Ministry of Education, Culture, Sports, Science and Technology
Commissioned project to Enhance and strengthen
the development of leading management professionals

MOT Education Core Curriculum
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Contents

Introduction ——Background and concept of the development and revision of MOT education core curriculum——

Management of Technology (hereinafter referred to as "MOT") refers to management that effectively explores technologies. In these days with the development of science and technology, technology has extensively and significantly affected business and organizational management as well as society. It means not only new technologies enable product innovation and production process innovation, but also, for example, the development of Information and Communication Technology (ICT) has further influence on the entire value chain of business. Under these circumstances, for businesses and organizations in order to promote creative management and contribute to society, it is increasingly important to understand and utilize technologies, in addition to executing research and development that helps create new technologies. In other words, it is not enough for companies and other organizations to simply pursue technological frontiers; it is indispensable for businesses and organizations to have the management competence to understand the roles of technologies and to take advantage of them. MOT education is offered with the aim of cultivating such management competence.

MOT professional graduate schools that specialize in developing advanced professionals have been established one after another since 2003 in response to the increased social demand for MOT. The aim of these MOT professional graduate schools is to develop human resources with the ability to address various social, corporate, and organizational issues and achieve creative results from synthetic perspectives on technology and management. MOT human resources are not only required to resolve the segmented individual issues with their expertise and skills, but are also expected to plan, develop, and implement comprehensive measures characterized by integrity in terms of a global and societal outlook (to survey all relevant aspects informed by synthetic perspectives on technology and management), foresight, logicality, and effectiveness and lead their company or organization at managerial or leadership positions. In order to ensure the sustainable development of industries and improve their international competitiveness, it is essential to nurture such MOT human resources.

To improve the quality of MOT education and respond to social demand, it is thought to be necessary to develop common educational content to be offered by MOT professional graduate schools and send it out to society. In March 2010, the MOT education core curriculum (hereinafter referred to as *Core Curriculum 2010*) was established based on the discussions among the member schools of the Japan Association of Professional Graduate Schools of Technology Management (J-MOT Association) and insights from the industrial world. Core Curriculum 2010, which was created as the basis of MOT education programs in Japan, indicates the content that all MOT professional graduate school students are supposed to learn, serving as a reference for the curriculums that those schools design. The *Core Curriculum 2010* has been used by MOT professional graduate schools to develop and reshape their courses and played an important role in accreditation.

After the development of *Core Curriculum 2010,* there have been significant advances in globalization and information technology in Japan's society and economy. For example, Japan and East Asia, as well as the Southeast Asian regions, have begun to closely link their production and consumption bases to

each other, which has demanded that MOT human resources should think and act from a global perspective. Also, information technologies including AI (Artificial Intelligence), Big Data, and IoT (Internet-of-Things) have been well accepted by society and brought great changes to our economic activities and lifestyle. MOT human resources must have basic knowledge in mathematical information science.

Such rapid changes in society and economy have made it necessary to revise *Core Curriculum 2010*. In response to this demand, Japanese professional schools have agreed to implement research studies concerning the development of core curriculum in graduate schools for management professionals (MOT field) and revise the MOT education core curriculum as a part of the 2016 Leading Management Human Resource Enhancement and Development Programs, funded by Ministry of Education, Culture, Sports, Science and Technology in Japan. The revision was led by the Revision Committee of the MOT education core curriculum consisting of representatives from J-MOT associate member schools, reflecting the opinions from the industry and other authorities concerned. Core Curriculum 2016, the revised version of the core curriculum, is finally concluded as it is in this booklet.

Core Curriculum 2016 adheres to the framework developed in *Core Curriculum 2010.* It comprises *learning items* (equivalent to *knowledge items* in *Core Curriculum 2010)*, of which all MOT students should learn, and *comprehensive area*s (called *integrated areas* in *Core Curriculum 2010*), which entails creative problem solving based on the use of the knowledge and skills the students acquired. *Leaning items* list that MOT students must obtain as their minimum requirements and the level of achievement that must be attained by them. *Comprehensive areas* describe the problem solving initiatives and the qualitative requirements to which the results of these initiatives are subject.

Considering the multifaceted nature of social expectation to the MOT field and the varied background of students who are going to learn MOT, the program contents and their implementation methods must be diversified. As mentioned above, the MOT education core curriculum is created to systematize and clarify in a written format the minimum achievement requirements that the graduates of the MOT professional graduate school must meet and the level of achievements to be attained. It should not interfere with the uniqueness and diversity of each school. MOT professional graduate schools are responsible for establishing their educational system respecting the development philosophy of the core curriculum and improving the educational quality, while ensuring the consistency with their own diploma policies.

