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**MASTER OF SCIENCE IN MANAGEMENT OF TECHNOLOGY (MSC. MOT)
EDUCATION – BENCHMARKING THE JAPANESE CASE AS AN
ADVANCED COUNTRY OF MOT EDUCATION AND EXPECTATION
FOR THE MOT EDUCATION IN UKRAINE**

Management of Technology (MOT) education at higher education institutes is a kind of professional higher education of practicing engineers who are employed in business or public services after having graduated from engineering schools (BS or MS in Engineering) or science schools. MOT education is intended to re-educate working engineers in strengthening their knowledge of management and finance to upgrade them to be talents fit for being technology oriented managers who could roadmap employers' business strategy and innovation from total business perspective. This paper benchmarks a case of Japan as one of the most populous MOT higher education countries in the world and tries to explore the future of MOT education in Ukraine.

Keywords: management of technology, education, benchmarking, innovation

Освітня програма з управління технологіями (MOT) є свого роду програмою професійної підготовки практикуючих фахівців, які працюють в бізнесі або державних установах після того, як вони закінчили ВНЗ і мають ступені бакалаврів або магістрів в галузі інженерії. Освітня програма МТО призначена для формування компетентності інженерних кадрів у зміцненні їх знань з управління технологіями та фінансів для створення та розвитку новітніх технологій на основі дорожньої карти щодо бізнес-стратегії роботодавців та інновацій з точки зору розвитку виробництва (бізнесу). Визначено орієнтири України щодо MOT та досвід Японії, як однієї з найбільш розвинених країн в світі, яка намагається побудувати майбутнє на основі управління інноваційними технологіями.

Ключові слова: управління розвитком технологій, освіта, бенчмаркінг, інновації

Образовательная программа по управлению технологиями (MOT) является своего рода программой профессиональной подготовки практикующих специалистов, которые работают в бизнесе или государственных учреждениях после того, как они закончили вузы и имеют степени бакалавров или магистров в области инженерии. Образовательная программа МТО предназначена для формирования компетентности инженерных кадров в укреплении их знаний по управлению технологиями и финансов для создания и развития новейших технологий на основе дорожной карты по бизнес-стратегии работодателей и инноваций с точки зрения развития производства (бизнеса). Определены ориентиры Украины по MOT и опыт Японии, как одной из наиболее развитых стран в мире, которая пытается построить будущее на основе управления инновационными технологиями.

Ключевые слова: управление развитием технологий, образование, бенчмаркинг, инновации

Aim of Management of Technology Programs in Higher Education Institutes

Management of Technology (MOT) education was founded for the first time by Massachusetts Institute of Technology (MIT) in 1982; MIT's MOT program (integrated with MIT Sloan Fellows Program in 2004

and was renamed as "MIT Sloan Fellows Program in Innovation and Global Leadership") has introduced the first Master of Science in Management of Technology degree. MIT's MOT program admits business professionals having more than ten years of working experience and clearly demarcates it from other MSc. programs who intake fresh or near fresh BS

undergraduates (MIT Sloan 101, 2014).

The aim of a MOT program is given as follows, as a typical example (Tokyo Institute of Technology Graduate School of Management, 2014).

The MOT Program educates practicing professionals and researchers who excel in the management of the innovation realization cycle which creates and socially and industrially deploys technology as intellectual assets, and who have global perspectives, high ethics and committed leadership. More concretely, the MOT prepares candidate professionals and researchers in the training of eminent leadership; strategy in management of technology; intellectual property (IP) management; new business creation; information and communication technology (ICT) strategy; and finance.

Case Study of Japan with Populous MOT Education

In terms of higher education, Japan is a balanced country with both, humanity and social sciences education, and natural science and technology (S&T) education unlike Ukraine which is biased to S&T education in terms of numbers of higher education programs and students enrolled because of the tradition of the former USSR days.

