Technology Development and Management in a Global Environment:
Exploring and understanding implications of “The World is Flat” for science- and technology-intensive organizations and what that means for individuals, organizations, innovation, R&D, and opportunities.

S. Massoud Amin
Director and Honeywell/H.W. Sweatt Chair in Technological Leadership
University Distinguished Teaching Professor
Professor of Electrical & Computer Engineering

Rochester Signature Series, Tuesday, October 21, 2008
Agenda for today’s workshop/class:

• Internationalization of high technology enterprises, R&D, and technology commercialization trends in the global context
• Regional, Government and institutional factors affecting technological and business development
• Intellectual property policy, law, management and strategy
• Technological products:
  – Historical Events and Technological Change: Continuum of science from IT/cyber to bio and nano
  – Difficult process technologies (can it be reverse engineered?) – can’t be duplicated from end product
  – Demographics: Suitable workforce
  – Multiple-use good (usable by everyone)
  – Economic factors, including capital and workforce
  – Rarity, status value, non-perishable, transportable
  – Timelines to get to market, and remain sustained in the market
  – Product is known for decades before widespread use
• Case studies: Information Technology, Energy, biosciences/pharma, IP and other selected areas focused on India and China
• Marketing analyses-- How do the market factors look?
• Infrastructure for power/energy and transportation
• Work force retention and escalating salaries
• Cost factors vs. emphasis on expertise
• Lessons learned, time lines, surprises, threats and opportunities
• Blockers, Accelerators, and the Next Steps: Possible innovations in global technology environment
Effects of Tech Globalization: Please consider the following questions & map out your thoughts

• The history and context in your organization, or in your “business” sector for technology development and management in global environments. How has it evolved over time and where are the likely destinations in the next 2-5 and 5-20 years?

• What are the key processes, models and the whole "system" for this shift: Inputs, outputs, stimuli, dynamics, players and actors, processes, incentives, and control mechanisms (blockers and accelerators)?

• How does it affect you individually, your organizations, and technology/market sectors?

• Who is the target audience?
  – Basically “what does all this mean to you and to our organizations in Minnesota?”

• What is your leadership role?
  – Find, highlight and analyze part(s) of the above opportunities that you or your organizations/companies in Minnesota can potentially lead as new business development or forming alliances.
Effects of Tech Globalization

• By 2008, China and India account for 31% of global R&D staff, up from 19% in 2004.

• 77% of new R&D sites planned for next 3 years will be built in China or India.

• The US ranks 17th among developed nations in the proportion of college students majoring in science and engineering.
Global Technology Diffusion

Guangdong Science Center -- China
Opens 2008

June 2006
The Problem of speed

- Knowledge created in the 1990’s is equal to all knowledge created in 300,000 years of human history to that decade.

- NSA estimates that the internet will carry 647 petabytes (billion million bytes) of data EACH DAY in 2007. For comparison, the Library of Congress holdings represent 0.02 petabytes.

- Estimated that in 2010, the cost of synthesizing bacteria genome-sized DNA sequence will be equivalent to the price of a car.
Worldwide industrial technology alliances and those with at least one U.S.-owned company: 1980–2003

1. The Cooperative Agreements and Technology Indicators database-Maastricht Economic Research Institute on Innovation and Technology (CATI-MERIT, funded in part by NSF), includes domestic and international technology agreements.

2. In 2003 (latest data available) there were 695 new industrial technology alliances Worldwide.

3. These alliances involve mostly companies from the United States, Europe, and Japan, focusing to a large extent on biotechnology and information technology products, services, or techniques.

4. Other technology areas include advanced materials, aerospace and defense, automotive, and (non-biotechnology) chemicals.

SOURCE: National Science Board, Science and Engineering Indicators-2008
Foreign-owned R&D in United States and U.S.-owned R&D overseas, by investing/host region

SOURCE: National Science Board, Science and Engineering Indicators-2004
Foreign-owned R&D in United States and U.S.-owned R&D overseas, by investing/host region: 2004 or later

SOURCE: National Science Board, Science and Engineering Indicators-2008
Macroeconomic Rationale

1. Endogenous growth models - theoretical support for domestic technology creation

2. \( Y = f(R, K, H) \), where:
   - \( Y = \text{GDP} \)
   - \( R = \text{R&D} \)
   - \( K = \text{physical capital} \)
   - \( H = \text{human capital} \)

3. Velocity and proportion of \( R, K, H \): determinants of success
Talent Availability Forecast

Potential surplus population in working age group (2020)

Sources: US Census, Press search; Industry associations

CDTL Center for the Development of Technological Leadership
**HOW DO WALMART’S SALES COMPARE?**

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP (year ending 1/31/05)</th>
<th>GDP Source: WDI, World Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>$301.6b</td>
<td></td>
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<tr>
<td>Wal-Mart Stores</td>
<td>$287.8b</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>$253.1b</td>
<td></td>
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<tr>
<td>Turkey</td>
<td>$240.3b</td>
<td></td>
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<tr>
<td>Norway</td>
<td>$220.8b</td>
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<tr>
<td>Ireland</td>
<td>$153.7b</td>
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<tr>
<td>Israel</td>
<td>$110.2b</td>
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<tr>
<td>New Zealand</td>
<td>$79.5b</td>
<td></td>
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<tr>
<td>Chile</td>
<td>$72.4b</td>
<td></td>
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</tbody>
</table>
World’s 10 most profitable companies

<table>
<thead>
<tr>
<th>Rank</th>
<th>(Profits in billion $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExxonMobil</td>
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<tr>
<td>Citigroup</td>
<td></td>
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<tr>
<td>General Electric</td>
<td></td>
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<tr>
<td>Bank of America</td>
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<tr>
<td>BP</td>
<td></td>
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<tr>
<td>Freddie Mac</td>
<td></td>
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<tr>
<td>Altria Group</td>
<td></td>
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<tr>
<td>Wal-Mart Stores</td>
<td></td>
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<tr>
<td>Microsoft</td>
<td></td>
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<tr>
<td>Total-France</td>
<td></td>
</tr>
</tbody>
</table>

Source: Forbes Feb, 2004
## World's 10 Most Profitable Companies

<table>
<thead>
<tr>
<th>Rank</th>
<th>(Country)</th>
<th>Profits in billion $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ExxonMobil (United States)</td>
<td>$ 40.61</td>
</tr>
<tr>
<td>2</td>
<td>Royal Dutch Shell (Netherlands)</td>
<td>$ 31.33</td>
</tr>
<tr>
<td>3</td>
<td>Gazprom (Russia)</td>
<td>$ 23.304</td>
</tr>
<tr>
<td>4</td>
<td>General Electric (United States)</td>
<td>$ 22.22</td>
</tr>
<tr>
<td>5</td>
<td>BP (United Kingdom)</td>
<td>$ 20.61</td>
</tr>
<tr>
<td>6</td>
<td>Total (France)</td>
<td>$ 19.247</td>
</tr>
<tr>
<td>7</td>
<td>HSBC Holdings (United Kingdom)</td>
<td>$ 19.14</td>
</tr>
<tr>
<td>8</td>
<td>Chevron (United States)</td>
<td>$ 18.70</td>
</tr>
<tr>
<td>9</td>
<td>PetroChina (China)</td>
<td>$ 18.21</td>
</tr>
<tr>
<td>10</td>
<td>Microsoft (United States)</td>
<td>$ 16.96</td>
</tr>
</tbody>
</table>

Source: Forbes, July 2008
International MOT Projects 2007 and 2008

Goals:
• Contrast between emerging & established (companies, countries, technology, foreign-owned vs. local, govt. vs. private sector, etc.);
• Management of Technology content;
• A “non-U.S. International” academic perspective on MOT;
• Ability to develop a coherent intellectual structure within this region/country (content, sequence, flow)
• Held in Delhi and Bangalore
India

Parts of this presentation were developed for a graduate course at CDTL’s Management of Technology (MOT) program for the International Management of Technology (MOT 8950). Considerable input and support from the students in the MOT classes of 2007 and 2007, as well as input from senior colleagues at Honeywell, Cummins Power, 3M, and organizations indicated in India is gratefully acknowledged.
Overview

• Indian economy – The 4th largest & 2nd fastest growing economy in the world
• India GDP for FY 2006 was approx USD 570 bn at constant prices
• A middle class customer base of over 300 million people
• More than 7% GDP growth for four consecutive years
• Targeted growth Rate: 8-9 %
• Infrastructure a key bottleneck - a cause for concern?
• Expected investment in infrastructure : USD 320 billion

<table>
<thead>
<tr>
<th>EIU Infrastructure Development Ratings</th>
<th>Brazil</th>
<th>India</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-05 Rating (out of 10)</td>
<td>5.4</td>
<td>3.1</td>
<td>4.5</td>
</tr>
<tr>
<td>2001-05 Ranking</td>
<td>47</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>2006-10 Rating (out of 10)</td>
<td>5.9</td>
<td>4.1</td>
<td>5.4</td>
</tr>
<tr>
<td>2006-10 Ranking</td>
<td>49</td>
<td>75</td>
<td>54</td>
</tr>
</tbody>
</table>