Learning items

Learning items consist of basic learning items and core learning major items. Each of these items consists of a set of included items. Based on the content, basic learning items are described as MOT fundamentals and include the basic knowledge required to understand MOT. It includes basic knowledge required to solve problems from integrative viewpoints on technology and management - ranging from technology knowledge within the context of MOT to those knowledge in accounting, corporate finance, marketing, and others requisite for the management of any companies or organizations. As the name suggests, the core learning major items consist of elements comprising the core and distinctive contents
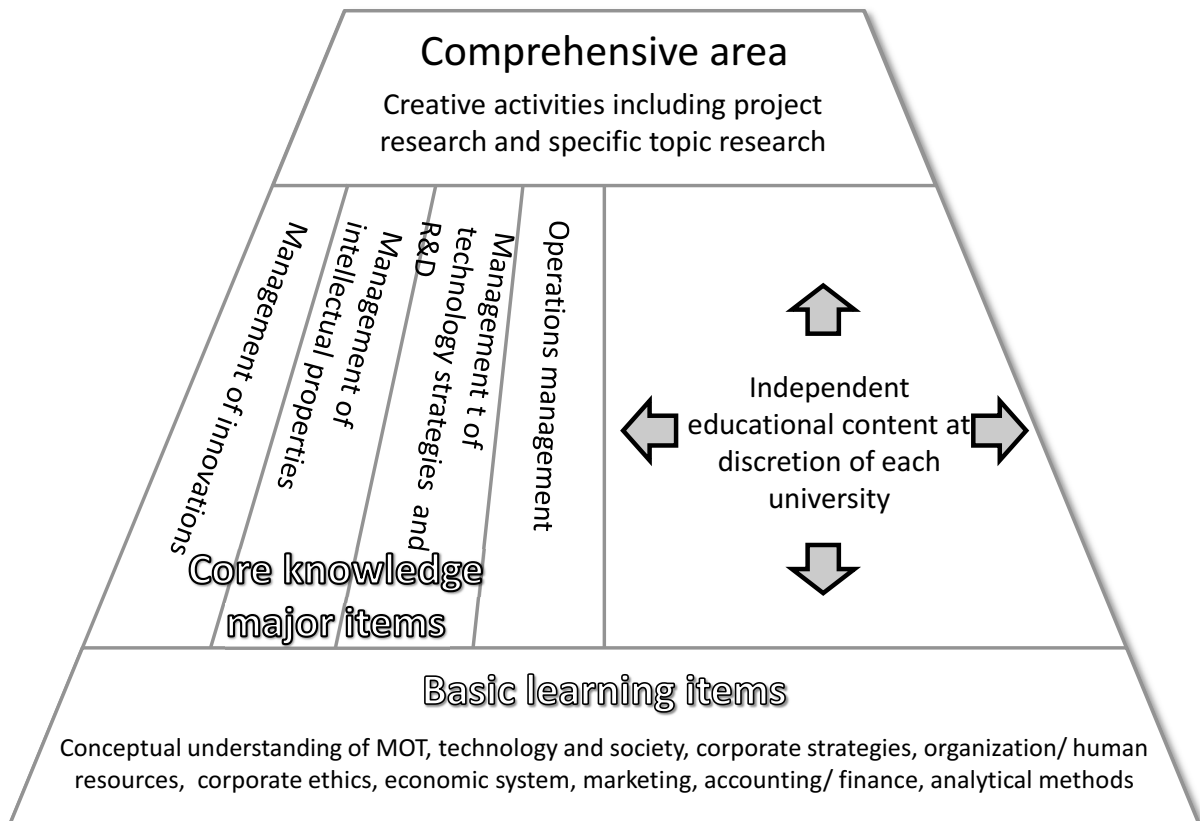
of MOT professional education.

While a graduate of an MOT professional graduate school is expected to demonstrate creative problem-solving skills from multiple viewpoints in MOT in the real world, the MOT graduate will, in practice, be required to collaborate with the relevant sections and personnel in a company or organizations in order to effectively solve problems. Basic knowledge of technology and management will be needed to provide a shared understanding or a common foundation for smoothly promoting such efforts. From this perspective, learning items are presented as the minimum requirement (learning requirements that the graduate must meet) of MOT education. As described earlier, there are diverse situations concerning the systemization of knowledge pertaining to MOT. Therefore, the method of describing the learning items has not yet been completely standardized. More detailed description should help to facilitate an understanding of certain items in some cases.

The names attached to the major and included items are to identify and facilitate the understanding of content that students must learn and are not necessarily consistent with the course titles offered under the major or included items. In addition, a single item in major or included level can be covered through several courses, and the order the items presented does not indicate the order where the education should be provided. There is also no need to constrain teaching style to traditional lecture, i.e., exercises, reading in turn, seminars, practical training, and other approaches may also be applied. Since students enrolling in MOT professional graduate schools have a diverse range of backgrounds, it is consequently conceivable that some of them will already be familiar when they enroll with certain knowledge of the core curriculum. As described earlier, the learning items in the core curriculum define the level of achievement that should be attained by the student. Hence, a student deemed to have already attained a given level of achievement should not be compelled to take a required course and should be dealt with flexibly depending on the situation.