Japan's ranking by the numbers of authorized Master programs in higher education is as follows according to the official statistics of the Japanese Government (Japanese Government Ministry of Internal Affairs and Communications, 2014):

1.	Laws	151 (including 75 Professional Laws Schools)
2.	Business Administration(MBA)	120
3.	Literature	100
4.	Nursery	100
5.	Economics	95
6.	Engineering	93 (*1)
7.	Pharmacy	63
8.	Pedagogy	59
9.	Medicine (Medical School)	55
10.	Science and Technology	31 (*2)
11.	Science	31
12.	Agriculture	25
xx.	Management Engineering	14
xx.	Management of Technology	8 (5 are Specialized Master) (*3)

It is noted that this ranking is based on the nomenclatures as applied by the respective universities and approved by the Ministry of Education, on Master programs and names of specialty is not uniform in

Japan, hence universities tend to name their programs uniquely although the contents are the same as the existing ones. Note 1 in the above table denotes the numbers of schools of overall Master program of engineering comprising four to 10+ engineering specialties, and if discrete MSc in Engineering in various specialty names are counted in, total number exceed 250; note 2 refers to the number of overall universities having faculties of integrated Master of Science programs having all disciplines of Science (mathematics, physics, chemistry, information science) and Engineering (mechanical, civil-structural-architectural, electrical, chemical, controls, mathematical engineering, nuclear, human (ergonomics), aviation, etc.; if looking at MOT specialty (major) as part of MSc. in Engineering programs, there are 41 programs.

There are three primary reasons that the first author has observed MOT programs are popular in Japan:

– Japan has always benchmarked the higher education system in the United States of America after World War II and the success in MOT of MIT, Stanford and other reputed universities in USA have been a strong incentive for the leading Japanese universities to found a MOT program; MOT programs were founded in Japan one after another in the early 2000's.

– Japan is a country of techno-culture (Shimura, 2006) and actually technology innovation as witnessed by the fact that its GDP divided by the territorial area is still by far the largest in the world. While Japan is excellent at creating new technological value in terms of functionality, quality and robustness, its profitability of industrial products is lower than that of US manufactured products by several percentage points (Nobeoka, 2006; Japan Machinery Center for Trade and Investment, 2013). This means that Japanese technological community lag behind USA in the knowledge and skill of strategy, management and finance that, together with technological excellence, complete a cycle of industrial competitiveness and the industry finds it necessary to re-educate practicing technological employees in MOT aspects.

– Japanese companies, having an embedded culture of management by goal and group dynamics as well as in-house engineer training programs on-the-job and off-the-dob, do not find the value of project management education as industry maintain they are already practicing much higher contents than what global project management standards and teachers of project management deliver. Therefore, the companies find more affinity with management of technology as it sounds more attractive to techno-cultural companies. There is no specialty of Master program in project management and there is only one Bachelor program in this field, in Japan.

The universities that position MOT as a stand-alone department is just eight, but there are 41 universities at least that are reported to have MOT specialty in a variety

of engineering departments. Also, it is found in the above government statistics that there exist in Japan 14 department of Master of Science in Management Engineering (and 56 Bachelor programs) 70% of which modules contents are the same as MOT specialties.

Most of MOT programs deliver Professional Masters (equivalent to Specialized Masters in Europe) that can be completed in one year as compared with 2 years required for full Master of Science programs and are intended basically for practicing engineering or technology specialists and not fresh intakes coming directly from undergraduate schools.

Also, as many of the subjects in MOT cannot be taught by in-university professors having no recent real world industrial experience or must be taught by visiting professors keeping up-to-date with industries - MOT programs if being taught by pure tenure engineering school professors cannot recruit master students from industries -, operating costs of the program are significantly high;. Hence, only overall universities (having science and technology – engineering, social science, medical schools), or strategic S&T schools such as Tokyo Institute of Technology or Japan Advanced Institute of Science and Technology (JAIST) can afford to offer MOT programs. Alternatively, second-tier private engineering universities offer one-year, low-cost and night-taught master programs with

four to six experienced part time (low cost) professors who were former professors of big (first tier) universities and retired at the age of 62 or 65.

