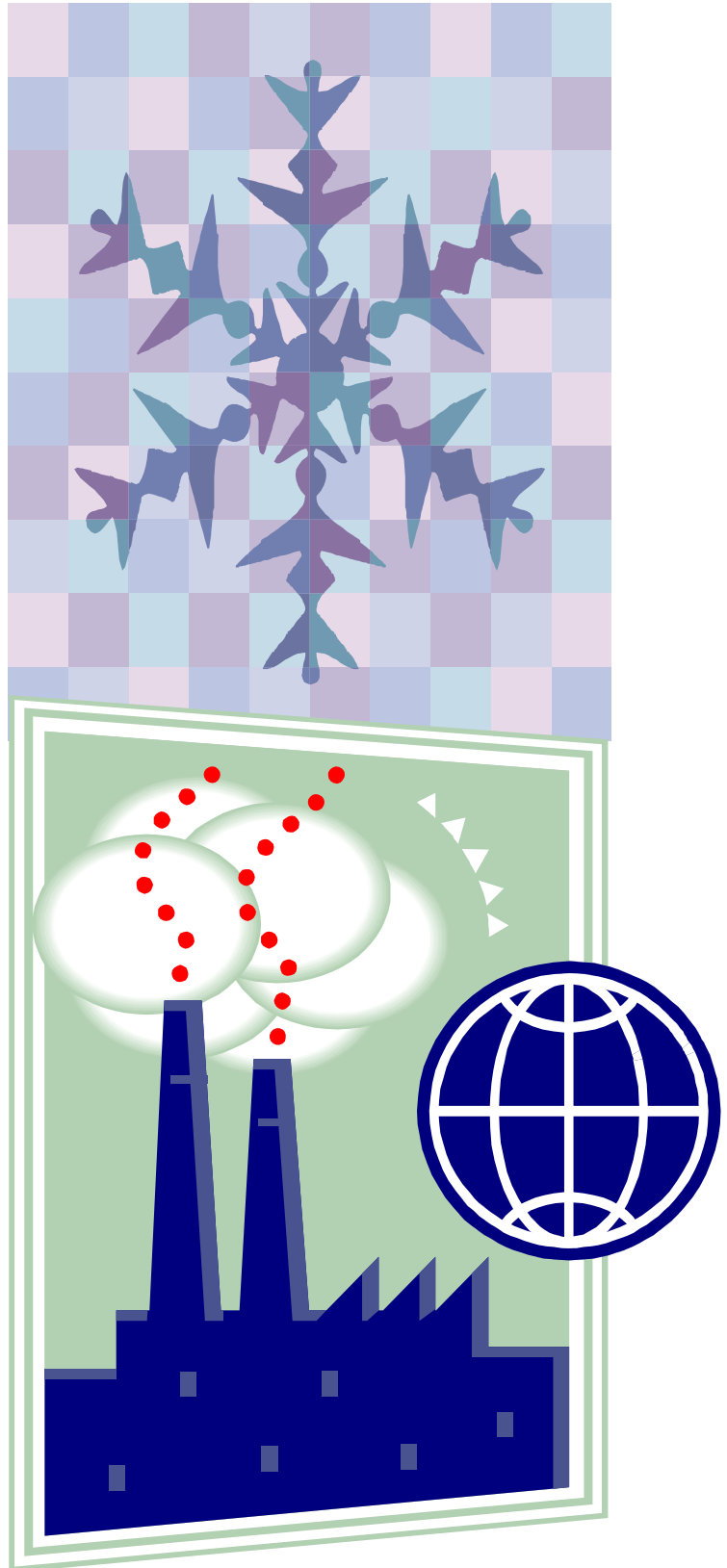


**Micro Industrial Models
Thru Miniaturization
Version 1.1**

A white paper

**CVMark Consulting
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Foreword

Technologies impact the way we work and often, they redefine the way we do things. In a market driven economy, exposing customers to ones products, in their best possible and feasible form, needs a variety of marketing and communication tools. Products and systems that are by design, large and complex, have difficulties in conveying their perceived, visual and functional appeal to the customers. The art and science of miniaturization offers very attractive proposition to organizations in making their industrial products and systems, an important point of discussion.

This white paper, is brought out as an exercise to market creation of miniaturized industrial model making. The paper touches upon the nuances of this trade and highlights its power as a new marketing tool that is redefining the way organizations would market their products, train their employees, exhibit their wares and support their strategic discussions.

