Human Resources Development in Japanese IT Industries: Current Challenges and Recommendations for the Future
日本のIT産業および人材育成の課題と将来への提言

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Executive Director, Center for Integrated Systems
Consulting Professor, Stanford University
Outline

♦ The ongoing IT revolution and its impact on business

♦ IT in 21st Century business: new demands for the labor force
  ♦ Education measures to meet the new demand

♦ Considerations specifically for Japan
Cloud computing: the third major wave of networked computing

1. Mainframe - terminal
2. Server – (PC) client
3. Cloud computing

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Networked computing:
Mainframe – terminal era (1940’s – about 1980)

Clients: (dumb) terminals – text only display

Clients link to mainframe via private custom networks; time share access

Application programs: custom-built for system
Networked computing:
Client – server era (c. 1980 – c. 2005)

<table>
<thead>
<tr>
<th>Early Stage</th>
<th>Late Stage</th>
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</thead>
<tbody>
<tr>
<td>Clients: Mostly workstations</td>
<td>Clients: PCs, workstations, peripherals</td>
</tr>
<tr>
<td>Ethernet LANs, spread of TCP/IP (Internet links)</td>
<td>Internet everywhere (LAN and open)</td>
</tr>
<tr>
<td>Standardized applications run on the client, processing-intensive programs run on server</td>
<td>Standardized “office” applications on the client; other apps on server; apps may use central database</td>
</tr>
</tbody>
</table>

Diagram from Procus (company) website

2013.04.22  Richard B. Dasher, Stanford University
Networked computing: Cloud computing era (c. 2005 – present)

- Many client types: smartphones, PCs, tablets, MP3 players, sensors, smart appliances
- Clients network to data centers & other clients via Internet; many LANs are just secure channels over public Internet
- Applications run on “virtual machines” in data center(s); clients access via browsers; physical location of data may be distributed

Diagram from Wikipedia
Some immediate impacts of cloud computing

♦ Almost any object can be a connected client: automobiles, electric power meters, movie tickets, coffee cups …

♦ Physical location of data and processing are unknown to user
  ♦ The technology and business have developed faster than the legal and regulatory frameworks that govern them – e.g. privacy…

♦ Users see value in the knowledge that comes from data, not in the data themselves
  ♦ Value increases: from data to information to actionable knowledge
  ♦ Analytic software is critically important to visibility of value

♦ Knowledge from big data becomes essential in almost all industries
  ♦ New possibilities for measuring human behavior, interrelationships between different phenomena (e.g. weather and crops), complex systems
Cloud computing: much more than just providing cloud computing services

♦ Cloud computing = entire ecosystem built on distributed information storage and processing
  ♦ Including analytic tools, etc., at application layer
  ♦ E.g. cloud enables, and is required by, mobile Internet businesses

♦ The shift to cloud computing is happening at the same time as another major functional shift in role of IT in business
  ♦ Earlier: focus on productivity improvement through office automation – consider ERP
  ♦ New focus: help company generate new revenue (e.g. customer acquisition), maximize revenue from customers = CRM functions

♦ Security will continue to be a race between hackers (some with government backing) and the establishment (business, gov’t)
  ♦ Unless there is a major terrorist attack, the Establishment will continue to find timely solutions
Cloud computing is already transforming some traditional industries

Example: marketing and advertising are being transformed

- Shift away from traditional media to new (online) platforms: mobile devices, smart TVs, online social communities
- New supply chain: publisher – supply side platform* – ad exchange – demand side platform** – advertiser
- New techniques: find and target “influencers,” not just reach larger audiences
- New business processes: real-time bidding
- Extensive use of analytic tools
  *maximizes revenue for suppliers of online ad space, guarantees inventory availability
  **allows advertisers to buy audiences rather than specific website ad placements

Expect new waves of industry transformation

Entertainment content delivery (disrupt TV, radio industries)
Smart communities (merge electric power AND communications AND transportation industries?)
Now: disruptive ideas from start-up companies with big data analytics for business applications

