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

♦ Introduction to EE-402A – requirements for credit

♦ Conceptual framework: disruptive ideas, open innovation
  ♦ How things work in Silicon Valley

♦ Disruptive ideas and stages in economic growth

♦ Some trends in Asia

♦ Looking ahead
Welcome to everyone!

♦ Weekly public lecture / panel discussion series presented by the US-Asia Technology Management Center
  ♦ Every Thursday, through December 5, 2013
  ♦ Thanks: sponsorship support from Allen Miner Foundation
  ♦ See <http://asia.stanford.edu> for schedule, info
  ♦ Intro’s: Siejen Yin-Stevenson (Assistant Director, US-ATMC) Sebastian Karl (Course Assistant)

♦ 2013 Theme: Impact of selected new technologies on value chains (in traditional industries), with focus on Asia

♦ Available for credit to Stanford students: EE-402A “Topics in International Technology Management”
  ♦ No pre-requisites, open to undergrads and graduate students
  ♦ May be repeated in future years for credit; each series is separate
EE-402A Requirements for Credit

♦ Obtain Syllabus for official statement of credit requirements

♦ MAY BE DIFFERENT THAN REQUIREMENTS FOR OTHER SEMINARS

A. On-site attendance at seven (7) of nine (9) sessions
   ♦ Requirement A waived for official SCPD students
   ♦ Today fill out survey, then weekly sign-up sheet at auditorium

B. Submit a comment / summary each week for eight (8) of the nine (9) sessions
   ♦ Send comment by email within two weeks of the session
     • To me (Prof. Dasher) <rdasher at stanford dot edu>
     • Always cc to Sebastian Karl <skarl [at] stanford [dot] edu>
   ♦ Comment must provide evidence that you watched the session
Request to everyone (visitors and students) for today, 10/03

Please fill out incoming-survey and leave with Siejen, Sebastian, or me

- Even if you have attended our programs in the past

- For students registering for credit, **this survey is your on-site attendance record for 10/03/2013**

- In addition, you will need to submit your comment / summary about the content of this session within two weeks
Conceptual framework: Disruptive ideas, start-up companies, and open innovation
Definition: disruptive idea (a.k.a. a “disruptive innovation”)

- A new product or service that creates a new market and / or value network…
  - Typically by selling the new thing or service to a new set of customers
- … and eventually disrupts an existing market or value network
  - Displaces an earlier industry (set of companies) that previously dominated the (old) market
  - Causes major changes in a supply chain or value chain
    - New suppliers, new loci of high value (versus commodity)
Example: smartphone cameras versus the camera industry

- Early experiments of phones with built-in cameras in 1990s; first camera-phone sold by mobile operator J-Phone (now part of Softbank) in Japan in 2000; more than half of J-Phone subscribers were using cell phone cameras in two years
- Early phone cameras were low quality (compared to compact digital cameras at the time) but had connectivity; people carry phones most of the time – convenient
- Appearance of smartphones (with standard OS, downloadable applications) added even more possibilities for photo sharing, etc.
- Cost of camera is bundled into cost of phone
- Performance improvements: esp. sensor (e.g. Nokia Lumia 1020 (2013): 41 Megapixel sensor on Windows 8 OS), application software
- Compact camera sales fell by 30 percent in 2011 (TechRadar)
- 37% of images taken in the U.S. in 2011 were with camera phones, number expected to rise to 50% by 2015 (Nat’l Geo / CEA)

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“Disruptive” because taking away business from earlier industries / markets

♦ Smartphone cameras (continued)
  ♦ Sales of big digital cameras by Nikon, Canon, etc. still growing
  ♦ But: “Canon and Nikon should pay heed…or risk sequestering themselves in the ultra high-end camera ghetto.” (The Guardian, 3/19/2012)

♦ Typical pattern of a disruptive innovation
  ♦ (a) creation of a new technology for a new market / customer base,
  ♦ (b) performance improvements in the new device, and then
  ♦ (c) disruption / displacement of some earlier product/market
  ♦ Often involves new firms taking over an industry, new industry structures (new supply chains, etc.)
Food for thought: automobiles as a disruptive innovation  (acc. to Christensen 2003)