The paper is intended to showcase an opportunity for engineers and entrepreneurs, who would be interested in this niche area for evolving their skills. The paper is above all, intended for engineering and industrial stakeholders, who are ever eager to find new ways to advance their products to their customers.

The white paper limits itself to a high level overview and content of miniaturization of industrial products and systems, and is intended to be a fore runner to a sequence of white papers in specific domains.

CVMark
Bangalore, 2005

Summary

Miniaturization of real life objects, *per se*, is an age old practice; however, miniaturization of industrial / engineering objects is not so. Making miniature models of industrial objects is a very specialized practice. Miniature models of real world objects provide those utilities of these objects, that are not readily fulfilled by original objects owing to size, cost or location constraints.

Today, industries are exploiting miniaturized models for various activities that include:

1. Showcasing: in exhibition, board room and corporate office e.g. plant landscape, process layout, infrastructural setup, complex large products etc.
2. Walk-thru exercise and Workflow simulation: through visualization of spatially large systems e.g. cement plant, power plant, automobile factory, steel mill etc.
3. Instructions & Training: to recruits, employees, customers and students, about features and functionalities of products and systems e.g. engine, high voltage switchgear, transformer, robot etc.
4. Working demonstration: Robot, conveyor system, lathe etc.

Customers of these models need to understand that model making involves very high level of engineering skills and such projects need to be carried out as any other engineering project.

Miniaturization of industrial product/ system is highly complex and customized process; and it follows the normal industrial practice of order handling. The complexity of engineering models is owing to, involvement of expert professionals in drafting the requirements of miniaturization models. The specification documents for engineering models e.g. battle tank, normally run over 50 pages of print and the order handling process follows the typical technical and general bidding process. Designs of engineering models are constrained by respective engineering standards. These have rigid scaling and precision contours based upon industrial tolerances. Design of complex internal details and manufacturing of components suitable for uncompromising assembly, demand sophisticated engineering skills.

The availability of micro manufacturing techniques and modern materials has led to increasing level of activities in the development complex micro models. Further, *growth of market driven economies has resulted in, more and more industries finding miniature models of their products, systems, locations and plants; as a very strong tool to support a variety of internal and external decision making systems.*

The exhibits shown here, stand testimony to the fineness and capability of this profession in providing an effective tool for marketing industrial products and systems that are large and complex.

1. Introduction

Miniaturization, with respect to model making, is the process of representing real life objects in smaller scale, to provide utilities, that are not readily fulfilled by original objects owing to size, cost or location constraints. The utilities offered by miniaturizing objects include

1. Showcasing: in exhibition, board room and corporate office e.g. plant landscape, process layout, infrastructural layout, complex large products and systems etc.
2. Walk-thru exercise and Workflow simulation: through visualization of spatially large systems e.g. cement plant, automobile factory, steel mill etc.
3. Instructions & Training: to recruits, employees, customers and students, about features and functionalities of products and systems e.g. engine, high voltage switchgear, transformer, robot etc.
4. Gift & memento: for customers, guests and team, e.g. car, rocket, tanks etc.
5. Working demonstration: Robot, conveyor system, lathe etc.
6. Hobbyism: toys, automobiles, guns, dolls, airplane etc.

In general, the scope of miniaturization varies from small and mass produced toys and mementoes to highly customized scaled down intricate models of large industrial plants.