Source: Prof. K.C. Iyer, IIT-Delhi
Transformation

Source: Prof. D.K. Banwet, IIT-Delhi
Energy: Size

- Generation capacity - 122 GW; 590 billion units produced (1 unit = 1kWh)
- CAGR of 4.6% in period 2002-2006
- India-5th largest electricity generation capacity in world
- Low per capita consumption at 606 units; less than half of China
- T & D network of 5.7 million circuit km – 3rd largest in the world

Source: Prof. K.C. Iyer, IIT-Delhi
Structure & Size

- Urban population – 300 mn (30% of national population)
- Growth – 5 times in the last 50 years

Urban Administration is decentralized to Urban local bodies

Source: Prof. K.C. Iyer, IIT-Delhi
Source: Prof. K.C. Iyer, IIT-Delhi
Structure

• India has extensive road network of 3.3 million km – the largest in the world (road density 1 km per sq km)

• Highways/Expressways constitute about 66,000 km (2% of all roads) and carry 40% of road traffic

• Government of India (GoI) spends about US $ 4 billion annually on road development

• Roads carry about 61% of freight and 85% of passenger traffic

Source: Prof. K.C. Iyer, IIT-Delhi
Size

- National Highways (NH) - total length of 65,569 km
- National Highway Development Programme (NHDP) - A total investment of USD 54 bn up to 2012
- Ongoing Major Programmes under NHDP
  - Golden Quadrilateral (GQ) four-laning - 5,900 km connecting Delhi, Mumbai, Chennai and Kolkata
  - North-South East-West (NSEW) corridor - 7,300 km to be completed by December 2009

Source: Prof. K.C. Iyer, IIT-Delhi
India Background: Current IT Infrastructure

• Power
  – Present shortage: 8 %, Peak demand shortage is 11.6%
  – Regional imbalances – surplus in East, deficit in North, South

• Telecom
  – India's current teledensity is 17 which means there are 17 main telephone lines per 100 population.
  – Currently there are 190 million telephone connections in the country.
  – The urban telephones density is as high as 35-40 where main businesses are situated.
  – Similarly there are 8.5 million Internet subscribers and 2.05 million broadband users. This gives about 10.55 million Internet connections. The actual internet users will be far more and restricted by number of PCs alone
Current Status: Indian Telecom

- Tele-density: 17
- Fixed + Mobile: 190 m
  - Growth: 50% per annum
- Wire line: 40.5 m  Marginal decline
- Wireless: 150 m
  - Growth: 50%
- Market share CDMA: 30%  GSM: 70%
- Internet Subscribers: 8.5 m (Annual growth of 26%)
- Broadband Subscribers: 2.05 m (Annual growth 50%)

Source: Mr. S.B.Khare, D.D.G. BSNL, New Delhi, India
Background

• Importance of science and technology for meeting economic and social needs of a country

• R&D spend
  
  USA: $276 billion (2002)
  India: Rs 22,000 crore (2004-05)

• Percent of GDP
  
  USA: 2.71 % (2002)
  India: 0.78 % (2004-05)

Source: Dr. Jyoti S. A. Bhat, DSIR
## Background

### Percent of GDP

<table>
<thead>
<tr>
<th>Country</th>
<th>2000</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Israel</td>
<td>4.43%</td>
<td>5.11%</td>
</tr>
<tr>
<td>Sweden</td>
<td>3.78%</td>
<td>4.27%</td>
</tr>
<tr>
<td>Finland</td>
<td>3.37%</td>
<td>3.52%</td>
</tr>
<tr>
<td>Korea</td>
<td>2.65%</td>
<td>2.91%</td>
</tr>
<tr>
<td>Japan</td>
<td>2.98%</td>
<td>3.11%</td>
</tr>
<tr>
<td>Singapore</td>
<td>2.12%</td>
<td>2.25%</td>
</tr>
<tr>
<td>Germany</td>
<td>2.53%</td>
<td>2.64%</td>
</tr>
<tr>
<td>China</td>
<td>1.00%</td>
<td>1.23%</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.87%</td>
<td>1.04%</td>
</tr>
</tbody>
</table>

Source: Dr. Jyoti S. A. Bhat, DSIR
## Country wise R&D expenditure (2000-02)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>4623</td>
<td>0.87</td>
<td>22.55</td>
<td>1736</td>
</tr>
<tr>
<td>China</td>
<td>10844</td>
<td>1.00</td>
<td>12.15</td>
<td>6530</td>
</tr>
<tr>
<td>India</td>
<td>2303</td>
<td>0.59</td>
<td>3.53</td>
<td>642</td>
</tr>
<tr>
<td>Israel</td>
<td>2841</td>
<td>2.78</td>
<td>755.91</td>
<td>1588</td>
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<tr>
<td>Korea</td>
<td>12249</td>
<td>2.65</td>
<td>288.50</td>
<td>9196</td>
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<tr>
<td>Taiwan</td>
<td>6326</td>
<td>2.05</td>
<td>284</td>
<td>3964</td>
</tr>
</tbody>
</table>

Source: UNESCO
Global Companies are starting to take notice of India, Private Equity Investment growing
India’s Global Transformation

Source: IIT Delhi Professor Sushil April 2007

Indian knowledge worker is flexible, adaptable

Not just lower cost brain power – (IIT, IIM)

Working to do this better (solid foundation)
Partner Maturity Index

USA previously focus on all levels, to reduce costs outsourcing lower levels and focus on top two

Challenges increase as we proceed up the pyramid

India’s has become highly efficient at the lower two levels and is trying to move up the value chain.

Potential barriers: University capacity and constraints. The need for focus on advanced degrees in leadership and innovation

Requires: Domain Expertise and Knowledge of Markets

Source: Shenoy - Philips Inc. April 2007

Each level has a different cost to operate

Perfect Partnership

Innovation

Key Competence

Offshore Development

Customer Needs and Wants
Select Competence in India

Biosciences and IT should be the major thrust areas for Collaboration & Partnerships

Adapted from Professor Carlson's Strategic PowerZone Analysis

Physical or Bio Sciences

Manufacturing
## Company Overview

<table>
<thead>
<tr>
<th>Company</th>
<th>Leading</th>
<th>Opportunity (with MN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jubilant</td>
<td>Bioinformatics and Data Warehousing</td>
<td>Collect patient medical history</td>
</tr>
<tr>
<td>Phillips</td>
<td>Application Development Mobile Phone Software</td>
<td>Partnering and Collaborating with MN companies for imaging</td>
</tr>
<tr>
<td>Honeywell</td>
<td>Linux and Java based Systems &amp; Controls</td>
<td>Security\Communications and medical diagnostics</td>
</tr>
<tr>
<td>SAP</td>
<td>Sales Force Automation (CRM) and Logistics (ERP)</td>
<td>Partner with MN based SME to assess all-in-one</td>
</tr>
<tr>
<td>GE</td>
<td>Medical Imaging &amp; 3D modeling</td>
<td>Collaborate with MN based medical companies</td>
</tr>
<tr>
<td>Maruti Suzuki</td>
<td>Manufacturing Process, Homegrown ERP</td>
<td>None</td>
</tr>
<tr>
<td>Wipro</td>
<td>IT Enabled Development, Knowledge Management Systems</td>
<td>State government IT outsourcing to reduce cost</td>
</tr>
</tbody>
</table>
## Technology Leverage for Minnesota

<table>
<thead>
<tr>
<th>Sector</th>
<th>IT</th>
<th>MEDICAL</th>
<th>UNIV</th>
<th>GOVT</th>
<th>BIO</th>
<th>TECH</th>
<th>AGRI</th>
<th>MFG</th>
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<tbody>
<tr>
<td>India Gov’t</td>
<td>X</td>
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<tr>
<td>Jubilant</td>
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<td>Phillips</td>
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<td>Honeywell</td>
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<td>SAP</td>
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<td>Maruti Suzuki</td>
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<td>X</td>
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</tbody>
</table>

### Jubilant Biosys

**MN Opportunities**
- Huge potential for bioinformatics data mining
- Like MN, strong Biomedical landscape
- Low cost bio/pharma R&D

### Wipro

**MN Opportunities**
- Looking to open small technology centers near US Universities to recruit top talent and evaluate technical trends

### SAP

**MN Opportunities**
- Partnering with MN companies to enhance SME software
IT Ties Between Minnesota and India: Goal

• Using IT, increase the opportunity for the lower class to attain better employment
  – Increase literacy rate through wider availability of primary education
  – Develop more opportunity for reputable secondary education

• Expose opportunities for MN vs.
Challenges

• Infrastructure limitations to provide full IT coverage to India
• Need funding to continue to expand both IT systems and infrastructure
• High attrition and a limited pool of qualified candidates; large pool unqualified candidates
• Create the perception and reality that India is progressing in technology – attraction of more technology
• Strict Indian government policy with respect to education
The IT Ladders in India

Opportunities

- e-Government
- E-Learning (Primary)
- Online Universities

Wall of challenge

- Availability & affordability for the people

Benefits

- Workaround for limited transportation infrastructure
- E-Gov helps expand IT availability to enable ladders 2 & 3
- Increased literacy rate
- Help close the gap between classes
- Increased qualified labor pool (competitive advantage)
State of Education

• Primary education
  – Private is very strong & expensive
  – Government schools are more affordable

• Secondary Education
  – Select Secondary Institutes are very strong (IIT, IIM, IISC)
  – Extremely difficult to gain admittance into top universities (IIT, IIM, IISC)
  – Other universities are either not accredited or not considered reputable
Percentage of Population Literate
Needs and Opportunities for IT in India

The Relevant Pool for Product Firms is Smaller

Source: SAP, Bangalore, India
Needs and Opportunities for IT in India

IT manpower gap (2009)

<table>
<thead>
<tr>
<th>Number (000s)</th>
<th>Total Demand (2009)</th>
<th>IT Services Exports</th>
<th>Domestic IT Services</th>
<th>Products and Technology Services</th>
<th>Current Pool</th>
<th>Supply Expected Based on Current Trends</th>
<th>Total Supply (2009)</th>
<th>Shortfall: 235</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT services exports</td>
<td>1,120</td>
<td>460</td>
<td>520</td>
<td>140</td>
<td>360</td>
<td>525</td>
<td>885</td>
<td></td>
</tr>
</tbody>
</table>

Note: Manpower supply numbers are based on extrapolation of current trends related to growth in educational institutions, attendance rates out-terms and labour participation as well as employment preferences.