♦ The invention of the automobile was not really a disruptive innovation
  ♦ It was a revolutionary technological achievement
  ♦ Created a new market that did not exist before
  ♦ But, early automobiles were expensive luxury items that did not take much business from the market for horse-drawn vehicles

♦ The automobile became disruptive with the introduction of the Ford Model-T
  ♦ Lower priced, mass-produced (= readily available)
  ♦ Then the auto changed the transportation market
  ♦ What did the Model-T disrupt? (Carriages? Trolleys? Rail transportation? Many early automobile companies & their suppliers,...) – yes to all of these
Some more recent disruptive innovations

♦ Online advertising
  ♦ At the center of a new supply chain
    ♦ Real-time bidding
    ♦ Supply side platforms, demand side platforms
  ♦ Disrupting traditional advertising industry (newspaper ads, TV commercials)

♦ Online retailing (ecommerce)
  ♦ Cutting into sales of “brick-and-mortar” retail businesses (bookstores, department stores, etc.)
  ♦ Changing the way that all retailers compete (e.g. use of email & SMS for loyalty programs)
Start-up companies are great sources of disruptive innovations

Typically, only start-up companies will carry both risks

Examples: Tesla Motors, Facebook (in its early days)

Develop new technology for existing market: big companies do this
Example: aircraft (Honda Jet)

Market risk
High
Low

Execution Risk
High
Low

Low

Incremental product development: big companies do this
Example: new auto models each year

Develop new market for existing technology: big companies do this
Examples: iPhone, iPad

(idea for figure based on Christensen 1997)

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But, (as with the auto), it’s not the initial invention that is really disruptive; it’s:

(A) the pattern of growth
- Ultimate size of market: potential to reach billions of lives
- Impact on multiple industries
- Impact on an economy (size of an industry)

(B) the transformative effect
- Change the supply chain (value chain) of an industry
- Change the way people live or work

Compare criteria for disruption in May 2013 report by McKinsey Global Institute:
- Study 12 disruptive technologies (out of possible 100)
- Likely to yield up to $33 trillion of new value by 2025 (to a world economy that is about $100 trillion at the time)
Disruptive innovations and new value chains

♦ Value chain
  ♦ Similar to supply chain, “value chain” refers to interlinked activities that are necessary to deliver a product to a market
    ♦ E.g. system design > component design & manufacturing > final assembly > distribution > sales
  ♦ But, value chain includes analysis of the relative contributions of the interlinked activities to the value of the final product
    ♦ How revenue is distributed or credited to upstream partners, degree of competition at each node in the chain (e.g. how many other suppliers could deliver an equivalent product?)

♦ Two ways to create a major new value chain
  ♦ Start from nothing (new product category that creates a new industry)
  ♦ Transform (disrupt) some existing value chain (including the value chain of another industry)
Silicon Valley economy: series of booms around new industries – each had high growth companies that became world leaders

“Silicon Valley” term first used in 1971

<table>
<thead>
<tr>
<th>Key S.V. industry</th>
<th>Disruptive innovation</th>
<th>Rising stars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early 1970s</td>
<td>Silicon wafer manufacturing</td>
<td>Silicon crystal growth</td>
</tr>
<tr>
<td>Late 1970s</td>
<td>(Highly) integrated microelectronics</td>
<td>Microprocessor</td>
</tr>
<tr>
<td>Early 1980s</td>
<td>New computer systems</td>
<td>RISC chip, new OS</td>
</tr>
<tr>
<td>Late 1980s</td>
<td>Software</td>
<td>Relational databases, graphic user interface</td>
</tr>
<tr>
<td>Mid 1990s</td>
<td>Internet</td>
<td>Hypertext</td>
</tr>
<tr>
<td>Late 1990s</td>
<td>E-commerce</td>
<td>DSL, business enablers</td>
</tr>
<tr>
<td>Early 2000s</td>
<td>Web 2.0</td>
<td>Search engines</td>
</tr>
<tr>
<td>Late 2000s</td>
<td>Social networking</td>
<td>New business models</td>
</tr>
</tbody>
</table>

“Silicon Valley” term first used in 1971
Some Silicon Valley superstar companies:
Sales growth rates during their first five years
Key Silicon Valley companies sustained high growth rates for at least ten years