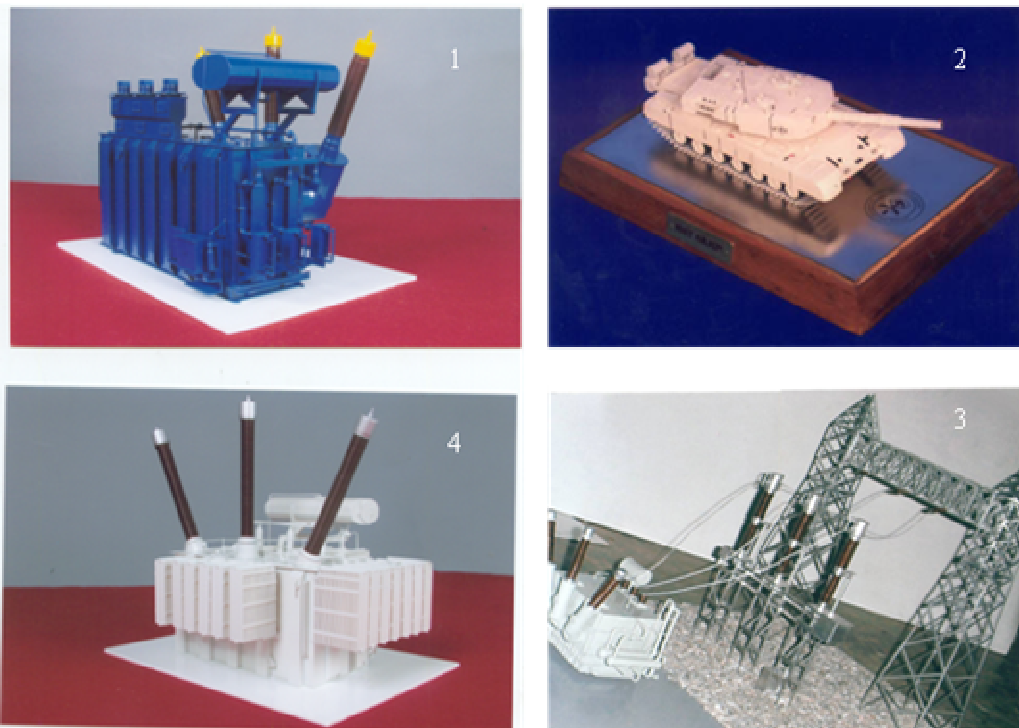


Figure 1: Micro Industrial Models

1.High Voltage Reactor, 2. Battle Tank 3. Special substation, 4.400MVA Transformer

Unlike the making of general commercial models used by kids, making industrial models that include engineering objects, is an engineering practice that involves mastering multidisciplinary approach. It needs expertise in industrial design, knowledge of assembly and precision manufacturing process, adeptness in painting, special carving and cutting process; ability to handle tiny components and special materials; and experience in structural landscaping. In making dynamic (or live) models, implementation of advanced industrial automation techniques is required, e.g. making miniature model of car welding process by robots, requires automation of welding process by using programmable logic controllers.

The miniaturization of engineering objects, often, needs skill-sets that are significantly different from re-engineering an original product or system. *It is actually, watch making versus clock making, where precision counts on all aspects, while seeking full compatibility with real life engineering objects.* A project landscaping like that of Hydro Power Plant, needs skills beyond manufacturing engineering, e.g. the conceptual angle of micro scaling and joint making, landscaping and onsite installation.

2. Complexity of Industrial Models

Miniaturization of engineering models is, therefore, the most complex and challenging of all categories of miniaturization of real life objects.

Complexity-wise, the miniaturization domain can be classified as shown in following figure.

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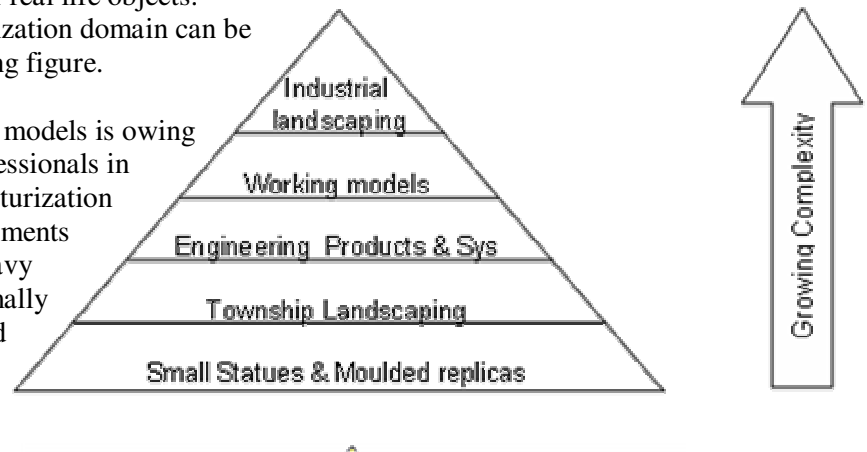


Figure 2: Complexity pyramid of miniaturization

Designs of engineering models are constrained by respective engineering standards. These have rigid scaling and precision contours based upon industrial tolerances. Design of complex internal details and manufacturing of components suitable for uncompromising assembly, demand sophisticated engineering skills. A key differentiators of engineering miniature models is their requirement of durability, that becomes significant challenge to the engineering team, when the models are dynamic. The dynamic models, apart from needing the home automation electronics, require implementation of industrial automation and control systems, often with user application software. Most of the engineering models are custom built that need very high level of engineering innovation in materials, tools and manufacturing process.

