing from usually 18 month up to 7 month. In this case has to be considered the increased degree of complexity of the parts.

The consequent realization of the methods of Simultanious Engineering including extented and early tests at real models allows the following advantages and principles.

- investigation and evaluation of constructive and technical variants.
- optimization of application features
- reduction of construction failures up to nearly "Zero"
- multiple usage of optimized CAD-data for follow up and parallel processes
- preparation of serial manufacturing and tooling in parallelization with the product testing.

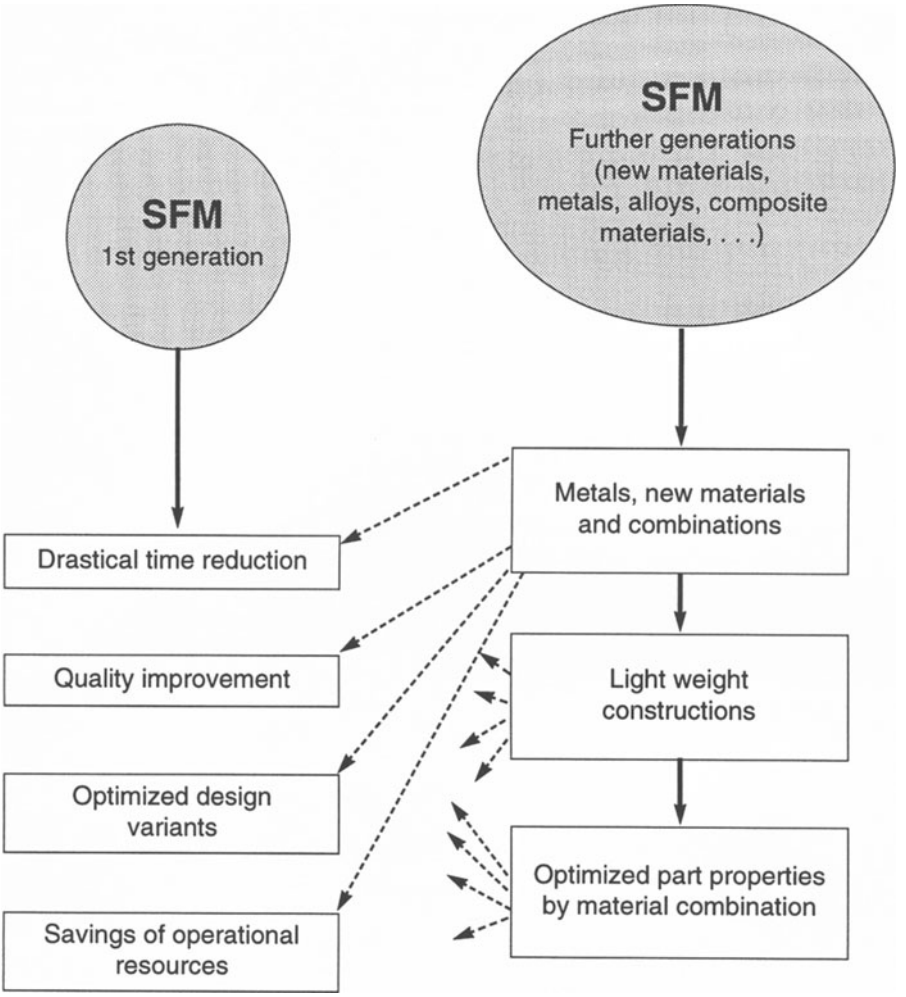



Fig. 5 Essential effects of the new epoch of Production Technology

## 5. Summary and concession:

The new technologies of Solid Freeform Manufacturing are still in the first phase of industrial application. But if this possibilities are not only applied as specific procedures for determined requirements, f.e. show and tell models, the entire advantages are most important. If the new technologies are understood and applied as a strategic tool along the entire process chain from product design till manufacturing, the effects can be enormous. The broad utilization of all given advantages guarantees highest quality, shortest time and lowest cost.
The successful development of the new NOBLEX Panorama camera is one evidence of the new development stage in direction of the new epoch of advanced production technology.
In general, by application of the new technologies, time and cost savings in the range of 50% up to 90% can be expected. The explanation for such tremendous advantages is given in Fig 5. This figure demonstrates also some essential trends for further developments.

## References


| | | |
|---|---|---|
| /1/ | Kruth, I.P. | Material Incress Manufacturing by Rapid Prototyping Technologies; Annals of the CIRP, Vol. 40/2 1991 |
| /2/ | Jacobs, P. | Rapid Prototyping & Manufacturing Fundamentals of Stereolithography; Dearborn, SME 1992, USA |
| /3/ | Kochan, D. | Solid Freeform Manufacturing - Advanced Rapid Prototyping ELSEVIER Amsterdam 1993 |
| /4/ | Kochan, D. | Intelligent Production Systems- Solid Freeform Manufacturing Proceedings International Conference Sept. 29.30.1994 GFaJ Sachsen |