<table>
<thead>
<tr>
<th>Company</th>
<th>Average annual growth rate over the first five years of sales</th>
<th>Average annual growth rate over the first ten years of sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel</td>
<td>167 %</td>
<td>91 %</td>
</tr>
<tr>
<td>Apple</td>
<td>284</td>
<td>125</td>
</tr>
<tr>
<td>Oracle</td>
<td>123</td>
<td>100</td>
</tr>
<tr>
<td>Cisco</td>
<td>203</td>
<td>131</td>
</tr>
<tr>
<td>SUN Microsystems</td>
<td>165</td>
<td>88</td>
</tr>
</tbody>
</table>

• Only a few companies achieved such sustained high growth
• Superstar companies became a model for most start-up companies and their investors in Silicon Valley
• But, economic success of the Valley not **just** from these companies -- 90% of successful exits are via acquisition by big firm
Challenge of innovation management for a company

Must create pipeline of bringing new ideas to market

Basic Research  Applied Research  Development  Target Market

Companies need to consider a broader range of research to have sufficient inputs to development

Only a few ideas from Research go on to Product Development and then to Market

Only those ideas with best prospects for success, best fit to overall company strategy
Traditional solution: (primarily) closed innovation

Bigger companies were more competitive, because they could support innovation pipelines through broad company-internal R&D

- drawing based on works by H. Chesbrough
Open innovation: use of inflow and outflow of knowledge across company boundary

Based on drawings by H. Chesbrough
Incoming open innovation: sources of ideas

Co. internal idea incubation (R&D)

Co. external idea incubation

Spin-out company

License out tech

New market

New market

Basic Research

Applied Research

Development

Target market

Idea A

Idea B

Idea C

Idea D

Idea E

University collaboration, multi-firm joint research

Corporate VC investing

Buy tech license, buy start-up company

Buy / merge with large company
Google: big company practicing open innovation

- Company-internal R&D spending in the year from 2011Q4 – 2012Q3 = $6.217 billion
  - 13.1% of revenues; average for software industries was 13.3%

- In 2011, Google made one large company acquisition
  - Motorola Mobility (2011, $12.5 billion) was about present day business

- In 2011, Google made 24 start-up company acquisitions
  - Areas expected to be critical to Google business within two years or so
  - Probably spent around $700 million (terms of some deals not public)

- Google established corporate VC fund (Google Ventures) 2009
  - Fund size $100 million, increased to $300 million in 2013
  - Makes minority investments in start-up companies (not complete ownership) that are 3 – 7 years from market

- Active supporter of university research at Stanford and elsewhere
Established (large) company motivations to engage in open innovation

- Very different motivations than “outsourcing”
  - Outsourcing is to entrust something the company already knows it needs to an external partner, because of the partner’s efficiency (lower cost), expertise, or other qualitative advantage.

- Open innovation motivations:
  - Increase the number of new ideas in its innovation pipeline
  - Let others pay for idea incubation until the idea reaches the optimum balance (for the big company) of value, cost, and risk
  - Most important: obtain access to different types of ideas than are already being incubated inside the company’s R&D group
As entrepreneurial innovations are incubated, they become targets for big firms.
Big companies, disruptive ideas, and open innovation

- Disruptive innovations: it is very difficult for company-internal R&D to incubate ideas that may disrupt existing business
  - Sales division will usually not allow idea to get through to product stage
  - Possible only with “personal attention of CEO” (Christensen 2000)

- Big companies need to deliver disruptive ideas once in a while
  - Otherwise, inevitable slowdown of existing markets, apparent lack of creativity in R&D division, loss of business to less expensive competitors

- Big companies seek disruptive ideas from outside
  = open innovation
  - Also seek unexpected opportunities: ideas not already in the company-internal R&D pipeline
Disruptive ideas (and open innovation) become more important as an economy becomes more advanced.
Creativity-based innovation becomes more important as an economy advances

