The Leading Program for Innovation of Manufacturing in Japan

- The project outline of “SIP: Innovative Design/Manufacturing Technologies” -

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1. Policy tools for innovation

2. Outline of SIP: Innovative Design/Manufacturing Technologies

3. Abstracts of R&D themes (Excerpts)

4. Closing Remarks
Three Arrows of the Economic Policies

1st
Bold Monetary Policy

2nd
Flexible Fiscal Policy

3rd
Japan Revitalization Strategy
New Growth Strategy

Cabinet decision on June 14, 2013

Closely linked with...

Three Action Plans

I. Plan for the Revitalization of Japanese Industry

II. Strategic Market Creation Plan

III. Strategy of Global Outreach

“Comprehensive STI Strategy” (Original, June 2013)

✓ Achievement of Council for Science, Technology and Innovation (CSTI)
✓ Cabinet decision on June 7th, 2013
✓ “Comprehensive STI Strategy 2014” was formulated on June 24th, 2014
HQ for Science and Technology to foster innovation
-CSTI: Council for Science, Technology and Innovation-

- Promoting effective measures across ministries to create innovation beyond the borders of disciplines, ministries and sectors

Three Arrows of Reinforcement of the HQ

1st

Improvement of the process for policy-making
“S&T Budgeting Strategy Committee” and “Action Plans for S&T Priority Measures”

- Prioritized area: “Energy”, “Next-generation infrastructures”, “Local resources”, “Health & Medical”
- Budget for FY2015: ¥296B

2nd

SIP (Cross-Ministerial Strategic Innovation Promotion Program)

- Budget for FY2015: ¥50B (FY2014: ¥50B)

3rd

ImPACT (Impulsing Paradigm Change through disruptive Technologies)

- Budget for FY2014-2018: ¥55B
# Prioritized Societal Issues

## Energy
- Innovative combustion technology
- Next-generation power electronics
- Structural Materials for Innovation (SM⁴I)
- Energy carrier
- Next-generation Technology for Ocean Resources Exploration

## Next-Generation Infrastructures
- Automated driving system
- Infrastructure maintenance, renovation and management
- Enhancement of societal resiliency against natural disasters

## Local Resources
- Technologies for creating next-generation agriculture, forestry and fisheries
  - *Innovative design/manufacturing technologies*
Outline of Presentation

1. Policy tools for innovation
2. Outline of SIP: Innovative Design/Manufacturing Technologies
3. Abstracts of R&D themes (Excerpts)
4. Closing Remarks
Shrinkage of Trade Surplus in Manufacturing Industry

The trade surplus in the electrical equipment industry has decreased by around 80% since 2005.

The record trade deficit has been continuing.

(Source) Trade Statistics of Japan, Ministry of Finance

(*) The difference between figures in this Chart and the trade balance in the Balance of Payments Statistics is caused by the difference in calculation methods.

(CY)
## Challenges for Manufacturing Industry of Japan

<table>
<thead>
<tr>
<th>Business Environment</th>
<th>Challenges Needed</th>
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<tbody>
<tr>
<td>High ratio of imported fossil fuel in the energy supply</td>
<td>Economizing energy in products and production processes</td>
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<td>Decreasing birthrate &amp; increasing aging population</td>
<td>Securing human resources and enhancing productivities</td>
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<td>Progress of ICT and manufacturing technologies</td>
<td>Rapid and flexible production reflecting consumer’s diversified requirements</td>
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<td>Globalization, necessity of international cooperation</td>
<td>Contribution by utilizing the strength of technologies of Japan (including SMEs in local economy)</td>
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Objectives of the Project

- To enhance the competitiveness of manufacturing industry by establishing **advanced design systems and novel manufacturing technologies** on the open innovation platform.

- To create new markets through innovation in regions by rolling out the new **“innovation styles”** utilizing innovative design/manufacturing technologies and ideas and know-how of regional manufacturers or citizens.

<table>
<thead>
<tr>
<th>Budget for the program</th>
<th>¥2.55B for FY2015 (¥2.55B for FY2014)</th>
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<tbody>
<tr>
<td>Duration of the program</td>
<td>FY2014-2018 / 5 years (planned)</td>
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<td>Program management agency (Funding agency)</td>
<td>New Energy and Industrial Technology Development Organization (NEDO)</td>
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</tbody>
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Target Outputs

Satisfaction

“Delightful” Manufacturing
- Delight
- Satisfaction
- Amazing

Conventional
- Quality
- Performance

SIP
Innovative design/manufacturing technologies

A. Upstream Delight Design
B. Innovative Agile Manufacturing Technologies
C. “Innovation style”

What’s “delight”? :
The products give users the great pleasure or satisfaction
A: Upstream Delightful Design