Needs and Opportunities for IT in India

Global IT Off Shoring Market

- India: 65%
- Europe: 18%
- Asia: 12%
- America: 5%

India IT Sector is poised to grow

Source: Nasscom McKinsey Report ‘05

2005:
- ~ $12 B

2010:
- $27 B - $32 B

~ 2 ½ X
India IT Capability Evolution

Learn to Produce

Learn to Produce Efficiently

Learn to Improve Production

Learn to Improve Products

Learn to Design New Products

Source: Forbes & Wield, 2002
# IT Technology Development

**Creativity**

- Expertise
- Creative Thinking Skills
- Motivation

## Innovation

**Constructive controversy Networking**

(Super brokers)

**Doors for creative ideas**

*Teresa Amabile HBR Sept ‘98*

<table>
<thead>
<tr>
<th>Item</th>
<th>India</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity of expertise</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Veteran to new team members</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Sense of fun &amp; play</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Include outsiders</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Diversity of thinking styles</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>Small project teams</td>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Low, Medium, High
India Education Policy

• Accreditation for universities in India are required by law unless it was created through an act of Parliament.
• Without accreditation, the government notes "these fake institutions have no legal entity to call themselves as University/Vishwvidyalaya and to award ‘degree’ which are not treated as valid for academic/employment purposes."
  – The University Grants Commission Act 1956 explains, "the right of conferring or granting degrees shall be exercised only by a University established or incorporated by or under a Central Act carlo bon tempo, or a State Act, or an Institution deemed to be University or an institution specially empowered by an Act of the Parliament to confer or grant degrees. Thus, any institution which has not been created by an enactment of Parliament or a State Legislature or has not been granted the status of a Deemed to be University, is not entitled to award a degree."
Takeaways

• E-learning: expansion of current market for computer based primary education
• Larger labor pool could reduce the wage inflation
• Making e-Government a priority will increase the rate of telecommunication infrastructure development
• Develop student exchange programs with India Institutes to learn creative thinking styles
Executive Summary

• Information Technology (IT) is no longer the leading Industry in Minnesota
• MN in-house IT still drives success
• MN leverages India to spark resurgence in IT
• India can help to globalize Minnesota companies
• India leverage MN strengths
  – Healthcare
  – Education
<table>
<thead>
<tr>
<th></th>
<th>India</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>Young median age (24.9 years old)</td>
<td>Strong base of IT Professionals in major MN companies (e.g. IBM, Oracle Retail, Best Buy, Target, Accenture, 3M, etc...)</td>
</tr>
<tr>
<td></td>
<td>English speaking</td>
<td>Excellent Universities: Computer Science and Technology Programs</td>
</tr>
<tr>
<td></td>
<td>Highly educated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.5 % GDP growth</td>
<td></td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td>Infrastructure</td>
<td>Lower enrollment in Computer Science programs due to bust cycle of early 2002</td>
</tr>
<tr>
<td></td>
<td>15% employee attrition rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Under-utilized talent pool</td>
<td>Limited local market - Saturated</td>
</tr>
<tr>
<td></td>
<td>Five year plans</td>
<td>Cold Winters</td>
</tr>
<tr>
<td></td>
<td>Politics</td>
<td></td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>Become the World’s Silicon Valley</td>
<td>Not a leader in IT Innovation</td>
</tr>
<tr>
<td></td>
<td>High Foreign Direct Investment (FDI) to develop new businesses - Innovation</td>
<td>Partner with local high school to encourage and provide roadmap to University IT programs</td>
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<td>Partner with Minnesota Universities/colleges to train future</td>
<td>Align and partner with other universities (IIT And IISc) to promote global growth of technologies</td>
</tr>
<tr>
<td></td>
<td>Indian educators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rising labor costs</td>
<td>Market fluctuation in demand based on economic cycles (boom/bust)</td>
</tr>
<tr>
<td></td>
<td>Unstable neighbors</td>
<td>High offshore competition for IT jobs</td>
</tr>
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<td></td>
<td>IPR</td>
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</tr>
</tbody>
</table>
## Minnesota – India Collaboration Opportunities

<table>
<thead>
<tr>
<th>Company</th>
<th>Leading</th>
<th>Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomson Reuters</td>
<td>Software, information, communication, BI, and data management</td>
<td>Accumulate and organize Indian legal, engineering, healthcare, and technology patent documents. Facilitate employee communications and</td>
</tr>
<tr>
<td>Digital River</td>
<td>E-commerce and marketing</td>
<td>Bollywood, Trusted software distribution</td>
</tr>
<tr>
<td>Vital Images</td>
<td>3-D images of the heart and other organs</td>
<td>Improve burgeoning healthcare industry</td>
</tr>
<tr>
<td>Lawson Software</td>
<td>ERP software and service solutions</td>
<td>Sales to Indian service and manufacturing sectors.</td>
</tr>
<tr>
<td>Wipro, Infosys, Tata, HCL, etc...</td>
<td>IT Enabled Development, Knowledge Management Systems</td>
<td>MN outsourcing to reduce cost – India IT outsource to MN for resources Sponsorship/Partnership</td>
</tr>
<tr>
<td>Opportunity</td>
<td>What should be done?</td>
<td>Who?</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>IT in business</td>
<td>India collaborate with Minnesota companies to manage information storage and retrieval.</td>
<td>Thomson Reuters and Indian companies</td>
</tr>
<tr>
<td>IT in healthcare</td>
<td>Increase collaboration between doctors and patients.</td>
<td>Hospitals, clinics, Vital Images.</td>
</tr>
<tr>
<td>IT in communications</td>
<td>Collaborate to create innovative ways for developing the communication framework</td>
<td>Indian companies and Digital River</td>
</tr>
<tr>
<td>IT Outsourcing</td>
<td>Use the experience in IT in MN and India to outsource resources to each other to expand their markets.</td>
<td>India Companies like: Wipro, TCS, Infosys, MN Companies like: Analysts International, Geek Squad</td>
</tr>
</tbody>
</table>
### Recommended Moves

<table>
<thead>
<tr>
<th>Threat</th>
<th>What should be done?</th>
<th>Who?</th>
<th>How?</th>
<th>When</th>
</tr>
</thead>
</table>
| Employees: Quality and retention      | • Increase talent pool in both India and Minnesota  
• Create attractive employment islands away from competitive centers to reduce attrition  
• Create employee centric workplace (HCL)  
• Improve promotion and create challenging work  
• Companies move to tier II cities for IT growth (Mysore) | IT organizations   | Internal instruction Partner with IIX           | Now        |
| Spark Innovation                      | • Format tests based on creativity and artistic ability  
• Promote VCs and Entrepreneurs                                                                                                                                       | IT organizations   | Promote Creativity                                | 1-3 years  |
| Infrastructure                        | Government and FDI enhance infrastructure to sustain growth – Supply Chain, BroadBand/Wireless, Water, Health Control                                                                                     | Government, Domestic and Foreign Companies | Policies for long term growth                  | 1-10 years |
## Recommended Moves

<table>
<thead>
<tr>
<th>Threat or Opportunity</th>
<th>What should be done?</th>
<th>Who?</th>
<th>How?</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rising Labor Costs</td>
<td>Create higher value add to keep FDI</td>
<td>IT organizations</td>
<td>Innovation, R&amp;D, Top Education Resources (ex: Business by Design)</td>
<td>3-10 years</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>Use IT to enable users with information for increase in Mobile users</td>
<td>IT Organizations Mobile Providers</td>
<td>Provide data content based on niche users</td>
<td>3-10 years</td>
</tr>
<tr>
<td>Increase Globalization</td>
<td>Grow companies internationally to spread risk</td>
<td>IT organizations</td>
<td>Expanders into Asia, Europe, NA and SA</td>
<td>5-10 years</td>
</tr>
</tbody>
</table>
References

- http://www.american.edu/initeb/zs2946a/Infrastructure.htm
- SAP presentation-- Lopamudra Bhattacharya VP, Marketing & Communications
- http://education.nic.in/drft_ict_schools.asp
- Science and Technology Macro Perspectives— Professor DK Banwet
- http://www.dot.gov.in/
- Overview of India’s Infrastructure— Dr. K.C. Iyer
- Telecom in India presentation— S.B Khare
- http://en.wikipedia.org/wiki/Education_in_India#Distance_education
International Management of Technology (MOT) Project

India - Minnesota Opportunities in Renewable Energy
Executive Summary

• India has a significant amount of renewable projects. Focus is needed.