<table>
<thead>
<tr>
<th>Typical per-capita GDP</th>
<th>Factor-driven Economies*</th>
<th>Efficiency-driven Economies*</th>
<th>Innovation-driven Economies*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below approx. $15,000 / year</td>
<td>Approx. $15,000 - $35,000 / year</td>
<td>Approx. over $35,000 / year</td>
<td></td>
</tr>
<tr>
<td>Societal developments</td>
<td>Industrialization, urbanization</td>
<td>Labor and capital shortages, needs for higher skills</td>
<td>Wealth spreads throughout pop, higher educ. levels</td>
</tr>
<tr>
<td>Business opportunities</td>
<td>“Gold rush” to supply basic demands</td>
<td>Develop new markets - domestic or international</td>
<td>Creative, fresh new ideas, “out of the box” thinking</td>
</tr>
<tr>
<td>Key competitive strengths</td>
<td>Get there first!</td>
<td>Operational efficiency, rapid scaling, high quality</td>
<td>Manage (allow) risk, early ID of great new ideas, sustain high growth</td>
</tr>
<tr>
<td>Focus of new government policies</td>
<td>Basic laws, establish industry base</td>
<td>IPR, select &amp; promote key industries</td>
<td>Encourage entrepreneurs, bridge over “valley of death”</td>
</tr>
</tbody>
</table>

* Terms from Global Entrepreneurship Monitor, chart & analysis original to RD
Innovation occurs at every stage of economic growth

- But, types & motives of innovations tend to shift along with types of economic / business opportunities
  - Factor-driven: “create an industry” (usually where no industry existed beforehand)
  - Efficiency-driven: “expand existing business to (world) markets”
  - Innovation-driven: “fresh new ideas, new ways of looking at old problems”
  - General: Why incur any more risk than one has to incur?

- Likelihood that an innovation will cause some disruption increases along with the evolution of an industrial base
  - Need disruptive innovations more in innovation-driven advanced economies
GDP of the top five national economies of the world

<table>
<thead>
<tr>
<th></th>
<th>2010 $ trillions</th>
<th>2010 GR - %</th>
<th>2011 $ trillions</th>
<th>2011 GR - %</th>
<th>2012 $ trillions</th>
<th>2012 GR - %</th>
<th>2012 GDP / person $</th>
</tr>
</thead>
<tbody>
<tr>
<td>World total</td>
<td>77.71</td>
<td>5.1</td>
<td>80.61</td>
<td>3.7</td>
<td>83.23</td>
<td>3.3</td>
<td>12,500</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>15.05</td>
<td>2.4</td>
<td>15.32</td>
<td>1.8</td>
<td>15.66</td>
<td>2.2</td>
<td>49,800</td>
</tr>
<tr>
<td>China</td>
<td>10.51</td>
<td>10.4</td>
<td>11.48</td>
<td>9.2</td>
<td>12.38</td>
<td>7.8</td>
<td>9,100</td>
</tr>
<tr>
<td>India</td>
<td>4.21</td>
<td>10.1</td>
<td>4.49</td>
<td>6.8</td>
<td>4.74</td>
<td>6.5</td>
<td>3,900</td>
</tr>
<tr>
<td>Japan</td>
<td>4.55</td>
<td>4.5</td>
<td>4.52</td>
<td>(-0.8)</td>
<td>4.62</td>
<td>2.2</td>
<td>36,200</td>
</tr>
<tr>
<td>Germany</td>
<td>2.99</td>
<td>3.7</td>
<td>3.10</td>
<td>3.0</td>
<td>3.19</td>
<td>0.9</td>
<td>39,100</td>
</tr>
</tbody>
</table>

• Ranking excludes EU (which would be bigger than U.S.A.)

Estimated amounts in 2012 dollars, according to PPP

*2012 CIA World Factbook*, data retrieved 4/01/2013

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GDP of other Asia economies in the top 50