- **Sales contact** analytics
  - Lattice Engines
- **Physical store** analytics
  - Euclid Analytics
  - Nomi
  - RetailNext
- **NLP** analytics
  - AlchemyAPI
- **Social TV** analytics
  - Bluefin Labs
- **Legal / IP** analytics
  - Lex Machina
- **Info network** analytics
  - Quid
- **Credit** analytics
  - ZestFinance
- **Healthcare** analytics
  - Apixio
- **Security** analytics
  - CrowdStrike

*Advertising analytics companies are not in this list.*

*From US-ATMC survey of 100+ new applications-layer companies (12/2012)*
New industries = new value chains

- Initial stage uncertainties in new value chains tend to favor vertically integrated business models
  - See right now in cloud-based IT service businesses:
    - ERP firms are extending their business lines to CRM, buying up social media analysis firms
    - IaaS companies (e.g. Amazon) are extending their services to PaaS

- Major challenge of as-a-service business model: How to pay for ongoing new product development with subscriptions?
  - Cash flow (R&D costs are up-front)
  - In accounting: R&D costs cause drop in net income

- Some strategies
  - Portfolio of low and high-value services to yield an average profit margin
  - More focus on open innovation: acquire new products, not develop them
    - But, integration takes time and R&D resources
Impact of cloud revolution on labor force
## Overview of cloud ecosystem impact on labor force

<table>
<thead>
<tr>
<th>Analytics for various aspects of business become more and more pervasive</th>
<th>1. All industries come to need personnel with advanced IT knowledge (e.g. data scientists)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud has no borders: markets and business activities become more intrinsically global</td>
<td>2. Demand for global business skills will become more pervasive</td>
</tr>
<tr>
<td>Business, markets, technologies show great uncertainty, develop very quickly</td>
<td>3. Workers focus on rapid learning ability, transferrable skills, self-managed careers</td>
</tr>
<tr>
<td>Businesses adopt fundamentally new processes for doing projects: e.g. crowd-sourced development</td>
<td>4. Many workers become more independent; increase in part-time contract workers</td>
</tr>
<tr>
<td>Rapid tech development; need for interdisciplinary knowledge</td>
<td>5. Interweaving of continuing education throughout career</td>
</tr>
</tbody>
</table>
New labor force needs: 1. Integrating IT knowledge in all industries

- "Data scientist: the sexiest job of the 21st Century"
  (Harvard Business Review, 10/2012)

- Integrates knowledge of big data infrastructure, advanced analytic tools, formal modeling with (industry-specific) practical knowledge

- Creation of “Certified Analytics Professional” program by Institute for Operations Research and the Management Sciences (INFORMS)
  - 10,000 member professional society
  - Certification developed by industry and university expert committee in 2012
Certified Analytics Professional program (cont’d)

- Candidates earn designation through a combination of:
  - Education
  - Experience
  - Confirmation of “soft skills” (in communication and presentation)
  - Rigorous examination

- First awards: April 2013
- Passing rate = 77%

<table>
<thead>
<tr>
<th>Domain</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Business Problem (Question) Framing</td>
<td>15%</td>
</tr>
<tr>
<td>II</td>
<td>Analytics Problem Framing</td>
<td>17%</td>
</tr>
<tr>
<td>III</td>
<td>Data</td>
<td>22%</td>
</tr>
<tr>
<td>IV</td>
<td>Methodology (Approach) Selection</td>
<td>15%</td>
</tr>
<tr>
<td>V</td>
<td>Model Building</td>
<td>16%</td>
</tr>
<tr>
<td>VI</td>
<td>Deployment</td>
<td>9%</td>
</tr>
<tr>
<td>VII</td>
<td>Life Cycle Management</td>
<td>6%</td>
</tr>
</tbody>
</table>

100%
New labor force needs:

2. Ability to work in global contexts

- Cloud infrastructure makes connectivity expected
- Cloud promotes both global market expansion and also local market customization
- Shift in business patterns
  - Away from centralized decisions being sent out to local subsidiaries
  - To real-time interaction between local markets and decision makers
  - More international teams
- Not just foreign language skills: includes flexible thinking, quick observation skills, cross-cultural sensitivity, ability to work with incomplete information
Increase of global cooperation: joint research papers with China and India co-authors