• Opportunities exist between MN and India in the following renewable energy arenas:
  – Wind Power
  – Biomass (Biogas, Biofuels, ...)
  – Hydro power
  – Water purification/filtering/recycling
  – Research
  – Manufacturing
Observations

- Multiple technologies required (no one solution)
- Small, medium, and large scale initiatives underway
- Infrastructure challenges & dependency
- NGOs involved in monitoring progress
- FDI requires local partnership

Buffalo Ridge, Minnesota (USA)

Univ. of Minnesota, Morris (USA)
## India / MN Renewable Energy Energy SWOT

<table>
<thead>
<tr>
<th>Strengths</th>
<th>India</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expanding technology base</td>
<td>Statewide mandates for increasing use of renewables</td>
</tr>
<tr>
<td></td>
<td>Favorable policy towards renewables</td>
<td>Strong movement toward green energy</td>
</tr>
<tr>
<td></td>
<td>Growing tax base</td>
<td>Successful history of renewable projects</td>
</tr>
<tr>
<td></td>
<td>Large workforce</td>
<td>Ethanol centric</td>
</tr>
<tr>
<td>Weaknesses</td>
<td></td>
<td>Limitied solar opportunities</td>
</tr>
<tr>
<td></td>
<td>Challenging infrastructure</td>
<td>Lack of cultural awareness</td>
</tr>
<tr>
<td></td>
<td>Leary of outside involvement</td>
<td></td>
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<tr>
<td></td>
<td>Lack of metering and regulation enforcement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of qualified personnel to maintain facilities</td>
<td></td>
</tr>
<tr>
<td>Opportunities</td>
<td>Increase public awareness</td>
<td>Future JV opportunities</td>
</tr>
<tr>
<td></td>
<td>High Foreign Direct Investment (FDI) can help develop new businesses</td>
<td>Cost arbitrage manufacturing</td>
</tr>
<tr>
<td></td>
<td>Technology transfer opportunities</td>
<td>Support industries (ex. Water conditioning and filtering)</td>
</tr>
<tr>
<td></td>
<td>Manufacturing and job creation</td>
<td></td>
</tr>
<tr>
<td>Threats</td>
<td>Competition for resources</td>
<td>Barriers to entry into Indian value chain</td>
</tr>
<tr>
<td></td>
<td>Increasing inflation rates</td>
<td>Foreign relations issues</td>
</tr>
<tr>
<td></td>
<td>Lack of strong infrastructure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of sustaining ecosystem</td>
<td></td>
</tr>
</tbody>
</table>
Minnesota Energy Sources

- Limited solar
- Good location for wind, hydro, and biomass renewable
India Renewable Energy Programs

• **Grid-interactive**
  – Biomass power (agriculture waste, manures)
  – Wind power
  – Small hydro
  – Cogeneration
  – Urban waste to energy

• **Decentralized**
  – Solar street lighting
  – Solar water heating
  – Wind pumps
  – Solar pumps

• **Village**
  – Family-sized biogas plants
  – Solar cookers
  – Home lighting
  – Solar lantern
  – Solar water Heating
## Minnesota Players

<table>
<thead>
<tr>
<th>Company</th>
<th>Purpose</th>
<th>Opportunity (with India)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Turbine Industries (Prior Lake)</td>
<td>Jacobs Wind Turbine</td>
<td>India Mfg, Village electrification,</td>
</tr>
<tr>
<td>Next Gen Power Systems (Pipestone)</td>
<td>Small wind turbine</td>
<td>India Mfg, Village electrification,</td>
</tr>
<tr>
<td>Donaldson (Bloomington)</td>
<td>Filtration</td>
<td>Biomass / Water / Sewage filtration; Clean Coal</td>
</tr>
<tr>
<td>Aeration Systems (Chaska)</td>
<td>Water purification</td>
<td>Infrastructure / Local water purification</td>
</tr>
<tr>
<td>Energy Conservation Products and Services (Duluth)</td>
<td>Solar space and water heating</td>
<td>Mfg in India – cost arbitrage</td>
</tr>
<tr>
<td>Rural Renewable Development Alliance – RREAL (Backus)</td>
<td>Solar space heating</td>
<td>Grassroots education and opportunity analysis in India</td>
</tr>
<tr>
<td>Solar Skies (Starbuck)</td>
<td>Solar water heating</td>
<td>Mfg in India – cost arbitrage</td>
</tr>
<tr>
<td>IREE – Univ. of MN (St. Paul)</td>
<td>Promote statewide economic development</td>
<td>Joint research programs with II-Sc</td>
</tr>
<tr>
<td>Wells Fargo (Minneapolis)</td>
<td>Banking and Financing</td>
<td>Consumer financing; Capital financing</td>
</tr>
</tbody>
</table>
## Indian Players

<table>
<thead>
<tr>
<th>Company</th>
<th>Purpose</th>
<th>Opportunity (with MN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suzlon</td>
<td>5th leading supplier for wind turbines</td>
<td>MN employer and leading wind turbine blade mfg</td>
</tr>
<tr>
<td>OVN BIO Energy Private Ltd</td>
<td>Biomass Gasifier (Developed by IIS-</td>
<td>Bring technology to UofM And MN farms</td>
</tr>
<tr>
<td>Moser Baer Photo Voltaic Limited (MBPV)</td>
<td>PV cell manufacturer</td>
<td>Manufacturer of thin film PV ideal for rural applications both in MN and elsewhere</td>
</tr>
<tr>
<td>Orb Energy</td>
<td>Working to make solar power affordable and accessible to citizens of India</td>
<td>Distribution channels and service capabilities in place to test and market MN technologies in India</td>
</tr>
<tr>
<td>Delhi Transco Ltd. [<a href="http://www.delhitransco.gov.in">www.delhitransco.gov.in</a>]</td>
<td>State Transmission Utility -- Organizes solutions, suppliers, financing, rebates</td>
<td>Get on the list of approved mfgs and suppliers [<a href="http://www.mnes.nic.in">www.mnes.nic.in</a>]</td>
</tr>
</tbody>
</table>
Initiative for Renewable Energy and the Environment (IREE at the University of MN)

IREE has funded 135 renewable energy related projects ($19 million), involving nearly 400 faculty, research scientists and students at the University of Min.
Opportunity Example: Anaerobic Digesters

- Move from satisfying individual to village level needs
- NBC Nightly News: Crave Brothers Farm - WI
  - Outputs: Power, Fertilizer,
Opportunity Example: Solar Water Heating

- Technology skills used:
  - Solar absorption
  - Heat transfer
  - Fluid conditioning and filtering

- Installed price: $500
- Rebate: $100
- Features:
  - Secondary loop to prevent calcium from hard water plugging micro channels
## Short-term Moves

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expand educational campaigns</td>
<td>NGOs, RREAL, Govt., Universities</td>
<td>Grass roots projects</td>
<td>Show and tell products, pilot projects</td>
</tr>
<tr>
<td>Local community action to build wind and solar generators</td>
<td>Solar clubs – India Windustry – MN</td>
<td>Build and integrate prototypes in rural communities</td>
<td>Kits for education and demonstration</td>
</tr>
<tr>
<td>Research projects for renewable energy</td>
<td>IREE, IISc, Govt.</td>
<td>Strategic technology development, government incentives</td>
<td>Private R&amp;D plus Govt. grants</td>
</tr>
<tr>
<td>Leverage multinationals that have integration / implementation capability</td>
<td>Honeywell / India Govt.</td>
<td>Joint research and implementation projects, memorandum of understanding between groups</td>
<td>Exchange programs, technology transfer</td>
</tr>
<tr>
<td>Technology transfer</td>
<td>US and Indian organizations</td>
<td>Energy Efficiency, Fuels, Renewable Electricity, Clean Coal, Biogas processing, MFG process</td>
<td>Consortiums Research Projects (Ex: Cellulolytic Enzymes, See MIT Tech Review – Apr 08)</td>
</tr>
</tbody>
</table>
# Long-term Moves

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop renewable component manufacturing facilities in India</td>
<td>Private Industry, Govt.</td>
<td>Solar cells, biomass components,</td>
<td>Tax incentives, partnerships</td>
</tr>
<tr>
<td>Partner manufacturing opportunities with co-generation to promote both mfg and renewables</td>
<td>Govt., Industry</td>
<td>Promote partnerships and collaboration</td>
<td>Setup industry conferences, use government resources to seek partnerships</td>
</tr>
<tr>
<td>Consolidate and integrate renewable energy policies—focused vs. shotgun approach</td>
<td>India Govt.</td>
<td>Create a centralize department to assist investors</td>
<td>Create a one-stop shop for investors to get information for starting renewable businesses</td>
</tr>
<tr>
<td>Develop an attractive market for private enterprises to support / service projects</td>
<td>Govt.</td>
<td>Attract startups and small-medium size companies to invest, remove investment barriers; Maintenance and service providers</td>
<td>Raise awareness of India’s opportunities, simplify INS/Visa requirements, setup free trade agreement</td>
</tr>
<tr>
<td>Measure the effectiveness of the renewable energy projects</td>
<td>NGOs</td>
<td>Continue monitoring of renewable projects</td>
<td>Publish monthly/quarterly results to inform and to show progress/regress</td>
</tr>
<tr>
<td>Develop ways to reduce costs of SPV applications for households</td>
<td>Industry, Govt.</td>
<td>Promote university and private research</td>
<td></td>
</tr>
<tr>
<td>Create a joint infrastructure/renewable policy</td>
<td>Govt.</td>
<td>Government incentives</td>
<td>Carbon credits in exchange for funding</td>
</tr>
</tbody>
</table>
Open Questions – Renewable Energy

• How do we make the renewable market attractive for private enterprises – ensuring equipment is maintained?