Comprehensive area

The aim of the comprehensive area is to provide students with chances to obtain the capabilities for creative problems solving by leveraging the integration of learned knowledge and skills. It is conducted by each university as a part of the program with various contents, namely project study, project exercise, and research on specific topics depending on the diploma policy. In this booklet, the comprehensive areas is described on the basis of the qualitative requirements.

The framework of *Core Curriculum 2016* is outlined in the chart below.

Comprehensive area
Creative activities including project research and specific topic research

Management of innovations

Management of intellectual properties

Management of R&D

Management t of technology strategies and

Operations management

Independent educational content at discretion of each university

Core knowledge major items

Basic learning items
Conceptual understanding of MOT, technology and society, corporate strategies, organization/ human resources, corporate ethics, economic system, marketing, accounting/ finance, analytical methods

A   Basic learning items

[Note] Sections denoted by an asterisk (＊) with text in *italic* font immediately following the explanations of the included categories are important notes that MOT programs should bear in mind and concepts that they should cover in the study of the included item.

Major item

1. MOT fundamentals

The knowledge that should be acquired as MOT fundamentals is categorized under the following areas and each has the included items: "conceptual understanding of MOT," "science, technology and society," "corporate strategies," "organization/ human resources and corporate ethics," "economic system," "marketing," "accounting and finance," and "analytical method."

General goal:

Systematically understand and explain the theories and frameworks required for technology, business management and operation from MOT perspective.

Conceptual understanding of MOT

Understand and explain the key points concerning the meaning and significance of MOT, the background and history of MOT. Understand the differences between other established study fields and MOT. Understand and explain the various new concepts emerging along with the development of science and technologies, society and the economy.

Included category:

(1)   Definition of MOT

Explain the definition and objectives as well as the necessity of MOT, and what the concepts of technology and management represent. Provide clear explanations on the scope where MOT is applied in academic field, and the scope where MOT is utilized in businesses and governmental organization practices by comparing MOT with existing study fields such as the study of business administration.

＊*Although the title of this included item is "Definition of MOT" in this booklet, other terms can be used; such as "MOT principles", and "MOT missions." Moreover, differences between MOT and MBA or PSM (Professional Science Master), interactions among information handled under the major core learning and basic learning items, and the differences between MOT and areas*

represented by different names such as techno-economics and techno-metrology should be addressed under this item.

(2)   <u>MOT historical background</u>

Explain the origins and the history of the development of MOT education and research fields, as well as the current global and Japanese situations and trends concerning MOT.

(3)   <u>Acquisition of new concepts from MOT perspectives</u>

Understand and explain various new concepts emerging along with the development of science and technologies, society and economy.

＊*New concepts concerning MOT emerge one after another; such as technology platform, design thinking, venturing and servitization, and it is important to cover those new concepts in the program where appropriate.*

Science, technology, and society

MOT encompasses management in organization underpinned by science and technologies. MOT professionals are required to have the skills to provide insights into the relationship between business management and science- and technology-specific issues wherein the benefits are not necessarily translated to economic value and apply the insights to management.

Included items:

(4)   <u>Engineering and scientific ethics</u>

Explain the impact and effect of science and technology on society and nature as well as the responsibilities of engineers and scientists toward society.

(5)   <u>Science, technology and society</u>

Understand the various interrelationships between science/technology and society and explain issues that must be addressed in the application of science and technology to innovation.

＊*"Societal acceptance of science/technology," "science/technology and environment," "science/technology and public policy," "science/technology and international relations" are the examples of course/class title relevant to this item.*

(6)   <u>Technology and risks</u>

Analyze, assess, and manage the risks attributed to technology and explain the issues that must be addressed in the application to innovation.

＊*"Risk analysis," "risk assessment," "risk management," and "quality control" are the examples.*

(7)   Technology and standardization

Explain the basic issues considering technology and standardization.

＊*"Significance of standardization," "stakeholders in standardization," and "standardization process" are the examples.*

Corporate strategies

Understand the various concepts of business management strategies, concepts of strategies and hierarchical structure of strategies, and acquire knowledge on the long-term growth of companies that will survive against the decline of the industry and on the establishment of a competitive advantage over the competitors. Especially in MOT, students learn basic concepts and logical frameworks required to design, develop and implement long-term managerial policies at company and/or at business unit so that they can derive economic value from science/technologies and technological results achieved by company and industry.

Included items:

(8)   Management philosophy (Mission)

Understand and explain the roles and importance of management philosophy (mission) that affects corporate strategies.

(9)   Corporate strategies

Explain strategies relevant to business portfolio and resource allocation across business units in a company.

(10)   Competitive strategies

Explain strategies for companies to establish a competitive advantage in each market.

(11)   Business strategies

Explain strategy development where strategy frameworks are used.

Organization/human resources and corporate ethics

Understand the various concepts of organization theory and acquire the knowledge on development and implementation of organizational measures to enhance the productivity and creativity of organization and its members. Especially in MOT, students learn the basic concepts and logical frameworks required to design, develop, and implement organizational policies, which

enhance organizational capability to combine scientific knowledge and technological abilities that individuals or organizations should have.

