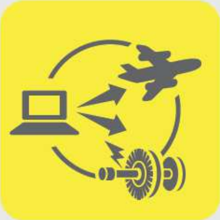

# “Materials Integration” for Revolutionary Design System of Structural Materials

## Significant reduction of cost and period for structural materials development by Materials Integration (MI)

**Manufacturing industries are dramatically changing because western countries, China, and other foreign countries intensively invest in materials development that is fully using artificial intelligence (AI).
To maintain and develop strength in the Japanese materials developments, it is necessary to significantly reduce cost and dramatically shorten the development period.
In Japan, Materials Integration (MI) has been constructed for the first time in the world by utilizing the high-quality data in the field of materials science. The final goal of this project is to construct a novel MI system for the inverse design, which can create suitable materials, processes, and structures from the required performance. Furthermore, super high performance structural materials developed by MI will be implemented socially and the reliability evaluation techniques for structural materials will be also established.**


Program Director

**Yoshinao Mishima**

Professor Emeritus and Former President,
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Executive Director, Technology Strategy Center,
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**Profile**

1975:Master’s degree in Metallurgical Engineering at Tokyo Institute of Technology (TIT); 1979:Ph.D. at the University of California, Berkeley, Assistant Research Engineer; 1981:Assistant Professor at the Precision and Intelligence Laboratory (P&I), TIT; 1989:Associate Professor, P&I; 1997:Professor, Department of Materials Science & Engineering, TIT Interdisciplinary Graduate School of Science and Engineering and Dean in 2006; 2010:Director, the Frontier Research Center; 2011:Director and Executive Vice President for Education and International Affairs, TIT; 2012-2018:President of TIT. Prof. Mishima has served in several government committees, including the Council for Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology and the Industrial Structure Council of the Ministry of Economy, Trade and Industry.

### Research and Development Topics

In this project, we focus on the following three targets:
- MI system for the inverse design will be utilized for the process from material to structure.
- Reduction of cost and shortening of development period will be demonstrated for structural materials development in MI platform.
- The successful examples of the application in structural materials will be created to introduce MI system for inverse design into industry.

#### (A) Development of MI system technology for the inverse design

The novel MI platform for the inverse design will be developed for the application in material research field, and we particularly focus on the inverse design to optimize the materials and process from expected performance. We will establish the platform by combining AI technology with the analytical technique effectively, advancing the following developments. ① Original MI platform for the inverse design. ② Novel calculation modules to apply the inverse design to various cutting-edge process in materials science and engineering. ③ Design technique for simulations from atomic scale to materials structure. ④ All-in-one system which enable the direct design unified ① ~ ③ and ⑤ Data base platform for the development of structural materials.

#### (B) Application of MI for the inverse design into the development structural materials

The structural materials which we focus in this project have been strongly developed in Japan and are internationally required as low-cost, heat-resistant, lightweight and high-strength materials. Japan has strengths in the advanced materials which include metal such as iron, steel, aluminum alloy, heat-resistant alloy and intermetallic compounds as well as nonmetal such as carbon fiber reinforced plastic (CFRP), ceramics, polymers and composite of these materials. And these materials will be developed in this project as the requirements are internationally increasing.

### Implementation Structure

Program Director (PD) manages to design the research and development plan and promotes this project. Promoting committee consisted of relevant ministries, agencies and experts is established to manage this project comprehensively. PD is chairman and this committee is administered by the Cabinet Office. Public offering of this project is carried out to select researchers through the utilization of grants from Japan Science and Technology Agency (JST). The proposals of the researchers are properly examined by the selection committee in JST and are flexibly selected by collaborating with the promoting committee based on the research and development plan. This project promotes through the organizations of universities, national research institutes, and private companies. The co-leader structure consisted of researchers at companies, universities (or national institutes) are introduced in this research teams to promote Industry-University cooperation. Intellectual property committee is established to keep and improve international competitiveness, especially patent strategy. International cooperation team is also set to understand overseas situation. JST manages the progress of each subject.

## Exit Strategies

The significant reduction of cost and the dramatic shortening of the period to develop materials and process will be realized by the introduction of MI into the development of various cutting-edge structural materials.
This project will contribute to Japanese materials industry and the further strengthening the international competitiveness of Japan.

- Introduction of next-generation MI system for the inverse design into the application of structural materials. The utilization of new MI system in Japanese industries.
- MI will be applied to cutting-edge materials and process such as airframe, engine of aircraft and turbine of power generator. As a result of this project, it will be implemented in material and heavy industries manufacturers.

## Expected Outcomes

(1) Information science (cyber) will be fused into materials science (physical) through development of novel MI platform for the inverse design. The final goals in this project are 50% reduction of the cost and 50% shorting of the period for materials development by newly developed MI. Achieve a materials revolution by building a framework for utilizing MI widely in companies or research institutes and derive new functions of the materials.

(2) Advanced process for the composite materials which have high design flexibility or heat-resistant alloys will be developed by the introduction of MI for the inverse design. Materials obtained by using MI will be utilized for environment/energy industry, such as power plant and aviation industry. In particular, the aircraft materials with specific strength, heat resistance, high reliability, and lightweight and high design flexibility will be requested in the aircraft industry. The improvement obtained as a result of this project will be introduced into small and medium-sized aircrafts as well as next-generation aircrafts which will be required in the future. Develop composite materials with heat resistance and lightweight will spread into the turbine of industrial power plant in energy and environment fields.

(3) Develop novel powder process technology such as 3D layered molding will more widely spread the utilization for complex shape elements in industrial power plant.