The Key Role of Engineering Education in the Digital Economy Era and its State-of-the-Art in Japan

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Trend towards Digital Business

The Internet Changes Everything!

Market Forces 1995 - 2005

1. Electronic Data Interchange
2. EDI Integrated w/ Internal Systems
3. Technical Data Interchange
4. Prod/Proc Data Driven Manufacturing
5. Outsourcing Over Internet
6. Distributed Collaborative Processes
7. Virtual Enterprises

The Challenge

Source: Dr. Michael McGrath, DARPA
Modern Manufacturing Systems

- Time based competition
- Customer order driven
- Customisation of products and processes
- Environmentally benign production
- Continuous innovation
- Globalisation of activities
- Digital Business

Extended / Virtual Enterprise

- Enterprise partnerships
- Total value chain
- E-business

Lean Production

- Use less resource
- High quality process

Agile Manufacturing

- Agility
- Quick response

Courtesy by Prof. Gim Browne
Digital Business - Extended Products by GEM

Extended products include:

I. Products incorporating and integrating specialist, frequently information based, services, e.g. mobile phone

II. Extension to include and incorporate end of life product dispositioning

Note: Extended products include:

- Co-Design
- Product Models
- Customer Driven Design
- Customer Order Fulfilment
- Reverse logistics
- Reuse
- Disposal
- Maintenance
- Operation

Supply Chain Management

Production Planning and control

Marketing and sales

Distribution

Operation

Product and process design

CAD/CAM

OEM-Manufacturing

The extended Enterprise

Material flow
Professional Graduate School in Japan

• Strong demands to educate practical professions in, Law, Management, Accounting, Management Of Technology (MOT), etc.

• Law school: 74
• Management and Accounting: 20
• Management Of Technology: 7 schools
  - National = Tokyo Inst. Tech., Yamaguchi Univ.
Why MOT Required in Japan?

- Death valley: R&D results collapse at practice stage
- Necessity to overcome death valley
- Rapid innovation brings increase of risks to enterprises
- Un-connected to business creation
- To manage to convert R&D results to economic value
- Expectation to MOT
MEXT (Ministry of Education, Culture, Sports, Science and Technology) Official Requirements for the Establishment of Professional Graduate Schools

- 1948: Official Requirements for the Establishment of Colleges and Graduate Schools in Japan
- 2003: 1948: Official Requirements for the Establishment of Professional Graduate Schools

Education society

Science School → Engineering School → Professional MOT School → Professional Business School

Real society

Technology
MOT Education Systems in Japan

- MOT (Management Of Technology) vs MBA (Management of Business & Administration)
- Non-degree MOT-like Courses

- 2003: Established New Law on Professional Graduate School by Ministry of Education
- 2003: 1st MOT, Shibaura Institute
- 2005: MOTs by National Unis such as TUAT, TIT, etc
MOT Professional
Graduate School (8)

- MOT Courses in General Engineering Colleges and Privates (70)
- MOT Schooling at Enterprises
- MOT Info. In Enterprise and society

MOT Education in Japan
Target to Educate Professions at Professional MOT

Based on technological knowledge,
To educate CEO, CTO, CIO,
through the whole process of
  Business Strategy (Market Driven)-
  Development-
  Design-
  Manufacturing-
  Application-
  Disposal
Japanese MOT Education Contents

Technological Core + Business Admin.

Educate Capability to Create New Businesses

High Value Added Prod.
MEMS, Info, Bio, Nano, Environment & their Manufacturing
Educational Practice of Professional Grad. School

- Schooling and Exercise
  + Verification of Knowledge
    by Case study
- Acquisition of Empirical Knowledge
  thru. Internship
- Practice of Knowledge
  by Business Plan Project
Value Added of Graduates

In advanced technology,

• **Practical Solution Ability** for Technological Problems

• **Wide Knowledge** to be Competitive Technology Manager

• **Business Planning Ability** in Advanced Technology Area
Extended products include:
I. Products incorporating and integrating specialist, frequently information based, services, eg mobile phone
II. Extension to include and incorporate end of life product dispositioning

The extended Enterprise

Material flow
Core Curricula of GEM/MOT School

Manufacturing sectors

Machinery, automobiles
Electrics and electronics
Information tech.
Chemistry and materials
Life science

Manufacturing company

Management of
Resource and Organization
Business
Technology and production

Core curricula

Digital Business Management
+ Digital Technology Management

Digital Technology
Japanese Manufacturing Competitiveness

Module Title: 中期紹介

Operational Flow
- R&D
- Manufacturing
- Operation
- Recycle, disposal

Technology Innovation & risk
- Product Innov. & risk
- Process innovation (Innovation of manufacturing and service) & risk
- Eco-innovation at the level of social environment & risk

Technology Develop. & risk
- MEMS
- Info. Intelligence
- Bio & bio-mimetics
- Nano-material
- Environment
- Total Quality Assurance, control & evaluation
- Product liability & evaluation
- Assessment technology>
- Terro-Technology (Comprehensive system maintenance)
- Preventive maintenance
- Remote & Self-diagnosis
- Self-repairing
- Recyclable production system
- Inverse manufacturing system

Management Innovation & risk
- A&D
- Outsourcing of research
- Rise of manufacturing service industry
- Outsourcing of sample production and manufacturing
- Service-oriented manufacturing industry
- Lease/finance scheme
- Long-term maintenance contract
- Environment management

- Cost performance
- Global production/supply
- Supply chain
- Product liability
- LCC
- Users’ manual
- Service-oriented manufacturing industry
- Less burdening to human being
- Less burdening to environment

- Less burdening to human being
- Less burdening to environment

- Recyclable production system
- Inverse manufacturing system

- Environment management

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Japanese Manufacturing Competitiveness

Graduate School of Technology Management
Tokyo University of Agriculture and Technology

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Exploitation at TUAT/MOT

• **Background:** Many business losses caused by technological/technical miss.