Included items:

(12)   Definition of organization

Explain the significance and functions of organizations themselves, and develop measures to address organizational issues of one's own company from an organizational theory perspective.

(13)   Organizational design and management

Explain the fundamental principles of organizational design and management methods that ensure a right balance between organizational efficiency and creativity.

(14)   Motivation

Explain the theories and frameworks for motivation management (including the personnel system) that are designed to ensure that organizational members act toward accomplishing organizational goals.

(15)   Leadership

Explain the role of leadership in achieving organizational goal and effective practical methods of demonstrating such leadership.

(16)   Compliance and Corporate Social Responsibility (CSR)

Explain the significance of the key laws and regulations and internal codes of conduct related to the conduct of one's own company and propose individual and organizational initiatives to ensure compliance. Understand the concept of CSR and explain the positioning and importance of CSR for business activities.

(17)   Risk management

Enumerate the key risk factors surrounding one's own company and their potential impact and explain the process of managing these factors in a systematic way.

Economic system

An economic system is designed to align social relationships on behaviors to produce, allocate and consume goods and services required for human beings to survive. Students understand the basic principles of the economic system, including consumer behavior, corporate behavior, and market mechanism. The scope of economic system covers a significantly wide range of areas from individual daily lives to activities of companies and the government. Especially in MOT, students acquire the basic knowledge that facilitates an understanding of the economic environment and

decision-making in a company reflecting the rapidly advancing information technology throughout society, industrialization of services, and internationalization of industries. It corresponds to the foundation of other learning items.

Included items:

(18)   Consumer behavior

Explain how people behave and the fundamental mechanism where changes in prices and income affect consumer demand. This includes the behavior of people as labor force.

＊*"Goods and Services," "tradeoff between cost and benefit," "rational men," "marginal change," "incentive," transaction terms and conditions,"" living standard," "labor market," and "change of consume behavior induced by information society" are the examples*

(19)   Corporate behavior

Explain the fundamentals on how corporations should behave given the market structure to maximize profit. This item includes not only production function, but also behaviors associated with investments and market creation.

＊*"Competitive market," "production function," diminishing returns and marginal costs," "sunk costs," "competition among differentiated products," and "change of corporate behavior induced by information society" are the examples.*

(20)   Market mechanism

Understand the basic concepts and principles of market. Explain the mechanism that consumer demand and corporate production can be adjusted through price. Understand the cases where market mechanisms will not work in real world.

＊*"Invisible hands," "market and welfare," "market failure," "externalities," "oligopoly and monopoly market," "government behavior," "economic cycles," "role of financial institution,", and "change of market induced by information society" are the examples.an information society.*

Marketing

Marketing means creations of customers and markets. As a result of the upgrading of living and technology standards, the capability to explore potential customer demands can affect corporate management. Acquire the fundamental knowledge of marketing and obtain the key knowledge required to develop and implement strategies.

Included items:

(21)   <u>Discovering and analyzing market opportunities</u>

Focus on customer needs, company seeds, and changes in the environment surrounding a business and explain methods of discovering market opportunities.

＊"Marketing research," "consumer behavior analysis," "understanding company seeds," "competitive analysis," "technology trend survey," and "selection of target markets" are the examples.

(22)   <u>Approaches to market</u>

Outline strategies that realize competitive advantages of products and services of one's own company from multidimensional perspectives including quality, price, and distribution channel.

＊"Positioning," "differentiation strategies," "market segmentation," "marketing mix," "industrial marketing and consumer marketing," and "market specificity by industry" are the examples.

(23)   <u>Interactions with customers</u>

Explain the characteristics of customer satisfaction and measures for enhancing the satisfaction. Explain the importance of brands and branding according to the circumstances.

Accounting and finance

Accounting to understand assets, liabilities, and profits and loss, and finance that represents financing build the foundation of corporate management. Students learn the basic concepts and systems of accounting and finance, including financial statements as well as the skills to apply financial analysis and valuation to corporate management.

Included items:

(24)   <u>Financial statements</u>

Understand the double-entry bookkeeping system and practice journal entries. Understand the significance and creation procedure of income statements, balance sheets, and cash-flow statements and explain their relationships to one another. Explain the difference between taxable income and that accounting profit.

(25)   <u>Cost accounting</u>

Explain the basic structure and role of cost accounting.

＊"Standard cost accounting," "direct cost accounting," "cost control," and "break-even point analysis" are the examples.

(26)   <u>Financing and corporate valuation</u>

Explain the structure of financing and its role for management purposes. Explain the concept of corporate value and the representative methods by which enterprise value is estimated.

＊*"Cost of capital," "financial strategies," "financing methods," "techniques of corporate valuation," and "investment appraisal" are the examples.*

Analytical Methods

There are diversified approaches to analyze various issues in the MOT field. Students obtain the skills to analyze MOT related issues using approaches given under this included category and other approaches and present solutions.

