Manufacturing For Design (MFD)

Sangkee Min
Mechanical Staff Scientist, Engineering Division
Lawrence Berkeley National Laboratory

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1. Definition

Manufacturing for Design (MFD) is a new manufacturing paradigm that enables industry and academia to design products with any possible materials, any features and shapes, and wide range of technical specifications. In other words, MFD is to provide an extreme design tool by removing all the constraints and limitations of manufacturing including material selection, feature design, tolerance, etc. This new paradigm will offer new business opportunity, innovative product concept, and creative economy.

2. Introduction

Manufacturing recently became extremely important strategic focus of many countries lead by U.S.A., China, Japan, and Germany. Recently emerged paradigms are 'industry 4.0', additive manufacturing, and sustainable manufacturing. Most of these eventually pursue maximum productivity, flexibility, and highly customized production using various manufacturing technologies such as complete automation, flexible manufacturing, smart factory, etc. DFM (Design For Manufacturing) is one of key methodologies to achieve those objectives by promptly reducing design-to-manufacturing cycle and is still critical practice for industry.

An experienced designer who understands manufacturability of designed features, materials, and tolerances removes any uncertainties at the design stage and delivers ready-to-manufacture designs. Over the years of training and accumulated knowledge gradually narrows down design creativity while it delivers efficiency. Therefore, it is extremely difficult to break through the framework he or she has been building and innovative design is rarely possible.

The computer case with aluminum processed by machining shocked industrial community for two reasons: first 'aluminum' case for consumer electronics was nonsense and second, 'machining' for mass production was not cost effective. Aluminum has never been considered as the material for consumer electronics and machining has never been practiced in mass manufacturing except automotive industry where its manufacturing cost can be compensated. With this revolutionary manufacturing practice, Apple offers a big question to the manufacturing community. What is the manufacturing innovation?

3. Approach and Outcome

MFD is to provide a manufacturing solution to any combination of materials, features, and specifications. The final goal of MFD is to remove any manufacturability issues so that any shape of any material with any specification becomes possible.

- Material Innovation: Manufacturing is to form or change a shape of material to be useful. Each industry conventionally uses a typical set of materials but emerging trend shows potential of the following three types of materials.

  - Non-engineering materials

- Criss-crossing materials
- Emerging materials

The biggest challenge of utilizing these materials is a lack of feasible manufacturing technologies to turn these materials into meaningful industrial products. MFD will survey array of materials in the abovementioned categories in terms of pre-defined aspects and manufacturing feasibility. This will connects current manufacturing technologies and list of challenges that will be allocated to appropriate manufacturing experts and community.

- Feature and Specification Innovation: Many designs have to comprise its intended shapes, features, or specifications such as tolerances and surface quality due to manufacturing constraints. These comprises reduce design creativity and function and value of the product. MFD will survey all these limitations in every processing technology and materials. Outcome will generate clear technology development guideline and lay out development roadmap.

- Processing Innovation: Manufacturing community in general is very conservative and risk reluctant due to huge responsibility on production delay and failure and capital investment. Manufacturing technology has been improved and innovated over last decades thanks to many efforts from manufacturing community and enabling technology in other fields. MFD will survey every manufacturing technology and identify its manufacturing capability relating materials, products, features, specifications, etc. The survey will provide reassignment of processing technology to a certain material, feature, specification, and product, hybrid multiple manufacturing technologies, and envision technology roadmap for future development.

MFD will offer potentials for materials selection, feature and specifications flexibility, and processing innovation. This strong tool will benefit all industry for innovative new product development, innovative manufacturing, and innovative business development.

4. Leadership

Industry should and does practice DFM for maximum value added process. MFD requires years of efforts to provide potentials for industry to use. Therefore, government and research institutes should drive MFD with active participation of industry.

5. Justification

Many manufacturing countries are facing a critical turning point. U.S.A. recognized the critical importance of manufacturing in overall economy and promotes various manufacturing propaganda. China is changing their manufacturing practices from cheap labor-based manufacturing to high-value added manufacturing. Germany established a new paradigm (Industry 4.0) and is trying to dominate leading efforts. Japan is reinforcing their manufacturing excellency.

Manufacturing industry in Korea is often compared to a sandwich between leading manufacturing countries such as Japan and Germany and followers such as China. Without breakthrough strategy, Korean manufacturing would not survive over this harsh international competition. In particular, SMEs (Small and Medium Enterprise) will be the first scapegoat. Fall of SMEs leads to a collapse of supply chain and in turn big manufacturers.

MFD will provides many potentials to SMEs and also to big manufacturers as below but not limited to;

- Innovative and creative product development potential,

- Innovative processing technology potential,
- Innovative business development potential.

6. New Paradigm and Credits

The concept of MFD is developed by Dr. Sangkee Min, a mechanical staff scientist at LBNL (Lawrence Berkeley National Laboratory) and an assistant professor at University of Wisconsin-Madison in U.S.A. This innovative idea is a result of years of Dr. Min's industrial and government experiences. He has been working as a designer, a manufacturing engineer, an assistant to government manufacturing policy and R&D development. This new way of thinking is a result of inverse concept and when this new paradigm was presented to a couple of industry and science practice, it resulted in unexpected innovation.

Dr. Min plans to create MFD society, journals, and consortium. UW-Madison and partners in Korea will be a leading body of MFD society.