• **Necessity:** to forecast and hedge technological/technical risks quantitatively by scientific tools.

• **Strategy:** to renovate manufacturing competency by educating/re-educating such students as holding balanced ability of
  “to create new business using leading edge technology as well as paying attention to technological/technical risks”.

• **Method:** to apply concept of GEM and modify its curricula so as to match to our strategy.
**Outline of MOT/TUAT**

- Open 2005 April

- Master of Management of Technology  
  (not Master of Manufacturing Strategy)

  - Schooling 2 yrs (4 semesters)

  - 40 students/year: 50% expected with several yrs. experience in business

  - 16 professors and another 15 part time professionals
Mission of TUAT/MOT

Create future and knowledge
## CURRICULA of TUAT/MOT

<table>
<thead>
<tr>
<th>Basics(B)</th>
<th>Subject Credit</th>
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<tbody>
<tr>
<td>Risk Basics(BR)</td>
<td>3~ / 6~</td>
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<td>Mng Basics(BM)</td>
<td>3~ / 6~</td>
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<td>Applications(A)</td>
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<td>Tedi. Mng.(AT)</td>
<td>3~ / 6~</td>
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<td>Adv. Ind. Creation(AA)</td>
<td>3~ / 6~</td>
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<td>PR &amp; Std.(AI)</td>
<td>2~ / 4~</td>
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<tr>
<td>Mng. Strategy(AM)</td>
<td>2~ / 4~</td>
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<tr>
<td>Project Research(P)</td>
<td>3~ / 14~</td>
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</tbody>
</table>
• Educate basic manage. & admin. ability
• Subjects
  BR1 : probability & statistics
  BR2 : risk assessment
  BR3 : human error

  BM1 : finance & accounting
  BM2 : cost estimation
  BM3 : enterprise management
  BM4 : business law
### Applications(A) • Tech. Mng.(AT)

- Educate risk understanding induced in adv. industrial activities
- Subjects
  - AT1: technology innovation
  - AT2: chemical materials management
  - AT3: life science ethics
  - AT4: supply chain management
  - AT5: life cycle engineering
  - AT6: product design review
• Tech. Mng. (AT), Cont’d

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<thead>
<tr>
<th>AT</th>
<th>Description</th>
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<tbody>
<tr>
<td>AT7</td>
<td>total quality assurance</td>
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<tr>
<td>AT8</td>
<td>information security</td>
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<tr>
<td>AT9</td>
<td>advanced manufacturing systems</td>
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<tr>
<td>AT10</td>
<td>factory safety management</td>
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<tr>
<td>AT11</td>
<td>environment management</td>
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<tr>
<td>AT12</td>
<td>technology management in SMEs</td>
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</table>
Applications (A) • Adv. Ind. Creation (AA)

• Subjects
AA1: leading edge machinery business
AA2: leading edge information business
AA3: leading edge bio business
AA4: leading edge nano-tech business
AA5: leading edge environment business
AA6: high secure info. system management
AA7: bio diagnosis tech. development
AA8: material business
<table>
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<tr>
<th>Applications(A)</th>
<th>IPR &amp; Ind. Std.(AI)</th>
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<tr>
<td>• Educate IPR &amp; Ind. Std. ability to develop enterprise technological activities</td>
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<tr>
<td>• Subjects</td>
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<tr>
<td>AI1 : IPR management</td>
<td></td>
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<td>AI2 : IPR defense &amp; utilization</td>
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<td>AI3 : advanced machinery IPR</td>
<td></td>
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<tr>
<td>AI4 : information systems IPR</td>
<td></td>
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<tr>
<td>AI5 : bio-technology IPR</td>
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<tr>
<td>AI6 : environment technology IPR</td>
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IPR & Ind. Std(AI) Cont’d

AI7: industrial tech. standardization
AI8: standardization strategy
Applications (A)  Management Strategy (AM)

- Educate advanced mng. & adm. ability
- Subjects
  AM1: enterprise management strategy
  AM2: enterprise structure
  AM3: management of tech. develop.
  AM4: commercialization process of R&D results
  AM5: enterprise competitiveness &
        evaluation
Manage. Strategy (AM), cont’d

AM6: marketing strategy
AM7: venture business strategy
**Project Research(P)**

- Educate enterprise management ability with technological risks
- **Subjects**
  - P1: internship of technology manage.
  - P2: field study of technology manage.
  - P3: case study of technology manage.
  - P4: business planning of technology management
E-Learning System

Urban campus

Graduate School of Technology Management
Tokyo University of Agriculture and Technology

E-Learning

TV lecture

Post lecture

Professors

1. シラバス配信
2. 講義資料の掲載
3. 学生からの質問への回答

Students

1. 予習
2. 教授への質問
3. 受講生同士の意見交換
4. 課題提出

Learning support sys.

インターネットを活用した学生と教員とのコミュニケーションシステムを完備。予習、復習用に講義資料を閲覧でき、レポート提出や質問、講義に関するお知らせなどにも活用しています。