Included items:

(27)   <u>Mathematical and statistical approaches</u>

Understand theoretical frameworks, evolution, concepts and methods of mathematical and statistical approaches, apply them to concrete phenomena, and explain the mechanisms in a quantitative manner.

This item includes, as an example, decision-making problems applying an optimization theory under mathematical approaches and the framework of statistical hypothesis testing and data collection and analysis methods under statistical approaches.

(28)   <u>Social scientific approaches</u>

Understand theoretical frameworks, evolutions, concepts, and the methods of economic, social, psychological, and other social scientific approaches and then explain the differences among these approaches. Students are capable of choosing an appropriate one from them, applying it to concrete phenomena, and explaining the mechanism.

This item covers, as an example, the concept that help understand the differences among approaches, including whether economic rationality should be the requirement. Also, social scientific approaches are not limited to those above but cover comparative analysis, a general analysis method widely applied in political science, and a method called ethnography derived from anthropology.

B   Core knowledge major items

[Note] Sections denoted by an asterisk (＊) with text in *italic* font immediately following the explanations of the included items are important notes that MOT programs must bear in mind and concepts that they should cover in the study of the category.

Major item

1. Management of innovations

General goal:

Understand the concept of innovation and acquire knowledge pertaining to its theoretical foundation to achieve innovation with a high probability. In other words, learn the basic concepts that are required when examining how to attain innovation.

＜Educational points to bear in mind＞

It is not simple to generalize and share more practical techniques and viewpoints because those vary with respect to the types of businesses, eras, regions, politics, and other elements of the external environment or corporate culture and other elements of the internal environment. It is hoped that practical techniques and viewpoints can be learned according to the needs of students and other factors. In such case, it is important to incorporate the consideration of social acceptance in addition to the relationship between technologies and market.

Included items:

(1)   Definition of innovation

Explain the concept denoted by the term "innovation," which includes Schumpeterian "new combinations."

＊*It is preferable for explanations to be based on an understanding of the following. Innovation is a concept associated with the creation of economic value. Thus technological change is not the essential condition. The term is an ex post concept and its accomplishment cannot be reliably controlled on an ex ante basis. Innovation management should be conceptualized as the efforts to raise the probability of success.*

(2)   Open innovation

Explain the meaning of business model and the concept of open innovation.

＊*This item aims to offer advanced understanding of R&D, product planning, and marketing by learning the significance of open innovation against differentiation that helps generate profits.*

(3)   Corporate management and innovation

Discuss why growth by Japanese companies based on innovation is presently required, the

necessity for a paradigm shift (why improvements are insufficient where a company evolves incrementally within the limits of conventional growth--track projections), and other such topics.

＊*Students discuss the necessity of innovation based on an understanding of the facts that the source of profits in modern society is due to differentiation, that the state of differentiation never remain forever and that the realization of differentiation is dependent on innovation.*

(4)   Social innovation

Understand the relationships between society and innovation, which include economic development based on innovation.

＊*As we move into the 21st century, various issues are becoming more visible, which includes environment and energy related issues, and cyberspace and regenerative medicine, which are technically feasible, and the markets exist but involve issues that need to be considered from a social acceptance point of view. Students understand the relationships between innovation and society in order to consider such issues.*

(5)   Architecture

Explain the concept of product and process architecture, and the significance of architecture within the context of innovation.

＊*Students learn the basic concept of modularization as a basis for more advanced learning and in order to understand platform and ecosystem as well as cloud sourcing.*

Major item

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2. Management of intellectual properties

General goal:

It is one of the basic issues in MOT to eliminate imitations and build impenetrable barriers to entry into each business by explicitly securing research and development results as intellectual property rights or gaining a monopoly by keeping information secret. It is also important to collaborate with external entities to gain advantages over competitors using intellectual property rights and expand one's business. Also, the basis to perform these activities is the ability to appropriately assess the value of intellectual rights. MOT related intellectual property rights include patent rights, design rights, trademark rights, copyright, and trade secrets. Students obtain management capabilities to precisely utilize intellectual property in collaboration with sections that are in charge of intellectual assets by possessing basic legal knowledge pertaining to intellectual property rights and understanding the practical procedures.

Included items:

(1)   Intellectual property and intellectual property rights

Understand the outlines of entire regulatory systems of intellectual property and intellectual property rights that are in place in Japan as well as other countries.

(2)   Securing rights

Understand the important practical procedures and laws for protecting research and development results as intellectual property rights.

(3)   Management within context of collaboration with external parties

Understand the key practical procedures and laws for explicitly engaging in the management of intellectual property rights within the context of collaboration with external parties, such as those in terms of the assignment and licensing of intellectual property rights within and outside the company and the appropriation of intellectual property rights arising from joint research.

(4)   Intellectual property strategies and portfolios

Understand the key analytical methods for ascertaining and strategically building an intellectual asset portfolio that is required for commercialization and for creating impenetrable barriers to entry. Students also understand practical procedures and laws for explicitly engaging in establishing the best intellectual asset portfolio by securing rights and keeping information secret.