A Case of MOT Program Curriculum

A typical case of the MOT program in Japan is introduced hereunder (JAIST, 2014).

Japan Advanced Institute of Science and Technology (JAIST), a national graduate university, has a world unique Master and Ph.D. Program of Knowledge Science Program (2 Years; optional 3 years for the Master and 3 years for the Ph.D.). As an extension of this program, JAIST offers MOT and iMOST (Master of Management of Service and Technology) programs, for engineers and managers in manufacturing, IT and other technology and service industry companies and R&D institutes. iMOST has more subjects on service science than MOT.

From the program objective as above, professors, except very few, have come from industries and have Dr. Eng. or Dr. Sc. diplomas but there grow young associate professors and assistant professors who have been grown in the academic field who strengthen scientific attributes of the program at least in JAIST.

The MOT and iMOST program curriculum is given below (edited by the first author for this paper).

Course Code (not shown)	Subject	Type of Faculty Instructor A: In-University Professor or Associate Professor B: Visiting Professor or Visiting Associate Professor
Common to MOT and iMOST Specializations – Core Subjects		
	Economics and Management of Innovation	A (ex Toshiba)
	Enterprise Science	A (ex Toshiba)
	R&D Management	A: Pr. Kosaka (Dept Head. Ex Hitachi)
	Intellectual Property Management	B
	Strategic Roadmapping	A (ex Toshiba)
	Leadership of Technology Management	B
	Practice of MOT Innovations	A
	Open Seminar	
	Management Strategies	B
	Advances Project management	B: Pr. Tanaka
	Open Innovation	B
	Innovation Implementation	B (ex Hitachi)
	Venture Business Fundamentals	B, B, B
Common to MOT and iMOST Specializations – Knowledge Science Core Subjects		
	Methodology for the Social Sciences	A Pr. Umemoto
	Methodology for Systems Science	A
	Theory of Knowledge Management	B: Pr. Nonaka, Pr. Toyama
	Comparative Study of Knowledge Institutions	B
	R&D and Innovation Policies	B
	Methodology for Knowledge Discovery	A, B, B, B
Common to MOT and iMOST Specializations – MOT & Social Science Fundamental Subjects		
	Introduction to Social Research Methods	A
	Project Management Basics (P2M Project Management)	B: Pr. Hiroshi Tanaka, Mr. A. Mitsufuji, President of Project Management Association of Japan
	Business Accounting	B
	Philosophy and History of Science	B

MOS Specialization, MOST Specialization – Service Management Core subjects		
	Marketing Theories	A, A, A
	Service Innovation	A, A, A
	Service Value Creative Modeling	B, B
	Service Business in the Manufacturing Industry	B
	Service Management	B
	Service Design on Social Layers	B, B, B, B, B
	Network Service Innovation	A
	Creative Design Strategies	A
	Business and Ethnography	A
	Servicing Business Trend in Information Industries	A, B, B
	IT-based Business Design	B, B
	IT Service Architecture	B
	Internet Service Systems	A, B, B
iMOST Specialization: Medical Service Science Core Subjects		
	Healthcare Industry Overview	B, B
	Healthcare Service Science	B, B, B, B, B, B
	Healthcare Service Informatics	B, B
Advanced Subjects		
	Advanced Topics on Knowledge Sharing in Ubiquitous Computing Environment	A, A, A
	Advanced Social Knowledge – Case Studies	A, A

Expectation for the MOT Higher Education in Ukraine

The authors welcome the planned founding of the MOT program in Kiev National University of Construction and Architecture.

Hiroshi Tanaka in his scientific paper “An Emerging Wave to Expand the National Industrial Competitiveness Using Open Innovation and Being Supported by Meta Program Management” submitted to PM Kiev 2010 (Tanaka, H., 2010) hosted by Ukrainian Project Management Association states as follows regarding the situation surrounding management disciplines in Ukraine:

Ukraine, having the tradition of high level of science, technology and engineering disciplines which had supported the former Soviet Union in the Soviet science and technology race against the U.S.A. and Western European countries, is one of the most advanced countries in Europe in the practice and knowledge level of project management.