3. Process of Miniaturization

The process of miniaturization of engineering objects, typically, follows the process similar to that involved in manufacturing custom built engineering products. Starting with engineering specifications, it follows thru design phase that specifies material, process, tools, machines, drawings, components and assembly. Thus far, miniaturization has been assumed as an art than a science; undermining professional requirement of delivering a quality solution. Steep time constraint demands specialists to work with scantiest details. Of course, that is the situation, where skill and experience of engineering designer comes into play. Although, there are instances when exact replicas have been done with mere a couple of photographs supplied by clients, client's awareness of the process of miniaturization, as an engineering practice, helps in delivering high quality models. Normally, visit to site to see the actual product and system has no replacement.

Miniaturization of engineering objects need every inch of details as their acceptability is often quite a bit subjective also. Quality elements that go into miniaturized model includes finish, attention to details, reliability, environment effect, strength, life, paint, joints, machining, labeling and photographing.



Figure 3: Miniaturization of a 3000TPD Cement Mill, the largest Cement Plant in India

4. Evolution of Miniature Models

Statues and toys were, probably, the first category of miniaturization, that were done to emulate real-life objects, as they gave an opportunity to hold these objects by hands closer to oneself.

Industrial objects used for miniaturization started as a hobby with hobbyists around the world building scale down models of trains, ships, cars and airplanes. Gradually, these moved over into higher end toy system industry, where these were produced in mass.

However, utility of these miniature models are limited to personal possession, kid's play and hobbyism. The instances of scaled down engineering models are mostly limited to laboratory models, where they are used to enhance visualization.

The advent of sophisticated machines allowed micro finish and micro cutting possible, that in turn enabled creation of delicate parts of modern material at sub-millimeter levels widespread.

Laser cutting technology is one such pioneering innovation that helped achieving higher productivity and enhanced detailing in miniaturization possible. Above all the sweeping changes brought in by market driven economy, led to industries exploiting engineering models for real business needs.

5. Use of Miniatures in Industry

Today, industries use these models by demanding intricacies matching to that of the original products/systems. Miniature models are now used to carry out design reviews of large engineering products, such as military tanks and electric transformers. Models of a system like, power plant, are used to study the infrastructural landscaping, space utilization and process flow. Almost all industries, whether of product or project type, use models for training their employees and engineers on engineering and operational features. Miniaturized models find significant advantages in product design labs that carry out solid modeling of these products e.g. turbine, jet fighter plane, high voltage switchgear etc. The miniaturization that occurs over a scale of more than 1:1000 e.g. a hydro electric plant, has huge benefits in several organizational decision making systems. Miniatures that capture bird's eye-view of a layout or landscape have been regularly used during launch of major green field projects and, such models, typically, are point of discussion for executive and strategic decision making.



Figure 4: On site Micro Landscaping of 1000 MW, Hydro Electric Plant at Bhopal over Narmada river

For large organizations, who manufacture a range of products over many domains, it is inconceivable to showcase their complete range of products to enterprise customers in one place and offer an integrated value. Miniaturization of products and systems, and presentation of these in a well knit cluster offers the only best solution to such organizations. ABB, a conglomerate with a wide ranging products and systems had no place on the earth, where it could demonstrate its value across value chain. It has now built a world class demonstration center in India, that is a combination of miniaturization of large systems and actual but smaller products, to weave a story that tells at one location about what is ABB. The demonstration center is used to showcase ABB's mind-boggling value chain in power and automation technology. The same model of representation is now being replicated in its Corporate Research Center in Sweden.

In a market driven economy, scaled down, packaged and portable models of large products e.g. substation, test lab facility, cooling towers, gas turbine etc, thus provide significant flexibility and cost effectiveness in showcasing and demonstrating key features in large exhibitions.

Organizations that are in the forefront of exploiting utility of miniaturization include, project offices, consultants, exhibition offices, product organizations, R&D organizations, defense(tank, missiles, gun, ship, airplane), educational institutions, transportation and space Industry.

The value chain ideally starts at Industrial Designers and Consultant level for both discrete and process plants, e.g. Cement, Steel , Power Station, Windmill , Refinery, Automobile, Food and Pharmaceutical industries.