New design method which can predict and evaluate the product value at the very early stage of designing process, and can reflect diversity of product value

→ Exceeding the functional design reflecting primary customer’s needs, values, and performance, and bring delight (quality for pleasure, satisfactory, etc.) to users

Personalized
(Eg. Electric appliances)
● New & attractive value indices
  • Sound: minimized → Comfortable
  • Design: Functional → Stylish
  • Spec: Maximized → Stable
● New concept appliances

Industrial
● Customized functions (specifications & costs)
  → Combination of products & services
  → Solution services
● New features to solve customer issues
● Systemized products and services

Providing new values exceeding customer needs

Customer needs model
B: Innovative Agile Manufacturing Technologies

Innovative agile manufacturing technology which can transform idea and design to products with rapidity

- **Manufacturing which has not been practical by now**
  - Technology to generate high value-added product of high strength, long life, etc. using processing resistant material, composite material and advanced material (Ceramics, Gel, Rubber, etc.)
  - New processing technique to dramatically improve functions and performance of conventional processing technique

- **Combination of technologies creating new values**
  - To generate products of non-conventional functions or shape, combination and systematization of new technique and existing processing technique
  - Research on phenomena of complicated machining

- **Minimizing time and costs for R&D and production**
  - Technology of manufacturing which embody new values, concept design and users’ needs with rapidity by fully utilizing IT (IoT, M2M, Smart Factory)
  - Manufacturing and prototyping system to minimize dramatically time and cost of manufacturing process (ex. not to require die & mold)
Innovative Agile Manufacturing Technologies

Products/Services of New Values Exceeding Users Expectations

Additive Manufacturing, Complex Molding/Processing
M2M, IoT, Smart Factory

Exploration of new & additional values (Sensing, Data Analysis, Workshops, etc.)

Prototyping

Element Detailed Design

Concept Design

Design

Functional Specs

Needs/ Data

Upstream Delightful Design

・Value Model
・KPIs

Delightful Design

Collaboration between Delight Design & Manufacturing
Collaboration between Delight Design & Manufacturing

Upstream Delightful Design → Delightful Design → Exploration of new & additional values (Sensing, Data Analysis, Workshops, etc.) → Prototyping → Element Detailed Design → Additive Manufacturing, Complex Molding/Processing → M2M, IoT, Smart Factory → Products/Services

Innovative Agile Manufacturing Technologies

Innovation Styles → Co-creation of Values

Needs/ Data → Functional Specifications → Design → Prototyping/ Production → Products/ Services

Value Model • KPIs

Concept Design

Detailed Design

Products/Services of New Values Exceeding Users Expectations
C: “Innovation Styles”

Collaboration between design and manufacturing + Various groups of players = Co-creation of values

Commercialization of High-value-added products and services
Exploitation of market

User’s voice

Corporate/Consumer Users

Design company Venture

Value exploration
Value design

Innovative technology seeds & idea

Design of Physical Specifications of parts, products and Systems

Public regional technology support organization

Regional company, SMEs

National laboratory

University

Corporate/Individuals

Demonstration Workshop, Data analysis, Knowledge base

Prototyping Manufacturing

Co-creation of values
R&D Themes - Technology Area – Adopted in 2014

**Upstream Delight Design**
- Delightful Design Platform
- Interactive Design Management
- New manufacturing by Additive Manufacturing
- Advanced 3D Modeling Technology Platform
- Resin Materials Advanced Materials

**Innovative Agile manufacturing**
- Idea Support for General View and Product Design
- Bio Innovative Design
- Rubber 3D Printing and Value Co-creation
- 3D-Anisotropy Customized Design and Manufacturing
- Designable Gel 3D Printing
- Fluidic Material 3D Printing
- Multi-scale/multi-material Manufacturing
- High Value Ceramics Modeling Technology
- High Value Laser Coating
- Nano-Assembly Technique of Advanced Materials
- Glass Component Advanced Processing Technology

**Design of Value Exploration**
- Initiative by METI 3D Printing Metal Materials

**Detailed Design and Verification**
- Fusion of Data Mining, GA and Rapid Prototyping
- Upstream Design based on Topology Optimization
- Snow sports gear using computational chemistry
- Construction of Manufacturing Circle by Ota Ward
- Molecule Adhesive Agent
- Metal Surface Processing Based on Actual Work
- Next-generation Electro-chemical Machining