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</tr>
</thead>
<tbody>
<tr>
<td>12. S. Korea</td>
<td>1,524</td>
<td>6.3</td>
<td>1,579</td>
<td>3.6</td>
<td>1,622</td>
<td>2.7</td>
<td>32,400</td>
</tr>
<tr>
<td>15. Indonesia</td>
<td>1,074</td>
<td>6.2</td>
<td>1,143</td>
<td>6.5</td>
<td>1,212</td>
<td>6.0</td>
<td>5,000</td>
</tr>
<tr>
<td>19. Taiwan</td>
<td>856</td>
<td>10.7</td>
<td>890</td>
<td>4.0</td>
<td>902</td>
<td>1.3</td>
<td>38,500</td>
</tr>
<tr>
<td>24. Thailand</td>
<td>612</td>
<td>7.8</td>
<td>612</td>
<td>0.1</td>
<td>646</td>
<td>5.6</td>
<td>10,000</td>
</tr>
<tr>
<td>27. Pakistan</td>
<td>482</td>
<td>3.1</td>
<td>496</td>
<td>3.0</td>
<td>515</td>
<td>3.7</td>
<td>2,900</td>
</tr>
<tr>
<td>29. Malaysia</td>
<td>448</td>
<td>7.2</td>
<td>471</td>
<td>5.1</td>
<td>492</td>
<td>4.4</td>
<td>16,900</td>
</tr>
<tr>
<td>32. Philippines</td>
<td>383</td>
<td>7.6</td>
<td>398</td>
<td>3.9</td>
<td>417</td>
<td>4.8</td>
<td>4,300</td>
</tr>
<tr>
<td>35. Hong Kong</td>
<td>340</td>
<td>7.1</td>
<td>357</td>
<td>5.0</td>
<td>364</td>
<td>1.8</td>
<td>50,700</td>
</tr>
<tr>
<td>39. Singapore</td>
<td>305</td>
<td>14.8</td>
<td>320</td>
<td>4.9</td>
<td>327</td>
<td>2.1</td>
<td>60,900</td>
</tr>
<tr>
<td>41. Vietnam</td>
<td>288</td>
<td>6.8</td>
<td>305</td>
<td>5.9</td>
<td>321</td>
<td>5.1</td>
<td>3,500</td>
</tr>
</tbody>
</table>

- Not included: Middle East countries
- Ranking excludes EU

Estimated amounts in 2012 dollars, according to PPP

2012 CIA World Factbook, data retrieved 4/01/2013

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China (GDP average $9.1K / pers) as a “factor-driven” economy

- Great business opportunities through creation and growth of new domestic markets
  - Much economic growth (until recently) was fueled by investment
  - More recently: consumer spending growth increasing faster than GDP growth
  - Often not necessary to disrupt an existing industry
- U.S. venture capital firms became active in China from early 2000’s
  - But they tend to invest in somewhat “lower tech” business ideas that arise along with evolution of industry, consumer demands
- Regional differences
  - East coast cities: GDP / person is higher, urbanization obvious
  - Disruptive innovations do happen: e.g. ecommerce (disrupting retail industries)
India ($3.9K/pers): innovation-driven economic “islands” in the middle of a factor-driven economy

- Advanced IT services innovation is a world-market phenomenon
  - Very little domestic sales by Infosys, Wipro
  - In this sector, opportunities and risk is similar to situation in advanced economies

- Bottom-of-pyramid businesses: a classic “factor-driven economy” opportunity
  - May or may not involve disrupting some existing industry
  - Redbus and Innoz from Spring 2013 “EE-402T” seminars
    - Redbus disrupted existing channels of bus ticket sales
    - Innoz provides Google-type search via cellphone SMS – often not accessible to target market via other channels
S. Korea ($32.4K/pers): at cusp from efficiency-driven to innovation-driven

♦ Big company successes still happening through world market expansion
  ♦ DRAM: industry focus shift from U.S. to Japan to S. Korea
  ♦ LCD TVs: “ “ “ “ “
  ♦ Automobiles: “ “ “ “ “
  ♦ Cellphones: from U.S. (Scandinavia, & Japan) to S.Korea
  ♦ Disrupted existing industry, but basically with existing technology
    ♦ At first: quality “as good,” efficiency (cost-perform) “better”
    ♦ To: quality “even better”

♦ New focus on “creative economy” (gov’t policy)
  ♦ Promotes entrepreneurship, internal creation (not copying)
  ♦ An attempt to mitigate the danger of high centralization of national capital and labor force in existing big companies
Japan ($36.2K/person): finding its way as an innovation-driven economy