• How do you develop the incentives to change?
Infrastructure Development Opportunities
Opportunities

- Water supply
- Sanitation/Waste disposal
- Highways/Railroads/Mass Transit
- Cold chain
- Power generation
- Education system
- Tourism infrastructure (hotels, airports)
Challenges

• Many aspects of infrastructure are under developed

• Population
  – Bottom 2/3 of country’s needs not being recognized
  – Bottom 2/3 of country holds tremendous voting power
  – Land acquisition issues
  – Cultural acceptance of mediocrity
  – Population may not be aware of importance of infrastructure
    • Every $1 invested infrastructure returns $5

• Government
  – Bureaucracy
  – From a Western perspective, need for a mutual cultural understanding, including dialogue on transparency, accountability, and political will to drive positive change
Tourism

• 8 Radisson hotels
  – Chennai, Delhi, Goa, Jalandhar, Noida, Varanasi, Calcutta, Kumarakom

• No lower cost hotels
  – Should develop Taj Express hotel chain specifically for India tourism market
Tourism

• Should provide direct flights to India
  – Continental provides Newark to Delhi

• Develop tourism packages using new partnerships
  – Hotels, restaurants, entertainment centers (parks, music, museums)
Highway/Road Construction in India

* From the Report “Financing of the NHDP” Published by Government of India

National Highway Development Project (NHDP)

- ~ US$ 50 billion to be awarded on concessions/contracts by 2012*
- BOT (Build, Operate, and Transfer)

Policy

- 100% FDI under the automatic route is permitted for all road development projects

Technologies

- Prefabricated Bridge Elements and Systems
- Pavement Materials and Construction Technology (Asphalt, Concrete, Materials)

Companies

- US: Bechtel, Flatiron (Flatiron-Mason Joint Venture is St. Anthony Falls (I-35W) Bridge in Minneapolis), Hoover Construction Company (Based in Minnesota)
- India: Hindustan Construction Company, Larsen & Toubro, GMR Group, GVK

Source: http://www.nhai.org/gqmain1.htm
Water Treatment

• Problems: disease, pollution, looming water shortages.

• Solutions: conservation and stewardship, municipal water treatment, industrial waste treatment.

• Minnesota technology partners:
  Membrane and cartridge filters and systems
  Ion exchange resins
  Process chemicals
Ecosan Philosophy

- restoring soil fertility
- agricultural use
- organic waste
- treatment / hygienization / energy recovery
- food
- faeces
- urine
- greywater
- rainwater harvesting
- groundwater recharge
- water reuse
- no waste disposal in water bodies
- nature
Sanitation

Technologies & Capabilities
- Membrane technology for water purification
- Bio-gas reactors
- Wastewater Treatment
  - Aeration
- Design & implementation services

Minnesota Companies
- Aeration Industries
- Pentair
- Applied Membrane Technology
- HDR Engineering
UofM Collaboration Center

“Connecting the Universities technology to opportunities in India and the developing world.”

Problems and Opportunities

Connect Opportunities to Research

Create Joint Business Opportunities

Indian Institute of Science
Bangalore, India

University of Minnesota
Driven to Discover

Office for Technology Commercialization
Solutions for India...

Are not imported western products!!

• 3M’s approach to “localization” of products

    And

• Systems approach solutions

   Not just the airport; but the roads to support the airport.
Recommendations

• **1st priority – Sanitation (Waste disposal, Water Purification)**
  – Represent the true need
  – Represent the health impact of not having adequate sanitation
  – Make it in the interest of private industry

• **2nd priority**
  – Transportation infrastructure
  – Infrastructure expansion
  – Maintenance incentive

• **All other priorities**
  – System approach to problem solving (not just the airport, but the road to the airport)
  – Irrigation & Agriculture automation
  – Technology to rid system of middlemen
  – Cold chain to fix food spoilage issue (Unacceptable loss of 40% harvest)
  – Low environmental impact power generation
Moves – Short Term

• **Public Education Campaign - Government**
  – Identification of costs of substandard sanitation (PSA – Give A Hoot!)
  – Make it everyone’s priority

• **Low Cost, Immediate Waste Infrastructure Actions – PPP**
  – Centralized waste and recycling centers (transfer stations)
  – Expansion of ecosan concepts (waste bins, composting latrines)
  – Enforcement of the new behavioral norms

• **Incentives to Bigger Business – Government/Private Industry**
  – Make it attractive to take on big infrastructure development
  – Tax credits for socially responsible actions
  – Business consortia to fund beneficial investments (identification of the costs of lacking infrastructure; health, time, loss of opportunity)

• **Engage The Individual - Government**
  – Garbage collection incentive
  – Recycling incentive
  – Urbanized work guarantees
Moves – Long Term

• **Large Waste & Sanitation Infrastructures – PPP**
  – Creation of; or coordination with empowered planning authority
  – Landfill, incineration, bio-reprocessing of waste infrastructure
  – Waste water treatment infrastructure
  – Coupled incentives for socially responsible actions

• **Urban Congestion Solutions – PPP**
  – Similar concept to what London is implementing (Mumbai)
  – Required metering solutions (GPS, RFID) in new cars, motorcycles, other

• **Consumption Based Revenue Generation – PPP**
  – Consolidation of existing toll road structures
  – Increased toll road penetration
  – Other models to support long term development and maintenance
Minnesota Suggestions

- Filtration technology for water purity (3M, Donaldson Company)
- University of Minnesota Civil Engineering Dept.
- Osmonic Water Treatment Plant (GE)
- Minneapolis Waste Incineration Plant
- Cold Chain Technology (Thermo King)
- Video Surveillance/Monitoring (Honeywell, Seagate)
# India / Minnesota SWOT

<table>
<thead>
<tr>
<th>Strengths</th>
<th>India</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>Lots of infrastructure opportunities</td>
<td>Educational background</td>
</tr>
<tr>
<td></td>
<td>Increasing federal revenues</td>
<td>Large, profit-driven MNC</td>
</tr>
<tr>
<td></td>
<td>Some acknowledgement of issue</td>
<td>Well defined financial markets</td>
</tr>
<tr>
<td></td>
<td>Over $500 B programmed</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weaknesses</th>
<th>India</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weaknesses</strong></td>
<td>Bottom 2/3 of country’s needs not being recognized (not profitable)</td>
<td>True understanding of FDI limitations</td>
</tr>
<tr>
<td></td>
<td>Bureaucracy, great change inertia</td>
<td>True operational business environment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>India</th>
<th>Minnesota</th>
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<tr>
<td><strong>Opportunities</strong></td>
<td>Tremendous opportunities</td>
<td>Partner with local high school to encourage and provide roadmap to University IT programs</td>
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<td>High Foreign Direct Investment (FDI) can help develop new businesses</td>
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<th>India</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Threats</strong></td>
<td>2/3 of country hold tremendous power to oppose change (poor)</td>
<td></td>
</tr>
</tbody>
</table>
# Short-term Moves

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What and When</th>
<th>How</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education campaign</td>
<td>Gov</td>
<td>Identification of costs of not changing current behaviors</td>
<td>Marketing/Advertising</td>
<td></td>
</tr>
<tr>
<td>Make it in private industries interest to drive infrastructure</td>
<td>Gov</td>
<td>Implementation of tax relief/credits for social infrastructure development</td>
<td>Incentives</td>
<td></td>
</tr>
<tr>
<td>Establish individual-level incentives for participation in public health concerns</td>
<td>Gov</td>
<td>Recycling incentive, Waste bins, Composting toilet systems</td>
<td>Payment structure development, urban work guarantee</td>
<td></td>
</tr>
<tr>
<td>Simple, low-cost waste fixes</td>
<td>Private/pub public partnership</td>
<td>Waste bins, Composting toilet systems</td>
<td>Tactical distribution of systems in urban environments</td>
<td></td>
</tr>
</tbody>
</table>
## Long-term Moves

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What and When</th>
<th>How</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transition to consumption based funding mechanisms</td>
<td>Infrastructure owners</td>
<td>Single toll road system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long term waste solutions</td>
<td>Public Private Partnership</td>
<td>Landfill development; Incineration methods, Biological reprocessing; recycling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban toll system to relieve congestions</td>
<td>Public Private Partnership</td>
<td>RF ID, GPS, other technology based congestion charging project</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Questions/Remaining

• What other information and concepts are available under the ecosan umbrella?