**Support for Design**
- Next-generation 3D Vision Initiative by MIC
- Multi-turret Integrated Processing Machine
- Intelligent Machine Tool by CAM-CNC Integration
- Additive Processing
- Materials Junction
- Forming Processing
- Removal Machining
<table>
<thead>
<tr>
<th>R&amp;D Clusters</th>
<th>R&amp;D Themes</th>
<th>Abstract</th>
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<tr>
<td>Idea Support for General View and Product Design</td>
<td>Development of an integrated framework to manage various data to design products, analytic tools to extract data by various methods, and useful display technology to visualize information.</td>
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<td>Upstream Design based on Topology Optimization</td>
<td>Construct conceptual design methods for macro/micro structures using topology optimization, and develop manufacturing techniques for devices based on the obtained design solutions. Additionally, to fabricate practical devices using the developed manufacturing techniques.</td>
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<tr>
<td>Bio Innovative Design</td>
<td>Biology that has the adaptability and robustness in nature is very attractive to design, but the design is rarely used in mechanical design. In this project, a new design technology called “Bio Innovative Design Technology” is developed.</td>
<td></td>
</tr>
<tr>
<td>3D-Anisotropy Customized Design and Manufacturing</td>
<td>Realizing a continuous streamlined production model from design and rapid making to trial use, delight assessment, after-sales service and feedback, with “Anisotropy” and “Customization” as super upstream design concepts.</td>
<td></td>
</tr>
<tr>
<td>Rubber 3D Printing and Value Co-creation</td>
<td>For integrated molding of shoes sole, novel 3D printer technology will be studied, e.g. using micro reaction field through two-liquid type ink jet nozzle or micro extruder, both of which require research of new rubber formulation.</td>
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<tr>
<td>Advanced 3D Modeling Technology Platform</td>
<td>Development of super 3D fabrication platform and production of high value-added products using stereolithography, which is 3D modeling at the resolution ranging from sub-µm to sub-mm.</td>
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</tr>
<tr>
<td>Delightful Design Platform</td>
<td>It is crucial to produce products with Attractive Quality in the future industry. Conventional design tools like CAD systems lack functionalities to support the design of such products (Delight Design). The main objective is to develop a “Delight Design Platform” which consists of tools and methodologies to achieve the above mentioned support for Delight Design.</td>
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<tr>
<td>Interactive upstream design Management</td>
<td>Design communication tool sets “design brain mapping” with multi-layer/multi-scale/time shifting functions based on test use at consortium for design effectiveness, which is a sensing tool for design process in the companies.</td>
<td></td>
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<tr>
<td>New manufacturing by Additive Manufacturing</td>
<td>・Thorough understanding of phenomena in powder melting and consolidation using laser and process development ・Design methodology development of high style sports prosthesis</td>
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<td>Molecule Adhesive Agent</td>
<td>Research development on the implementation as follow: 1)Clarifying the utilization range through the experiments, 2)Development of materials with adhesion and processing properties, 3)Advancement of adhesion surfaces and 4)Practical application of new functional products</td>
<td></td>
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<tr>
<td>Designable Gel 3D Printing</td>
<td>Based on the world-first 3D gel printing technology, we aim to develop 3D gel printing system to realize free-shape design of soft and wet materials.</td>
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<td>Fluidic Material 3D Printing</td>
<td>In this research and development, 1) To achieve nano-materials of ceramic hybrid functional materials, and to develop highly concentrated and highly functional inks (fluidic materials) 2) To develop 3D additive manufacturing by ink-jet</td>
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## R&D Themes Review (2/2)