(5)   Standardization and intellectual property rights

Understand the systems and laws for formulating technology strategies to facilitate appropriate exercise of intellectual property rights while striking a balance between they rights and

standardization.

(6)   <u>Intellectual assets valuation</u>

Understands the significance and methods of assessing the value of intellectual assets.

Major item
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3. Technology strategies and R&D (research and development) management
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General goal:

In order to achieve company and business goals, develop and implement the policy for technology augmentation and R&D themes which are coupled with other interrelated strategies. Evaluate those results and reflect to the next strategy development. Explain the methodology for technology strategy process.

Understand the difference of role between research and development given the current situation. Explain the methodologies required for R&D management, including roadmapping with concrete objectives induced from the future vision, process management of R&D themes, resource management and human resource development, and design and administration of R&D organizations.

Included items:

(1)   Concepts of technology

Explain the features of technology from diverse viewpoints based on the understanding of its historical background.

＊"History of technology background," "comparison between science and technology in terms of motivation, behavior, and attributes (assessment viewpoints)," "comparisons of general-purpose technology with unique technology," "knowledge, technique vs. technology, intangible asset, intellectual asset, and intellectual property vs. technology," and "product architecture and technology" are the examples.

(2)   Company and/or business goals and technology strategies

Explain the key factors configuring technology strategies and the relationships between technology strategies and other related strategies (e.g. intellectual property strategies) to achieve company and/or business goals. Explain the outlines of market and technology trends, and the methodologies with which to predict and analyze the trends. Especially, explain the outline of technology roadmap and the methodologies for developing the roadmap which enables to link markets and technologies.

＊"Survey methods and understanding of market and technology trends," "technology roadmap," "relationship between measures of technology augmentation and R&D themes with business portfolio," "relationship of technology strategies with company, business, functional and area strategies," "relationships among marketing, innovation, and technology," "relationship between market needs and technology," "relationship between products/services and technology," "technology diffusion and 'Death Valley'," "technology contribution to business as investment activities," "activities review and reflection to the future strategies/plans," "market prediction and trends analysis methodologies" are the examples.

(3)   Technology acquisition approach

Explain the methods to systematize and assess technology for analyzing technological resources of companies and to explore internal and external technological resources for establishing technological competitive advantage.

＊"Technology classification and technology systemization," "technology portfolio," "product/ technology matrix," "technology map," "internal technology development for technology acquisition," "alliance with external parties," "science and technology policy and the role of public research institutes and universities," "industry-government-academia cooperation," "start-ups, venture capitals and alliance of companies" are the examples.

(4)   Roles and activities of R&D

Understand "research" and "development" have different objectives and contents while R&D as a whole is executed for a wide variety of reasons. Explain the roles and key activities of research and development.

(5)   R&D management

Explain process management, resource management and human resource management including the development of creativity and imaginative power, and methodologies to design and run organizations, which are all required for R&D management.

＊"Transitions of R&D models," "importance of resource allocation for R&D activities," "roles and linkage between stationary organizations and temporary projects," "use of external organizations and alliance (partnerships)," "roles of the core and local site in global R&D," "process and financial control ranging from idea creation to implementation and termination," "importance of building business ecosystem," "career path programs such as dual career ladders," "establishing knowledge management," "evaluating the efficiency and productivity of R&D activities," "basic understanding of business law (tax advantage, contract terms and conditions, understanding of antimonopoly laws, etc.) are the examples.

Major item

4. Operations management

General goal:

Understand that the goal of operation management is to improve the effectiveness and efficiency of activities pertaining to the production of services and goods, and explain the design and operation of effective and efficient production system using basic concepts including production system, quality and productivity. Also, students explain the basic mechanisms of methods to improve business processes including total quality control (TQC), supply chain management, and project management.

Included items:

(1)   Production system

Understand basic concepts pertaining to the production of services and goods including material procurement, manufacturing, shipment, inventory management, logistics, job design, factory layout, and schedule and explain production system using these terms.

(2)   Evaluation indicators

Understand indicators to evaluate the effectiveness of quality, prices, lead-time and flexibility as well as to evaluate productivity. Explain the design and operation of effective and efficient production system using those indicators.

(3)   Total quality control

Explain the total quality control (TQC) concept and the control methods used.

(4)   Supply-chain management (SCM)

Explain the basic mechanisms for SCM.

(5)   Project management (PM)

Explain the role and body of knowledge that have been accumulated with respect to project management (PM framework).

C   Comprehensive area

Objective and definition of comprehensive areas

Education is offered by MOT professional graduate schools with the aim of cultivating students who will be capable of solving the various issues confronting companies and other organizations that involve multifaceted perspectives on technology and management. To achieve this, it is not sufficient to learn specific knowledge and skills in an isolated manner. Since experience is necessary to explore knowledge and skills on a selective and integrative basis in light of the problem attributes that should be resolved for identifying and resolving the problem independently, the comprehensive area is configured within the core curriculum to facilitate the integrative use of knowledge and skills. Comprehensive areas is intended to guarantee, by the achievement of the study, the acquisition of methods of addressing various problems in practice, which students could conceivably face in the future, in a way that will lead to creative solutions.