• Agriculture concerns
  – Why don’t 70% of farmers have irrigation
  – Is it a technology problem
  – Is it a water problem

• Why is FDI not rushing into opportunities?
• Why does political stalemate persist (real progress is rewarded with loss of election)?
• Why has the industrial revolution stalled?
• Why is India not learning from US, China (other)?
Technology Transfer in the Rural Sector
Overview

1. Rural Sector and Agriculture in India
   a. History and insights
   b. The Indian agricultural industry today
   c. Comparison with the U.S.

2. Major Players
   a. Government support (e.g. National Agriculture Policy)
   b. Foreign investments & global market

3. Enablers, Barriers to ToT in Rural Sector
   a. SWOT analysis: 1) Indian Perspective 2) Minnesota Perspective

4. ToT Scenarios
   a. Change in raw material (e.g. UoM gene plasma)
   b. Change in farming process (e.g. Cargill contract farming)

5. IMTP – Lessons Learned and Recommended Moves
Contract Farming Ventures in India

The government of India’s National Agriculture Policy envisages that “Private sector participation will be promoted through contract farming and land leasing arrangements to allow accelerated technology transfer, capital inflow and assured market for crop production, especially of oilseeds, cotton and horticultural crops.”
Rural Sector and Agriculture in India
Agriculture in India – Background

1. Approximately 22% of GDP but 65% of population in this area
2. Lack of GDP growth in Agriculture – only about 2% currently – World average is 8-9% annually
3. Indian farmers receive less than 1/5 of the price that consumer pays, compared to over a 1/3 in countries like Thailand and USA
4. Production costs are less than half of those in other parts of the world, but high cost of distribution erodes any advantage to Indian farmers.
5. R&D expenditure is third on the list for India – Indian Council of Agriculture funding is about 13.5% of India R&D money
6. National Agriculture Labs: Crop Science (10), Animal Science (7), Horticulture (9)
7. Poor logistics lead to delays and wastage and weaken farmers’ incentives to improve quality and yields
8. Limited standardization of farming practices
# International Comparisons of Yield

**Table 8. 4 : International comparisons of yield**  
Selected commodities—2004-05

<table>
<thead>
<tr>
<th></th>
<th>Rice/paddy</th>
<th>Wheat</th>
<th>Maize</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rice/paddy</strong></td>
<td><strong>Wheat</strong></td>
<td><strong>Maize</strong></td>
<td></td>
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<tr>
<td>Egypt</td>
<td>9.8</td>
<td>4.25</td>
<td>U.S.A</td>
</tr>
<tr>
<td>India</td>
<td>2.9</td>
<td>7.58</td>
<td>France</td>
</tr>
<tr>
<td>Japan</td>
<td>6.42</td>
<td>2.71</td>
<td>India</td>
</tr>
<tr>
<td>Myanmar</td>
<td>2.43</td>
<td>2.06</td>
<td>Germany</td>
</tr>
<tr>
<td>Korea</td>
<td>6.73</td>
<td>2.37</td>
<td>Philippines</td>
</tr>
<tr>
<td>Thailand</td>
<td>2.63</td>
<td>7.77</td>
<td>China</td>
</tr>
<tr>
<td>U.S.A</td>
<td>7.83</td>
<td>1.64</td>
<td></td>
</tr>
<tr>
<td><strong>World</strong></td>
<td><strong>3.96</strong></td>
<td><strong>2.87</strong></td>
<td><strong>3.38</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cotton</th>
<th>Major Oilseeds</th>
</tr>
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<tbody>
<tr>
<td>China</td>
<td>11.10</td>
<td>Argentina</td>
</tr>
<tr>
<td>U.S.A</td>
<td>9.58</td>
<td>Brazil</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>7.98</td>
<td>China</td>
</tr>
<tr>
<td>India</td>
<td>4.64</td>
<td>India</td>
</tr>
<tr>
<td>Brazil</td>
<td>10.96</td>
<td>Germany</td>
</tr>
<tr>
<td>Pakistan</td>
<td>7.60</td>
<td>U.S.A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nigeria</td>
</tr>
<tr>
<td><strong>World</strong></td>
<td><strong>7.33</strong></td>
<td><strong>1.86</strong></td>
</tr>
</tbody>
</table>

*Source: Ministry of Agriculture and Cooperation.*
Rural Sector and Agriculture in India

1. Colonialism background
   a. British business model
   b. Stigma of Imperialism

2. Gov’t and social farming
   a. Government rules limit farm sizes
   b. Physical segmentation of farms only on paper

3. Landlords and farmers
   a. Nearly one-third of all farmers own no land
   b. More than half of all farms are less than three acres
   c. Affluent land owners politically control poorly educated farmers

4. State and local Gov’t
   a. Local parties benefit from rural segmentation
   b. Local parties would lose leverage on farmers if consolidation and social farming happened
## Technology Transfer: Indian Perspective

<table>
<thead>
<tr>
<th>S</th>
<th>W</th>
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<tbody>
<tr>
<td>Agriculture represents 20% of GDP&lt;br&gt;65% agrarian population&lt;br&gt;Population is engaged in policy making&lt;br&gt;Farming land availability&lt;br&gt;Favorable climate&lt;br&gt;Democratic Government&lt;br&gt;Agriculture beyond subsistence</td>
<td>Deficient infrastructure&lt;br&gt;Water quality&lt;br&gt;Old technologies&lt;br&gt;Rural technology delivery&lt;br&gt;Weak Government policies&lt;br&gt;No Government subsidiaries&lt;br&gt;Local corruption&lt;br&gt;Education</td>
</tr>
<tr>
<td>O</td>
<td>T</td>
</tr>
<tr>
<td>Successful at TT&lt;br&gt;Agriculture reform&lt;br&gt;Farming process modernization&lt;br&gt;Business opportunities (e.g. edible vaccine)&lt;br&gt;Improved yields, reduced waste&lt;br&gt;Higher farm income&lt;br&gt;Improved animal nutrition&lt;br&gt;Globalization, Int’l market&lt;br&gt;Improvement in Infrastructure – including electricity, rail, roads and ports</td>
<td>Widening gap between high-tech and rural technology delivery&lt;br&gt;Substantial poverty in rural sector weaken Government&lt;br&gt;Foreign investments going to China</td>
</tr>
</tbody>
</table>
Technology Transfer: Minnesota Perspective

<table>
<thead>
<tr>
<th>S</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-tech approach to agriculture</td>
<td>Dependent on local infrastructure</td>
</tr>
<tr>
<td>Large scale enterprise</td>
<td>Indian bureaucracy &amp; policies</td>
</tr>
<tr>
<td>Foreign direct investments</td>
<td>No central point of contact</td>
</tr>
<tr>
<td>Vertically integrated supply chain</td>
<td>Offset requirements</td>
</tr>
<tr>
<td>Robust innovator in farming process and processing capabilities</td>
<td>TT more welcome from academia</td>
</tr>
<tr>
<td>Global market</td>
<td>Cargill’s bad past experience with Indian market</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>O</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global market</td>
<td>Successful model in another country might not suit India</td>
</tr>
<tr>
<td>Contract farming</td>
<td>Unable to convince federal and/or local Gov't</td>
</tr>
<tr>
<td>Retail commodity market</td>
<td>Push-back from rural population</td>
</tr>
<tr>
<td>Strengthen link between UoM and IIT</td>
<td>Activists: “Cargill in the name of contract farming is exploiting Indian farmers”</td>
</tr>
<tr>
<td>Governor Pawlenty looking at business opportunities in India</td>
<td>IP not protected (e.g. engineered seeds sold to competition)</td>
</tr>
<tr>
<td></td>
<td>Patenting of life forms (e.g. GMOs) rejected in the market place</td>
</tr>
<tr>
<td></td>
<td>Fragmented sales for national-level player</td>
</tr>
</tbody>
</table>
Lessons Learned

1. Why Cargill’s business model did not fit in India!
   a. There were no tangible benefits to the community
   b. There was no equitable win-win solution
   c. The cultural dimension was more important than the business model
   d. Business model did not include technology transfer

2. The value creation should be obvious to customers
   a. Local vs. national-level player (use local players to develop trust)
   b. McDonald’s adage “think global, act local”
   c. Rural farmers should receive financial benefits
   d. Educational opportunity

3. Overcome barriers to direct foreign investments
   a. “Politically correct” strategy
   b. Join ventures with Indian companies
   c. Partnership with academia (e.g. PepsiCo’s partnership with Punjab Agricultural University)
Recommended Moves

India

1. Reduce trade barriers, foreign exchange, restriction and strive for economic reform – red tape will be difficult to overcome in short-term

2. Improve communication, transport, storage, distribution and agricultural support services

3. Improve the fragmented supply chain – currently India’s transportation costs are on average 20-30% higher than other countries

4. Improve product quality standards and production standards

5. Reduce gap of organized versus unorganized employment
   1. Through educational improvements
   2. Continue infrastructure improvements