The Ukrainian project management model, which used to be reliant on its home-made project management body of knowledge focusing on heavy engineering-construction of state (including the Soviet) defense systems, social infrastructure and heavy industry factories, had gradually shifted to a modern project management model with the collapse of the Chernobyl Nuclear Power Plant No. 4 Station in 1986 becoming a turning point. Under the leadership of the Government and supported by Western countries cooperating with Ukraine in its struggle against radioactive contamination caused by the tragedy, Ukraine had introduced the

national project management capacity building program sponsored by the World Bank to introduce a robust management system for projects; as a result, almost all Ukrainian project leaders and managers as well as professors have been trained afresh, who are now backbones of the nation’s project management capability.

Professor Sergey Bushuyev, Founder and President of Ukrainian Project Management Association and Chair of Program and Project Management Program at Kiev National University of Construction and Architecture, on the foundation of his leadership in major national infrastructure programs and projects to that time, served as the state program manager for the national project management capacity building program and has been pivotal in continually nurturing the national capability in program and project management with the following results to date:

- 16,000 project management professionals who completed the World Bank program (mentioned above);
- Continuous growth of Ukrainian Project Management Association supported by dedicated volunteers and with well established and active regional chapters;
 - 1,500 International Project Management Association (IPMA) four-level certification folders;
 - 20 graduate programs of project management at national universities with 150 doctors (both Doctors of Technical Science and PhDs) and 1,000+ masters in project management;
 - Flexibility of applying all of the world’s major project management standards, viz. IPMA Competence Baseline (European), Project Management Institute

(PMI®)'s PMBOK Guide®, Project Management Association of Japan's P2M®, UK Government's PRINCE2® depending on the real needs of practitioners having a variety of exposure to and experience in project management, and business interests;

- State award of outstanding scientific contribution (laureate) by program and project management to the top leaders of project management headed by Professor Bushuyev in December 2009.

(It is noted that the figures quoted above are based on the first author's unstructured hearing from the nation's project management concerns and are not based on statistics.)

Against this situation as a backdrop, strength and areas remaining to be improved with respect to the field of program and project management formation and practice in Ukraine are as follows:

Strength

- High level of science (natural science), technology, engineering disciplines that can render fundamental potential for innovation.
- Powerful academia supporting the project industry which are competent in scientific analysis and mathematical modeling.
- Intelligent and well qualified project professionals as well as engineering talents.
- Broad experience in central planning that could be a weapon in scheming a major program, if coupled with mechanism building capabilities.
- Broad experience in large infrastructure projects.
- Strategic geological position having averagely short distances to Western Europe, Central Asia, Middle East and North Africa.

Areas Remaining to Be Improved

- Capabilities of national economic operations.
- Market development sense, especially service innovation sense.

- Mechanism building capability using “ba”, a mental field of shared context in motion for collaborative value creation for the Ukrainian state.

- Developing full-time, agile project management companies compatible with the global project industry (not just engineering or construction companies).

- Project delivery capability as against good theoretical strategy building ability.

As can be well argued from the above statement, a MOT program in Ukraine would provide a clue to further the strength cited above and solutions to the areas remaining to be improved, in particular:

- Weak market creative capacity out of science;
- Lack of global orientation in its education system;
- Weak integration of diverse science and engineering disciplines – lack of systems engineering education;
- Lack of integration between science and technology and business management and social science areas such as economics, foreign languages.

Conclusion

This paper has benchmarked the state of management of technology (MOT) higher education and analyzed expected role for MOT education in Ukraine of which first program is being planned in the coming Academic Year 2013. In summary, MOT programs educate practicing professionals and researchers who excel in the management of the innovation realization cycle which creates and socially and industrially deploys technology as intellectual assets, and who have global perspectives, high ethics and committed leadership. The MOT program educates more concretely professional talents and researchers in business and hence helps Ukraine create the industrial future.

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