- Some disruptive new ideas
  - Uniqlo (Fast Retailing Inc.) disrupting chain retail industries
- But most superstar innovations in Japan have been first-moves that create new industries / big new markets (without disrupting existing ones…?)
  - Suica – prepaid cash card for micropayments (from train system to other transportation, convenience stores, etc.)
  - DeNA, Gree mobile game publishing (platforms)
  - Earlier: Softbank – delivered standard software products distribution to Japan
- Older big firms have difficulty with open innovation
  - Too difficult to break out of old customer relationships
  - Incentives for open innovation (to R&D personnel) not developed
Taiwan ($38.5K/pers): early stages of innovation-driven economy

- Recent out-flow of much manufacturing to mainland
- Companies don’t compete on growth of domestic (Taiwan) market
- Long history of science and technology parks
- Still strong base of contract / component manufacturing
  - Competing via world market expansion: Hon Hai Precision Industry Co. (major supplier to Apple) forming JV to sell cellphones in Indonesia (9/30/2013)
  - But shift in TSMC business (from cost-based competition to manufacturing excellence-based competition to customer service-based competition) – Lee and Whang 2006 case
Hong Kong ($50.7K/pers) and Singapore ($60.9K/pers): investment-driven urban economies

- Some characteristics of being innovation-driven urban centers – similar to Silicon Valley, etc.
  - Strong R&D institutions: universities, research institutes
  - Entrepreneurship centers on “entrepreneurship of opportunity” (not “entrepreneurship of necessity”)

- Economic growth probably driven mostly by external (not domestic) investments
  - Especially in growth of other Asia markets
  - Some innovation services strong (IP law, accounting, etc.)

- But, top students tend to aim more for jobs in financial industries, government

- Governments: working to promote innovation
U.S. economy – growth of the entrepreneurial sector in innovation

♦ Share of total corporate R&D spending in U.S.

<table>
<thead>
<tr>
<th></th>
<th>Small firms (&lt; 1,000 employees)</th>
<th>Medium (1K – 25K)</th>
<th>Large firms (25K+ employees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>4%</td>
<td>25%</td>
<td>71%</td>
</tr>
<tr>
<td>2005</td>
<td>24%</td>
<td>38%</td>
<td>38%</td>
</tr>
</tbody>
</table>

♦ Share of U.S. patents to firms with less than 1,000 employees
  ♦ 1972: 5% of new U.S. patents
  ♦ 2000: 30% “ “ “

(Borchardt 2008)

♦ This pattern shows a shift in the funding of innovation – from big company R&D budgets to venture investors
Open innovation still lags behind U.S. in Asia economies

<table>
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<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>746,359</td>
<td>271,785</td>
<td>36.4</td>
</tr>
<tr>
<td>OECD (excl. US)</td>
<td>1,338,182</td>
<td>350,136</td>
<td>26.2</td>
</tr>
<tr>
<td>Japan</td>
<td>287,219</td>
<td>12,647</td>
<td>4.4</td>
</tr>
<tr>
<td>S. Korea</td>
<td>26,891</td>
<td>3,864</td>
<td>14.4</td>
</tr>
</tbody>
</table>

- A firm tends only to file “high value” patents in a foreign country; may skew U.S. filing percentage higher for U.S. small firms
- But, higher percentage of small firms in non-US OECD countries filed in U.S. than did Japan (OECD member) and Korea (non-OECD)
- Some non-US countries have high percentage: 52.4% of U.S. patents from Israel were filed by “small entities,” 19.1% of UK filings in U.S.

Data from Kingston & Scally 2006
Where do we go from here?

Examine some (potentially) disruptive innovations / new value chains in Asia economies

Explore whether these new value chains are indicating an increase in open innovation activities
Some upcoming sessions

♦ New platforms for data-driven analysis  (10/10)

♦ CrowdANALYTIX  (India): crowdsource problems to community of data scientists

♦ Algorithms.io  (U.S. with Korea investment): modularized platform for easy custom data analytics development

♦ Nano-electronics

♦ New industry consortium in Japan

♦ Data-driven marketing  (S. Korea:  SK Planet)

♦ Hydrogen energy storage  (Japan)

♦ Water resource management  (India)

♦ Ecommerce and retailing  (China)