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<td>Innovative Complex Molding</td>
<td>Nano-Assembly Technique of Advanced Materials</td>
<td>To overcome difficulties in the conventional powder metallurgy process Development of Functional Powder and Advanced Composite Materials for Potential Use.</td>
</tr>
<tr>
<td></td>
<td>Multi-scale/multi-material Manufacturing</td>
<td>Requirement of 3D printing technology to multi-scale and multi materials Innovation manufacturing of multi-scale and multi materials for seamless composites</td>
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<td></td>
<td>High Value Ceramics Modeling Technology</td>
<td>1) Ceramic powder/slurry layer manufacturing for complex-shaped/hollow- structured products. Ceramic laser sintering which realizes concurrent forming and sintering. 2) Hybrid aerosol deposition (AD) and ultrafine-particle thermal spraying for highly adhesive coating onto 3D surfaces, enhancing design freedom and product functions.</td>
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<td></td>
<td>High Value Laser Coating</td>
<td>The layers composed of high functional and processing-resistant materials and the high added value to overthrows the concept of manufacturing can be realized by the laser coating methods, which contributes the delight design-based manufacturing including user needs such as lightness, thinness, inexpensiveness, saving energy and long life time.</td>
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<td></td>
<td>Glass Component Advanced Processing Technology</td>
<td>In this research theme, we improve speed, precision and area of glass process drastically by elucidating a complicated phenomenon to occur at the time of glass processing.</td>
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<tr>
<td>Combined and Intelligent Machining Technology</td>
<td>Intelligent Machine Tool by CAM-CNC Integration</td>
<td>A new methodology to generate instruction commands for prompt machine control instead of preparing NC programs is developed to realize an innovative intelligent machine tool.</td>
</tr>
<tr>
<td></td>
<td>Next-generation Electro-chemical Machining</td>
<td>Utilizing nanometer order removal unit with high efficiency, machining of cemented carbide and inconel with higher material removal rate and machining accuracy by 40% than conventional ECM, and surface roughness of Ra30nm will be achieved.</td>
</tr>
<tr>
<td></td>
<td>Multi-turret Integrated Processing Machine</td>
<td>Necessity of turning-milling machine tools which are easy usage for high accuracy and high efficiency. In this research, 1) Development of technologies for optimum process planning, 2) Development intelligent machining technology for high accuracy and efficiency, 3) Verification experiment of intelligent machining system for a multi-turret turning-milling machine tool.</td>
</tr>
<tr>
<td>Field-Oriented R&amp;D</td>
<td>Fusion of Data Mining, GA and Rapid Prototyping</td>
<td>Establish a streamlined process of SHISAKU(trial manufacture) business with Knowledge-intensive production and activation by Innovative Industry.</td>
</tr>
<tr>
<td></td>
<td>Snow sports gear using computational chemistry</td>
<td>Based on advanced measurement technique and simulation, we develop snow sports gear (snowboard, chair sky, wax etc.) for the Olympics and Paralympics.</td>
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<tr>
<td></td>
<td>Metal Surface Processing Based on Actual Work</td>
<td>Metal processing technology originated in manufacturers’ craftsperson will be sophisticated by polishing up with cutting-edge sciences.</td>
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<td></td>
<td>Construction of Manufacturing Circle by Ota Ward</td>
<td>Sustainable and evolutionary system for developing innovative products, combined with marketing, business start-up and human resource development</td>
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R&D Themes Examples

- **Advanced 3D Modeling Technology Platform**
  - Polymer model
  - Femtosecond pulsed laser beam

- **Nano-Assembly Technique of Advanced Materials**
  - Photopolymer
  - Polymer model

- **Femtosecond pulsed laser beam**

- **Intelligence-based workspace**
  - Optimize design process

- **Additive Manufacturing**
  - Artificial leg

- **Delightful Design Platform**
  - Advanced Quality
  - Concept Design: NBD (Model-Based Design)
  - Kansei DB
  - Kansei Model

- **Advanced 3D Modeling Technology Platform**
  - Photopolymer
  - Polymer model
R&D Themes – Geographical Distribution

**Star**: Involving Public Research Organization

- **Field-Oriented R&D**
  - Snow sports gear using computational chemistry
  - Metal Surface Processing Based on Actual Work
  - Construction of Manufacturing Circle by Ota Ward
  - Fusion of Data Mining, GA and Rapid Prototyping

- **Combined and Intelligent Machining Technology**
  - Next-generation Electro-chemical Machining
  - Multi-turret Integrated Processing Machine
  - Intelligent Machine Tool by CAM-CNC Integration

- **Optimized Design/Manufacturing**
  - Bio Innovative Design
  - Rubber 3D Printing and Value Co-creation
  - 3D-Anisotropy Customized Design and Manufacturing
  - Idea Support for General View and Product Design
  - Upstream Design based on Topology Optimization

- **Innovative Complex Molding**
  - High Value Laser Coating
  - Glass Component Advanced Processing Technology

- **Innovative Materials and 3D Molding**
  - Designable Gel 3D Printing
  - Fluidic Material 3D Printing
  - Molecule Adhesive Agent

- **Upstream Delightful Design/Manufacturing**
  - Interactive upstream design Management
  - Delightful Design Platform
  - New manufacturing by Additive Manufacturing
  - Advanced 3D Modeling Technology Platform

- **High Value Ceramics Modeling Technology**
- Multi-scale/multi-material Manufacturing
- Nano-Assembly Technique of Advanced Materials
Outline of Presentation

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4. Closing Remarks
Closing Remarks

- New paradigm in manufacturing must realize the total system including design and production process to create new market of “delight products and services”.

- National initiatives are adopted for innovation in manufacturing today in various countries and areas.
  - UK: Catapult Centre
  - DE: Industry 4.0
  - EU: Factories of Future

- New paradigm in manufacturing will be established through collaboration and competition in the global scale.
  - Enough room to learn and collaborate from each other in terms of future technologies
Thank you very much for your kind attention!