Based on the consideration above, the comprehensive area as a part of the core curriculum, is defined as follows: Creative efforts towards the problem defined *per se*, in the scope pertaining to MOT, from integrative perspectives on technology and management that are based on a fusion of knowledge and skills obtained through lectures, exercises, and case discussions, being carried out under the supervision of instructor, with the results satisfying the qualitative conditions below and submitted in the form of a report.

As stated above, comprehensive area is intended to ensure the acquisition of methods of addressing various practical issues, which students could conceivably face in the future, in a way that will lead to creative solutions. In other words, the comprehensive area is educational activities in consideration of the student's future, in other words, consideration of society (exit of the student). MOT professional graduate schools have their own diplomacy that states what skills they would like their students to acquire before going back to the society ("exit"). Based on these understanding, comprehensive area shall specifically provide education consistent with their diplomacy.

Conditions to be satisfied by comprehensive areas and resulting objectives

The conditions that are to be satisfied by the results are as follows.

- Educational results are to be accepted. In other words, the knowledge and skills obtained from a professional graduate school are to be used.

- Results represent the development of appropriate, valid logic. In other words, the data subject to investigations and studies have been collected using appropriate methods, and their reliability has been ensured. Appropriate methods of analysis have been selected and properly applied. Ingenuity is evident in assertions and recommendations, such that they are not simply a repetition of information that is already known.

Satisfies at least two of the followings.

- Utility:　　　　Does not refer simply to an enumeration of individual impressions and survey results. Encompasses a projection of contributions to society, industry, the company, or organizations.

- Feasibility:　　Assertions and recommendations demonstrate feasibility.

- Academic value:　　Information has academic value in terms of objectivity, rigor, novelty, originality, and other qualities.

Because the activities pertaining to comprehensive area is diverse depending on the backgrounds and interests of individual students due to the characteristics of each MOT professional graduate schools, the comprehensive area constituting the core curriculum is prescribed on the basis of the qualitative conditions described above.

Such qualitative conditions are designed to have students appropriately survey and analyze issues that they have configured independently and procure for these students the experience of creative problem solving. Students are expected to demonstrate creative problem-solving capabilities based on diverse perspectives on technology and management with respect to issues that they may face in practice after graduation according to approaches to arriving at solutions that they have conceived through this experience. Therefore, they must explore and select the optimal knowledge and skills for solving problems and, where necessary, learn new knowledge and skills to satisfy the qualitative conditions that apply in comprehensive areas.

Relationship between comprehensive area and learning items

The value of achievements obtained through efforts aimed at creative problem solving from multifaceted perspectives on technology and management in practice is not always consistent with academic value. In contrast to autonomous nature of academic research, problems to be resolved in practice are not always configured by oneself; it is conceivable that many cases will arise where the issues have been defined by managerial, operational, or occupational necessities. Therefore, the required creative problem-solving capabilities should not be applicable to the limited areas. It is also insufficient to merely have students at MOT professional graduate schools only learn advanced knowledge and skills pertaining to specific issues to be handled in comprehensive area.

To demonstrate effective problem solving in practice, graduates will be required to collaborate with various relevant sections and personnel within the company or other organizations. Basic knowledge pertaining to technology and management will be needed as a common element or a common foundation for smoothly promoting such collaborative efforts. In other words, failure to acquire basic knowledge will make it difficult to raise the possibility of successful problem solving in practice even with the experience of applying methods obtained during the course of studying comprehensive area. As a result, education presented as learning items in the core curriculum is essential, such that comprehensive area is meaningful only when underpinned by a solid foundation of fundamentals so that creative problem solving can be implemented on an ongoing basis from integrative perspective on technology and management.

Conclusions ——Background of the establishment of MOT and changes in social circumstances after the development of the previous core curriculum——

It is said that Japan's economic growth has greatly contributed to the development of the business administration study.

This is because that the astonishing growth of Japanese companies after the early 70s caused the decline of US companies, which had dominated the international market up to the point of time. This encouraged the establishment of the theory of strategies. US companies lost out to competition from Japan and lost their market share in the key industries of steel, home appliance, and automotive. Above all the decline of automotive industry, which was referred as the Big Three being a symbol of US industry, had a strong impact on US society and induced activities to revitalize industrial competitiveness, such as the International Motor Vehicle Program (IMVP Project) by the Massachusetts Institute of Technology (MIT). This series of enhancements of business administration study, specifically the development of the theory of strategies, was a phenomenon occurring in the course of that American companies tried to restore their shares in the markets.