6. Miniature Industry Models are Customized Products

Miniaturization is not a straight forward product manufacturing but each miniaturization job is a solution that has significant customization. The required effort and skillset, depends on the purpose of miniaturization, the object, the scale, the choice of material and aesthetics. The pricing of miniaturized products (that are not mass products) is quite tricky and it needs to be

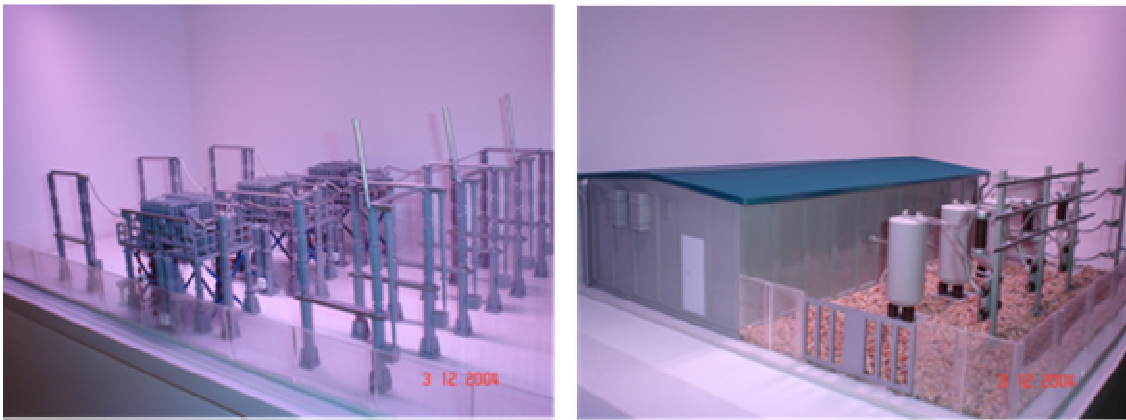


Figure 5: Power system micro structures, ABB Corporate Research, Sweden

worked out from first principle. The process starts with interaction with customers to understand their needs, working thru their requirements and coming out with an agreed specifications. The agreed specification is the basis of estimating effort. The effort there onward involves, drafting and design of each components and assembly, choice of material, tools and manufacturing process; and adherence to special processes including gluing, testing, packaging and transportation. Packaging and transportation is a very critical part of successful delivery. In most of the cases, it involves site installation and structural landscaping, since the developers are the best to install a system like substation or a cement plant that would contain thousands of small parts.

7. Miniature Models in Market Driven Economy

Miniaturization of general consumer products, has merged with toy industry and is a flourishing business. Industrial product miniaturization has been in practice, predominantly, in developed countries and in those countries that have adopted market driven economy. Emerging countries like, India, opening itself to globalization and the eventual privatization, is rapidly moving from command economy to market driven economy. Miniature models are likely to find growing demands in these regions, although there are very few local miniaturization engineering skills available.

Organizations offering world-class miniaturizations of engineering products and systems are rare breed. One exception is Precise Engineering of Bangalore, India. Over past five years, it has served over 40 customers from varied industries and has provided “wow !” impression to the models. Precise has been serving defense, power, automobile and cement industries in India and abroad. Nityanand Mahale, partner Precise Engineering summarizes this world by “*a complex mix of engineering discipline requiring knowledge of real-world product and a high level visualization and miniaturization skills*”. The market is still nascent in India, but customer awareness created by Precise is giving a sort of buoyancy that makes this business a special place in engineering and marketing industry. In less than a quarter of the year, order booking of Precise is reaching close to 50% of last year’s revenue. His team has recently delivered miniaturized model of the largest capacity cement plant of India; and is now busy miniaturizing a major Rural Electrification Project for a multinational company.



Figure 6: Nityanand Mahale at ABB Corporate Research Center, Sweden; during installation of Micro Power System Structures

Entrepreneurs who have a knack for materials, machining and space, would find this business very appealing, as it provides a large scope for seeking perfection, while providing a good business sense. India is a land of huge engineering talents; and miniaturization that needs sleek resources and small investment; could be one area beckoning innate engineers to try their imagination.

8. Closing Note

The team developing a green field project or product, has to gain immense visualization by using a scaled down models as a point of discussion. Builders of complex and sophisticated large products and owner of large manufacturing or processing plants, could capture details of these objects, physically existing in the form of miniature models, in their board room, reception, training room, marketing office or in exhibition hall. In the coming days, miniaturization of industrial models will give a reason to pull attention towards products and establishment. As it is true; there is no replacement to exact replica that is physically present in front of audience.

9. Related Publications

1. A whitepaper on “Showcase your Cement Plant through Micro-modelling”.
2. A whitepaper on “Showcasing Power Industry through Micro-modelling”.
3. A whitepaper on “Showcasing Engineering Products and Systems through Micro-Modeling”.

These are also available as downloads from <http://www.enggmodels.com>

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