<table>
<thead>
<tr>
<th></th>
<th>China, ‘99 – ‘03</th>
<th>China ’04 – ‘08</th>
<th>India ‘99 – ‘03</th>
<th>India ’04 – ‘08</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>16,389</td>
<td>39,428</td>
<td>6,725</td>
<td>10,728</td>
</tr>
<tr>
<td>Japan</td>
<td>7,251</td>
<td>13,418</td>
<td>1,908</td>
<td>3,017</td>
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<tr>
<td>Germany</td>
<td>4,480</td>
<td>8,263</td>
<td>2,667</td>
<td>4,284</td>
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<tr>
<td>U.K.</td>
<td>4,433</td>
<td>9,987</td>
<td>2,137</td>
<td>3,646</td>
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<tr>
<td>Canada</td>
<td>2,806</td>
<td>7,547</td>
<td>927</td>
<td>1,590</td>
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<tr>
<td>Australia</td>
<td>2,796</td>
<td>7,116</td>
<td>643</td>
<td>1,338</td>
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<tr>
<td>Singapore</td>
<td>1,782</td>
<td>4,635</td>
<td>-- (no data)</td>
<td>-- (no data)</td>
</tr>
<tr>
<td>S. Korea</td>
<td>1,565</td>
<td>4,485</td>
<td>558</td>
<td>2,074</td>
</tr>
<tr>
<td>Taiwan</td>
<td>1,471</td>
<td>3,219</td>
<td>540</td>
<td>1,102</td>
</tr>
</tbody>
</table>

Battelle, R&D Mag, Dec 2009. 2010 Global R&D Funding Forecast
Increase in global business: New U.S. patents with foreign authors – clean energy & pollution control

Share:
Japan = 45.4% (1995)
42.9% (2010)

S. Korea = 0.9% (1995)
11.6% (2010)

National Science Board,
Science and Engineering Indicators 2012
米国科学財団、
2012年の科学・工学指数
New labor force demands:
3. Learning ability more than knowledge itself

- Stanford Dean of Engineering: “Curriculum content in Engineering has a half-life of three years.”
  - = 50% is out-of-date in three years
- Cisco Systems Senior VP of HR:
  “I don’t hire an engineer just because of what they know; that knowledge is mostly useless within 18 months. I hire someone because of their ability to learn.”
- Cloud is creating new value chains
  - Great uncertainty as markets rapidly evolve
  - Rapid adaptability essential at all levels of company
Unstable employment patterns

  ♦ 30-year study of “baby boomers” born between 1957 – 1964
  ♦ First interviewed in 1979, last interviewed in 2010
♦ Individuals held an average of 11.3 jobs between ages 18 to 46
  ♦ Men with university degree or higher = 11.4 jobs
  ♦ Women university graduates or higher = 12.2 jobs
  ♦ Time spent in one job increases as worker gets older, but…
  ♦ Among 40 to 46 year olds who started a job, 33 % of the jobs ended in less than one year, 69 % ended in less than 5 years
♦ Stanford EE Dept. Head: “Graduates this year (2012), on average, will change companies seven times in their careers.”
New labor force needs:
4. Greater independence in work relationships

- Example of new trend: crowdsourced product development
  - Fiat Mio (2011): took into account 10,000 suggestions from people in more than 160 countries
  - Google: competition for applications of Google Glass
  - Enabled by cloud connectivity
- Cloud also enables new work patterns (part-time, telecommuting)
  - May enable greater participation by working mothers in labor force
New labor force needs:

5. New lifelong educational relationships

- Due to rapid pace of technology development, interdisciplinary nature of new IT problems

- IT employees need continuing connections to newest theoretical knowledge and tools coming from universities

- New challenge and opportunity for university
  - Help students develop T-shaped knowledge profile
  - Rapid progress of knowledge: distance from basics to advanced knowledge increases
  - Prepare students for new models of collaboration, design thinking
  - Provide educational “refreshers,” “updates” for industry
Focus on developing “T-shape” knowledge