6. Create an integrated and competitive domestic market
Recommended Moves

Cargill

1. Investment in educational programs for rural communities – i.e. satellite educational systems / web-based e-learning systems
2. Promote value-added benefits to farmers and cooperatives
   a. Grain Storage and Grain Handling – Cargill roots
   b. Improved quality, crop yields and application benefits
   c. Improved Animal nutrition – Cargill Feeds
   d. Risk management and farming consultancy – education of new farming practices
Recommended Moves – continued

Cargill

1. Promote benefits to Government for new product development and process development in Agri/Food Sectors
   a. New Patent Law since 2005 allowing for Food and Agriculture processes and products

2. Innovate in processes rather than products

3. Create more demand by using joint ventures with domestic companies
   a. Build or lease value-added processing plant such as oilseed plant or bio-fuel plant – will create excess supply of non-food applications
   b. Leverage strength in Sugar Industry and improved processing techniques for sugar mill – currently opportunity for many plants to improve on energy efficiencies
Recommended Moves – continued

University of Minnesota

1. Promote Technology Transfer for new product development and process development in Agri/Food Sectors
2. Joint effort with Indian Universities for Agricultural Extension Centers – enables farmers to be educated on latest farming techniques and practices
3. Collaborate on Agri-Business Majors and advanced degrees
4. Commercialization of Honey Crisp Apples and other successful UofM Agri-products
5. Collaborate on Animal Science and Nutrition
Medical Industry

Opportunities for India-Minnesota Collaborations
Overview

- Personal experience
- SWOT Analysis
- India Strengths / Barriers
- Business requirements for India
- Opportunities Assessment
- Minnesota opportunities
- Minnesota and India Medical Industries
- Market Access / Partnerships
- Minnesota Actions
Executive Summary

- Several potential new markets for Minnesota medical device companies
- Numerous opportunities for industrial and academic collaborations (e.g. device – drug combination).
- Second source for skilled manufacturing labor for specific medical products (e.g. vascular products).
- Biggest barriers to enter will be cost, access, and regulatory approval.
India Healthcare: Personal Experience

- Fast – Inexpensive – Efficient
- Self Managed
- Readily available
- Distributed
# SWOT Analysis

<table>
<thead>
<tr>
<th></th>
<th>India</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>Cost competitive advantage</td>
<td>Strong medical device company base: Medtronic, St. Jude, Boston Scientific</td>
</tr>
<tr>
<td></td>
<td>Highly educated workforce</td>
<td>Global regulatory expertise</td>
</tr>
<tr>
<td></td>
<td>High savings rate offset need for insurance</td>
<td>Laboratory testing – Beckman Coulter</td>
</tr>
<tr>
<td></td>
<td>Manufacturing capabilities – labor intensive assembly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mobile workforce enables innovation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>English speaking, call-center capabilities, collaborative development experience</td>
<td></td>
</tr>
<tr>
<td><strong>Weakness</strong></td>
<td>Cost pressures</td>
<td>High labor costs</td>
</tr>
<tr>
<td></td>
<td>Job competition with IT sector</td>
<td>High development costs</td>
</tr>
<tr>
<td></td>
<td>Intellectual property laws</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of strong infrastructure</td>
<td></td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>Partnership with Minnesota universities</td>
<td>Partnership with Indian universities</td>
</tr>
<tr>
<td></td>
<td>High Foreign Direct Investment (FDI) can help develop new businesses</td>
<td>Partner with Indian medical device companies</td>
</tr>
<tr>
<td></td>
<td>Medical tourism</td>
<td>New health delivery business models</td>
</tr>
<tr>
<td></td>
<td>Acquisition of Minnesota start-ups</td>
<td></td>
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<tr>
<td><strong>Threats</strong></td>
<td>Rising labor rate</td>
<td>Global competition</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>Restrictive FDA rules for new treatments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Profit pressures for large companies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loss of IP</td>
</tr>
</tbody>
</table>
India Strengths

- Manufacturing basis
- Skilled labor (knowledge workers and manufacturing)
- Bio and pharmaceutical startups
- Cost competitive
India Barriers

- FDI
- Bureaucracy
- Supply chain
- Business methods
- Policy and legal issues
- Access and exposure

India has significantly fewer doctors and nurses than the world average:

World average 1.2 doctors and 2.6 nurses per 1,000 people

India has 0.6 doctors and 0.08 nurses per 1,000 people
Requirements for Success in India

• Local management
• Cost conscious products
• High volume
• Short-process loops
• Low-tech solutions (e.g. Aravind eyecare, Jaipur foot)
Opportunities Assessment

- The World Health Organization (WHO) estimates 60M Indians suffer cardiac heart disorders, and this is likely to reach 100M by 2011.
- 2M Indians die of sudden cardiac arrest (SCA) every year.
- Only 1% of the population of India has access to US type therapies that use advanced medical devices like pacemakers.

% of health expenditure: 3.7%
Growth: 5.8%
Per capita spending: US$1
Minnesota Opportunities

- New markets for medical devices
- Device – drug collaborations
- Second source for skilled manufacturing labor (e.g., vascular products)
- University & research collaborations
- Clinical studies and study centers
- Western Medicine meets traditional Ayurvedic (holistic) medicine
Minnesota Medical Industry

[Logos of various medical companies]
Indian Medical Industry
India Market Access

• Central Drugs Standard Control Organization (CDSCO) and Indian Ministry of Health
  – Provides guidelines for import, registration, manufacture, and sales of medical devices
    (latest revision June 2005)
India Medical Device Partners

• Shree Pacetronix
  – Seventh largest manufacturer of pacemakers in the world and has 35% market share in India.
  – Aim to launch a defribillator for ~$5000 USD.

• Medived
  – In collaboration with CCC Medical Devices (Uruguay)
  – Brand new, world-class manufacturing facility in Bangalore India for advanced implantable medical devices,

Ventralith-I : VVI Non Programmable Pacemaker
Pinnacle: VVI, multi-programmable pacemaker
Charak: DDD, multi-programmable pacemaker
Stellar: VVI, multi-programmable pacemaker
Potential India State Partners

• Pharmaceuticals:
  – Dr. Reddy’s: Andhra Pradesh
  – Jubilant: Uttar Pradesh
  – Ranbaxy: Haryana

• Medical devices
  – Shree Pacetronix: Madhya Pradesh
  – Medived: Karnataka
### Minnesota Actions

<table>
<thead>
<tr>
<th>Company</th>
<th>Leading</th>
<th>Opportunity</th>
</tr>
</thead>
</table>
| Medtronic        | Medical devices, heart valves, spinal products | • Create partnerships and utilize India’s strength in skilled labor and manufacturing for surgical and vascular products.  
• Create clinical study partnerships  
• Evaluate long-term implantable device opportunities (Shree Pacetronix)  
• Drug collaboration for devices |
| Upsher-Smith     | Generic pharmaceuticals              | • Form partnership to leverage generics distribution and regulatory knowledge |
| AGA Medical      | Heart repair products                | • Create partnership to sell heart repair products                           |
| Incisive Surgical| Sutures                              | • Establish relationship to bring Insorb® surgical sutures to market         |
Biotech Market – Dynamic and Growing

- Largest segment: Biopharma
- Revenue from exports 2003-04: 56%
- Total investment 2003-04: US $137M
  Growth rate over 2002-03: 26%
Biotech Market – Consistent Uptrend

2002-03
- 25% growth in investment
- 70% growth in employment
- 74% growth in R&D manpower

2010
- US $5B annual revenues
- 1 million skilled jobs
- 10% of global industry

Source: Confederation of Indian Industry (CII)
Diagnostics Segment Factors

• Healthcare represents 5.1% of GDP

• Population to grow from 1 to 1.6 billion by 2012
  – 14% covered by healthcare (prepayments)
  – 64% pay out-of-pocket

• 30,000 labs serving 1-1.25 million patients/day

• 25% annual growth
Diagnostic Segment  Areas of Focus

- In-Vitro Diagnostics (IVD)
  - Rs. 6.75 billion
  - US $147M
  - 40% equipment
  - 60% re-agents

<table>
<thead>
<tr>
<th>Segment</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunology</td>
<td>24%</td>
</tr>
<tr>
<td>Critical Care</td>
<td>7%</td>
</tr>
<tr>
<td>Haematology</td>
<td>14%</td>
</tr>
<tr>
<td>BioChemistry</td>
<td>37%</td>
</tr>
<tr>
<td>Coagulation</td>
<td>3%</td>
</tr>
<tr>
<td>Urine Routine</td>
<td>6%</td>
</tr>
<tr>
<td>Microbiology</td>
<td>4%</td>
</tr>
<tr>
<td>Others</td>
<td>5%</td>
</tr>
</tbody>
</table>

*Source: Suresh Vazirani
Transasia Biomedical, LTD
Diagnostic Segment Issues (technology)

• Intellectual property
  – Enforcement is difficult; litigation is slow
  – Before 2005, 90% biotech products were un-patentable
  – Patent application alone obtains 5 1/2 years of protection and serves to block competition
  – Less than 5% of patent applications are actually granted
  – Insufficient resource has been a process bottleneck

• Development capabilities
  – Preference for products over technologies
The Indian patent regime is changing …

• Compliance with the TRIPs agreement.
• Drugs will become patentable as products, and not just as processes.
Diagnostic Segment Issues (social)

• Diverse population
  – Reaching beyond major urban areas to rural needs
  – No “average” Indian consumer – segment the market
  – Lack of prepaid healthcare will require direct to consumer marketing and distribution
  – Per capita income is very low and product offerings must be priced accordingly

• Social implications
  – Anyone licensing patents to India must consider the social implications (e.g. GE Ultrasounds)
India on the Biotech Radar

• India’s share in the global biotech market is currently about 2%.

