Preface

With the growing importance of creating value-added products in the industrial area, the product design should be, more or less, carried out by integrating various knowledge in differing engineering spheres, and in certain cases, we also need to incorporate the knowledge obtainable from the liberal arts and concerns. In fact, we have recently had some newcomers even in the engineering field, e.g. biomechanical engineering, medical engineering, rehabilitation engineering and liberal-arts engineering. In accordance with ‘Issues in Science and technology’ 2002, an argument in USA placed its stress on the cultivation of the production engineer, who is capable of encompassing ‘Liberal-Arts Engineering’, and in 2007 CDIO has incorporated a lecture course called ‘External and Social Context’.¹

In retrospect, the concept of the ‘Culture of Manufacturing’ was proposed in the 1990s as an idea for the synergy of the production technology and the industrial sociology. In short, we must use the knowledge of wider scope than ever before in the product design, so that the product can have the potential to overcome the cutting-edge competitiveness in the world market. More specifically, we must conduct the product design by positively using the multidisciplinary and trans-disciplinary knowledge, where the former and latter mean those across the whole engineering fields and far beyond the circumference of engineering, e.g. sociology, folklore and geopolitics, respectively.

Conceptually, we can, for example, nominate the ‘Heat Sink Devices’ for the personal computer and supercomputer, and also the ‘In-Mould Decoration (IMD)’ as the representatives of such products. In fact, the higher the computational speed, the more difficult is the heat dissipation. As is widely known, the rise in temperature results in performance deterioration of the computer. More specifically, the heat sink technology ranges from the CPU design and heat dissipation remedy of the main unit, through performance enhancement of the heat sink device itself, to the manufacturability of devices.

A burning issue is, thus, to what extent an individual engineer should manage to solve an engineering problem. As can be readily seen, we used to manage such

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¹ CDIO is a network among universities and institutes to conduct the creative engineering education for the new area under an acronym to represent ‘Conceive-Design-Implement-Operate’ (http://www.cdio.org).
activities with a group of engineers with different talents, also involving people from the liberal arts. In this case, it is desirable that a group leader should have his or her own leading specified field and also wider knowledge about tail-off covering technologies, although we face acute shortage of such engineers. In many respects, the more the innovation in the product, the more necessary it is to foster the multitalented engineer.

In fact, nearly all universities as yet have no established educational programme compatible with such a requirement. Reportedly, we have had some proposals for such a challenging programme, but are yet to hear a success story. In addition, there have been no noteworthy publications discussing engineering problems, which range from multidisciplinary to transdisciplinary professional spheres. For example, the Indian Institute of Information Technology, Design and Manufacture in Jabalpur (IIITDM-J) has been challenging such an educational programme with the cooperation of the Japanese Government since its foundation around 2005. In short, the foundation philosophy is based on the extreme fusion of the information and production technologies.

In consideration of such environments surrounding the university, this textbook was planned especially aiming at the qualification enhancement of both post-graduate students and young academic staffs in the university. The editor and contributing authors expect the noteworthy fruition of the textbook to foster multitalented engineers and also to support Continuing Professional Development (CPD) of the experienced engineer, including self-learning. The textbook can be characterised by its challenging and unique aspects, which are facilitated by the necessary and inevitable knowledge and remedies in consideration of the essential features of each engineering problem.

For the ease of understanding such aspects, a quick note will be given in the following by taking IMD as an example. IMD has been mushroomed in the telecommunication, home appliances, electronics, motorcar, metre, medical devices, toys and cosmetics industries, and can benefit product differentiation by combining the functional and unique graphics with plastic-moulded components. In addition, IMD can reduce, at least, the cost related to the overlying label applications and post-mould processes.

More specifically, the IMD technology is a synthetic technology, and consists of the (1) colour and decoration design by Computer Graphics (CG) including the industrial design and considering the cultural and mindset differences in each nation, (2) printing technology of the output of CG on the in-mould transfer foil after deploying three-dimensional patterns to that in two-dimensional plane, (3) ink technology for thermoforming and distortion graphics and also the foil engineering, (4) plastic injection moulding technology with inserting the graphic overlay, and (5) moulding die manufacturing. Of note, IMD is, in certain cases, called ‘Insert-Mould Decoration’ or Film Insert Moulding.

Figure 1 shows a first-hand view of primary concerns in IMD together with some examples of engineering problems. As can be readily seen, the in-mould transfer foil is dominant in IMD, and we have a considerable number of manufacturers who have been providing various foils on the market. Figure 2 is a
schematic view of IMD processes, and herein the hard coat is stuck on the product surface while peeling off from the backed-up layer, e.g. PET film, in the foil, i.e. pattern transferring. In general, the in-mould transfer foil is provided with functionalities, for example (1) higher transparency, (2) higher hardness, (3) better printability, (4) ease of moulding, and (5) static-free characteristics.

Of note, the advantageous features of IMD are as follows:

(1) Ease of providing product with hard-coating and scratch-resistant surface texture.
(2) Protection of surface texture with intricate and stunning graphics of various images.
(3) Easier to recycle with less contamination.

Summarising, it is worth noting that the first-hand view of current engineering problems is useful to grasp at a glance to what extent the problem expands and what sciences and technologies are concerned. Each chapter will thus illustrate quickly the corresponding first-hand view.

The book consists of 13 chapters, and the contributing authors are as follows:

Chapter 1 “Tangential Force Ratio and Its Applications to Industrial Technologies: Anti-Vibration Steel Plate for Refrigerator and Derailment of Rolling Stock”: Professor Emeritus of Tokyo Institute of Technology, Dr.-Eng. C Eng FIET, Yoshimi Ito.

Chapter 2 “In-Process Measurement for Machining States: Sensing Technology in Noisy Space”: Yoshimi Ito.

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**Fig. 1** First-hand view for and primary concerns of engineering problems in IMD
Fig. 2 Conceptual illustration of IMD

**Chapter 3** “Ultrasonic Waves Method for Interface Pressure Measurement: What is *Acceptable Definition of Interface Pressure*”: Yoshimi Ito.

**Chapter 4** “The Painless Injection Tube: From Bio-mimetic Technology to Medical Engineering”: Associate Professor of Tokai University, Kazuyoshi Tsuchiya.

**Chapter 5** “Water-jet Machining and Its Applications: Relaxation of Stress Concentration in Cylindrical Roller Bearing and Preferable Finish of Artificial Joints”: Associate Professor of the University of Tokyo, Dr.-Eng. Shin’ichi Warisawa.

**Chapter 6** “Heat Sinks in Computers”: Past Professor of Tokyo Institute of Technology, Dr.-Eng. Wataru Nakayama.

**Chapter 7** “Noise, Vibration and Pulsation Problems in Oil Hydraulic Components and Systems”: Past Departmental Director and Chief Engineer of Fuji-koshi, Takashi Nishimoto.

**Chapter 8** “Design and Development of Construction Equipment”: Manager, Construction Equipment Development Centre, Hitachi Construction Machinery, Hiroshi Tsukui.

**Chapter 9** “Remanufacturing at Machine Shop: Reuse and Disposal of Swarf”: Yoshimi Ito.

**Chapter 10** “Similarity Evaluation for Flexible Manufacturing Cell: An Interesting Application of Graph Theory to Manufacture”: Yoshimi Ito.
Chapter 11 “Model Determination for Production Activities within Enterprises: A Challenging Trial for Virtual Concentration of Production Bases”: Yoshimi Ito.


Chapter 13 “Clarification for Essential Features of Scrapped Slideway by Step-Land Bearing Model: Conversion of Skilled Craft to Industrial Technology”: Yoshimi Ito.