♦ Deep knowledge of major field
♦ Plus:
  ♦ “General education requirements” (undergraduate)
    ♦ Critical thinking, world cultures, communication skills, etc.
  ♦ Elective courses in other fields (history, philosophy, etc.)
  ♦ “Design-school” type courses: applications of knowledge to real-world (interdisciplinary) problems
♦ Stanford promotes faculty proposals to teach special freshmen and sophomore interactive courses (“seminars”) – limited enrollment
  ♦ E.g. “The physics of musical instruments”
  ♦ New ways of introducing core curriculum content
Expansion of core – example Computer Science

- New analytics, security
- Unstructured data, Hadoop
- Quantum phenomena
- Cloud computing
- M2M, Internet of Things
- AI
- Databases
- Human interface
- Control
- Theory
- Systems & architecture
Expansion of core – plus demands for practical (experience-based) knowledge

**Big data analytics**

- New analytics, security
- Unstructured, Hadoop
- Quantum phenomena
- Sensor networks for smart grid, ITS, healthcare
- Social media analysis
- Virtualization, software defined networks
- Cloud computing
- Control
- M2M, Internet of Things
- Theory
- Databases
- Human interface
- AI
- Systems & architecture

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One solution: develop “tracks” inside the major Core Theory Systems & architecture Databases AI Unstructured, Hadoop Quantum phenomena

New analytics, security

Social media analysis

Cloud computing
Virtualization, software defined networks

Control

M2M, Internet of Things

Human interface

Sensor networks for smart grid, ITS, healthcare

Big data analytics

Big data analytics

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Big data analytics

Big data analytics
For new learning styles and new content: one group is the “d.school”

♦ Interdisciplinary
  (mechanical engineering is core, plus art, education, psychology, etc.)
  ♦ Team-taught courses (profs from different disciplines)
  ♦ Limited to small classes, students who apply are selected for diverse fields

♦ Focus on practical, real-world problems
  ♦ Theme for Winter 2013 is “Tackle Big Challenges”

♦ “People-centric” approach

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Some d.school classes in Winter 2013
“Tackle Big Challenges”

- Design Leadership in Context
- Design for Science
- A Hands-On Course about Teaching Online
- From Play to Innovation (graduate students only)
- Launchpad: Design and launch your product or service
- Storytelling and Visual Communications
More focus on serious lifelong learning

♦ Big direction of change: from traditional 竹の節目 model to lifelong interweaving of university and work

♦ Stanford has long history of distance education in engineering
  ♦ Early delivery by TV to “member companies”
  ♦ Shift to online delivery via Internet
  ♦ Masters degree possible by combination of TV / online courses plus face-to-face courses

♦ Now: more emphasis on short modules of courses
  ♦ Up to one week “crash courses” in new technology topics

♦ Next: certificates of updated knowledge (?)
Considerations especially for Japan
Japan and the cloud computing revolution

- Given high rate of Internet use, robust mobile businesses (e.g. Rakuten, game companies), utilization of the power of cloud computing across industries is surprisingly slower than in U.S., U.K.
  - In particular, adoption of big data analytics is slow
  - Technology R&D workers have up-to-date knowledge
  - Use of big data may be further slowed by relative lack of advancement of semantic analysis of Japanese language, double-byte code in general
- Main problem: B2B innovation is slowed by strength of long-term customer relationships, unwillingness to be first-to-change an industry (especially if it disrupts old business)
- But, Japan is great early adopter market for consumer technology – now must move forward to measure, analyze
Summary

♦ Ongoing IT revolution: cloud computing is a new ecosystem of information storage and processing on worldwide scale

♦ Labor force demands
  ♦ IT becomes pervasive: must integrate IT knowledge with knowledge of other areas (e.g. specific industry knowledge, sales processes, etc.)
  ♦ Global business skills are essential
  ♦ Workers must cope with uncertain, rapidly changing environment – workers must manage their own careers
  ♦ Especially, new business patterns lead to more independent work relationships
  ♦ University and industry must develop new ways of working together for lifelong cooperation in keeping workers up-to-date

♦ Japan has not yet realized full opportunities from cloud (but it can!)