In the late 80s, science based industries, such as the semiconductor, biotechnology, and IT, started prospering and became major players in the US economy. A big difference between these science based industries and engineering based industries including automotive industry, is where designed functions cannot necessarily be achieved. In the semiconductor and bio industries unknown phenomenon often happen when technology is converted into a commercial substance, and it is not rare that unexpected side effects occur after commercialization. Potential market risks and production realization risks cannot be ignored in these industries. It is indispensable to understand physics and science for product realization, which is why these industries are called science based industries. In other words, the link between engineering study, which helps us consider product realization using scientific knowledge, and business administration study, which helps us consider methods to earn appropriate profit, has become essential. MOT has definitely become essential. This notion is supported by the fact that MIT started an initial MOT program in 1981 and the MOT program at Haas School of Business, University of California Berkeley, first full-fledge MOT course, started in 1989. With the support of the Ministry of Economy, Trade and Industry, Meanwhile, it was in 2003 when a full-scale MOT program started in Japan, meaning that the establishment of the MOT program in Japan was more than 15 years behind the major universities in the United States. And the progress in science and technology have changed society and the industrial world further.

As we move into the 21st century, environmental issues represented by global warming and energy issues are becoming more prominent. Also, the progress of communication technology has, against the benefits, caused issues in the Internet space such as cyberterrorism. The advances in gene technologies, triggered by the birth of cloned sheep Dolly, have raised questions about bioethical issues. Most of these events becoming visible in this century inhere social acceptance problems.

Restarting of nuclear power plants has become a significant issue in Japan. Taking this as an example, it

is technologically feasible, and there are solid market needs in terms of stable power supply. However, it is not fully accepted by society; therefore, these nuclear power plants have not fully restarted. In the midst of the debate over the responsibility of Tokyo Electric Power Company (TEPCO) after the 3.11 nuclear disasters, the significance of management, corporate, and engineering ethics are recognized, and the development of crisis management and risk science study underlying it is being required. In other words, sociological and psychological knowledge and perspectives have become indispensable for business management.

It means the distance between science and technology policies and other public policies and business management is becoming closer, and public policies and social trends cannot be ignored by business management. Incubation of entrepreneurial companies, which had been long awaited, have not progressed as expected. The relationships between policies including future direction of regulation and corporate management have to do with this disappointing reality.

Also, the surroundings of PR and sales activities, which are performed by companies to gain social understanding, including market understanding, has drastically changed with the wide use of mobile devices and mobile application development. It is becoming more and more important to understand ideal communication as an ethical consideration. Also, workstyle and consumer behaviors have been largely changing due to the development of the Internet, and it is vital for business managers to understand worker and consumer minds.

Consequently, what is demanded of MOT obviously expands from *Core Curriculum 2010*. Sociology, philosophy (including studies on ethics), public management, psychology, and linguistics (communication studies) have clearly become more important. However, in terms of their scale, it is impossible for any of the schools referred as MOT professional graduate schools to cover all of them. Society has made strong demands of them to develop more focused educational curricula in line with their educational philosophy, not copying what overseas major schools do and providing wide and shallow education.

Afterword

The scheme of professional graduate school, launched in 2003, aiming to develop advanced professional human resources, has been widely exploited in various fields and recognized as the core device for recurrent education in Japan. Promoting standardization of the learning content at professional graduate schools is as important as promoting the certified evaluation and accreditation system to ensure the quality of education, which also helps improve the social cognition and respond to the issues on mutual recognition of professional qualifications on a worldwide basis.

The member schools of the Japan Association of Professional Graduate Schools of Technology Management (J-MOT) developed *Core Curriculum 2010* in March 2010 with the aim of harmonizing learning content. It had played a significant role at MOT professional graduate schools in terms of program design and accreditation. However, the rapid social, economic, and technological changes later on led to the need for the review of *Core Curriculum 2010.*

In respond to this demand J-MOT member schools have agreed to implement the research and studies concerning the development of core curriculum in graduate schools for management professionals (MOT field) and revise the MOT education core curriculum as a part of the 2016 Leading Management Human Resource Enhancement and Development Programs. The revision was led by the Revision Committee of the MOT education core curriculum consisting of the representatives of the MOT member schools. We developed the revised version of the core curriculum as *Core Curriculum 2016* reflecting the opinions from industry and relevant organizations. We hope that each MOT professional graduate school will endeavor to provide their own unique education.

We would like to express our gratitude to those who participated in this project as a committee member and provided us of their valuable inputs. We also would like to take this opportunity to thank for their kind support everyone from the Professional Education Division of the Higher Education Bureau at the Ministry of Education, Culture, Sports, Science and Technology and the Academia Industry Cooperation Promotion Office, Industrial Science and Technology Policy and Environment Bureau, the Ministry of Economy, Trade and Industry.

Finally, we organized workshops in order to cooperate with overseas countries especially with Asian countries, for exchanging information and opinions with the schools offering postgraduate education for practitioners. The workshops deepened our mutual understanding and may result in further cooperation based on what we achieved from this revision. We would like to continue working on improving MOT education in Japan and the world.

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Revision Committee of the MOT education core curriculum

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