• Sales of biotech products in India are growing at a CAGR of 8.4%.

Source: A Report on the Indian Biotechnology Market Mindbranch.com
Domestic Companies - Going International

- Biocon
- Shantha Biotechnics
- Bharat Serums And Vaccines Limited
- Wockhardt
- Panacea Biotec
- Nicholas
- Serum Institute Of India Ltd.
Distribution of Indian Biotech Companies

Agro-biotech (including seeds) is the largest sector with 42 companies.

Source: Biotech India 2003
### Example R&D Expenditures

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>R&amp;D/REVENUE (%)</th>
<th>LINE OF RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workhardt</td>
<td>10.5</td>
<td>Genome technology</td>
</tr>
<tr>
<td>Zydus Cadila</td>
<td>7.5</td>
<td>Genome technology</td>
</tr>
<tr>
<td>Torrent Pharma</td>
<td>6.4</td>
<td>Pharmaceuticals</td>
</tr>
<tr>
<td>Ranbaxy</td>
<td>6.0</td>
<td>Pharmaceuticals</td>
</tr>
<tr>
<td>Biocon</td>
<td>5.0</td>
<td>Enzymes</td>
</tr>
<tr>
<td>Dr. Reddy’s Labs</td>
<td>4.4</td>
<td>Therapeutic proteins</td>
</tr>
<tr>
<td>Cipla</td>
<td>4.0</td>
<td>Vaccines</td>
</tr>
<tr>
<td>Sun Pharma</td>
<td>4.0</td>
<td>Pharmaceuticals</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>5.9</strong></td>
<td></td>
</tr>
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</table>

Government Support via Research Allocation

<table>
<thead>
<tr>
<th>AGENCY</th>
<th>BUDGETARY ALLOCATION * (RS. CRORE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Grants Commission (UGC)</td>
<td>1,407</td>
</tr>
<tr>
<td>Indian Council of Agriculture Research (ICAR)</td>
<td>1,399</td>
</tr>
<tr>
<td>Council of Scientific and Industrial Research (CSIR)</td>
<td>912</td>
</tr>
<tr>
<td>Department of Science and Technology (DST)</td>
<td>779</td>
</tr>
<tr>
<td>Indian Council of Medical Research (ICMR)</td>
<td>147</td>
</tr>
<tr>
<td>Department of Biotechnology (DBT)</td>
<td>136</td>
</tr>
<tr>
<td>Department of Scientific and Industrial Research (DSIR)</td>
<td>58</td>
</tr>
</tbody>
</table>

Total budgetary allocations

~ Rs. 50 billion

Source: Status and Development of Biotechnology in India: An Analytical Overview  Sachin Chaturvedi  RIS Discussion Paper
Opportunity Categories

• Technology Transfer (licensing revenue)

• Outsourcing Business Processes (cost savings)

• Leveraging R&D expertise (extending innovation)

• Entering growing Indian Market (global footprint)
Indian Company Observations

- GE
  - Auto bone, Reach-in diagnostic imaging, Surgical navigation
  - Initially unsuccessful; re-focused on people in India until ready to go back to markets

- Phillips
  - Imaging technologies (e.g. MRI)
  - Value chain strategy

- Jubilant Biosys
  - Strengths in reverse engineering
  - Focus on support services business model and drug development (not marketing)
Case Study: GE

• GE Healthcare
  – US $17B company
  – Entered India in 1970
  – Invested US$100M in India
  – Sourced 15% of its products in India (2x2002)

• India not viewed as cost arbitrage but for talent pool

• Three diagnostic imaging products to be introduced in 2007
  – Auto bone, Reach-in diagnostic imaging, Surgical navigation

• Collaboration with Manipal Hospitals in Bangalore
  – GE’s Global Clinical Studies Program
  – Supports vision of “Early Health” using diagnostic imaging
  – Benefit local patients through increased access
Case Study: Inverness Innovations

- Inverness Innovations
  - US $552M company
  - Entered India in 2007
  - Acquired two Indian companies (distribution and assembly)
  - $4M purchase price + bonus if successful after one year

- Collaboration combines innovation and local distribution
  - Spectral Diagnostics Private Limited – distribution
  - Source Diagnostics Private Limited – assembly and packaging

- Rapid professional testing
  - India population needs testing for blood borne pathogens
  - HIV, Hepatitis, Malaria, Dengue Fever, and Tuberculosis
Opportunity Model

Value Chain Partner

R&D

Outsourcing Business Processes/Services

Developed Markets
Technology Acquisition

Indian Market
Direct Presence
Technology Licensing

MN Companies
Key Questions

• How does the Indian market compare to other developing markets for medical diagnostics (e.g. China, Brazil, others?)

• What are the trends and potential value for IP applications?

• What is the potential for disruptive innovations to spill over to developed markets?
Resources

• Technology Transfer
  The Department of Biotechnology [http://www.dbtindia.gov.in/](http://www.dbtindia.gov.in/) tracks technology transfer in India

• The Asia and Pacific Center for Technology Transfer (APCTT) [http://www.apctt.org/](http://www.apctt.org/) facilitates technology transfer and brings buyers and sellers together

• Networking

• The American Chamber of Commerce in India (AMCHAM - India) [http://www.amchamindia.com](http://www.amchamindia.com) - can help with understanding business conditions and networking
Resources

• **U.S. Commercial Service: Gold Key Service**
  American Center, 24 Kasturba Gandhi Marg
  New Delhi 110001- India
  Tel: 91-11-23316841, Fax: 91-11-23315172
  – Matchmaking appointments with pre-qualified sales representatives and partners, appropriate government officials, related associations and others
  – Customized market and industry briefings

• **Directorate General of Health Service**
  Ministry of Health
  Nirman Bhawan
  New Delhi
  Phone: 91-11-2-301-8863

• **Confederation of Indian Industry**
  Lodi Road
  New Delhi
  Phone: 91-11-2-462-9994
India’s Aerospace and Defense Sector

“A tough environment has driven quality systems”
## SWOT – Aerospace and Defense

<table>
<thead>
<tr>
<th></th>
<th>India</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>• Self reliant</td>
<td>• Self reliant</td>
</tr>
<tr>
<td></td>
<td>• Very strong and autonomous space program</td>
<td>• High Tech</td>
</tr>
<tr>
<td></td>
<td>• Very strong technically</td>
<td>• Strong Industrial base that is commercially operated</td>
</tr>
<tr>
<td></td>
<td>• Solid Commercial Companies</td>
<td>• ~ 85% “Systems Contracting”</td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td>• Some reliance on Russian defense systems</td>
<td>• Unwilling to transfer technology internationally</td>
</tr>
<tr>
<td></td>
<td>• Lots of systems (too many calibers)</td>
<td>• Most US companies don’t have an effective Global Strategy (“Made in the USA”)</td>
</tr>
<tr>
<td></td>
<td>• Most procurements are “breakout”</td>
<td>• US Embassy does not currently have a mechanism for US Defense contractors to source supplies from India</td>
</tr>
<tr>
<td></td>
<td>• Defense Industrial Base is Govt.Owned/Govt. Operated (GOGO)</td>
<td></td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>• Move to GOCO (commercial operate)</td>
<td>• Align with India for a NATO- like common operating specification, i.e., common calibers, interchangeable systems, etc.</td>
</tr>
<tr>
<td></td>
<td>• Export Defense articles and Space services</td>
<td></td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td>• China</td>
<td>• China</td>
</tr>
<tr>
<td></td>
<td>• Red tape (both in India and US)</td>
<td>• Red tape (again both ways)</td>
</tr>
</tbody>
</table>
Business Scenario

The United States-India Peaceful Atomic Energy Cooperation Act

Today, President Bush Signed The United States-India Peaceful Atomic Energy Cooperation Act. This Act will strengthen the partnership between the world's two largest democracies and help our countries meet the energy and security challenges of the 21st century.

This Act Is An Important Step That Will Help Allow Us To Share Civilian Nuclear Technology And Bring India's Civilian Nuclear Program Under The Safeguards Of The International Atomic Energy Agency. On his visit to India earlier this year, President Bush reached an historic agreement with Indian Prime Minister Singh, under which the United States and India committed to take a series of steps to make nuclear cooperation a reality. The bill the President signed today is one of the most important of these steps. Nuclear cooperation will help the people of India produce more of their energy from clean, safe civilian nuclear power, help both our economies grow, and make America more secure.

America And India Are United By Deeply Held Values. Our two great democracies are allies in the War on Terror, partners in global trade, and stewards of our environment. India is a democracy that protects the rule of law and is accountable to its people, and an open society that defends freedom of speech and freedom of religion.

The United States And India Are Working Together To Expand Economic Opportunities In Both Our Countries. India's economy has more than doubled in size since 1991, and it is one of the fastest-growing markets for American exports. This trade is creating new jobs in America and raising the standard of living for millions throughout India.

“America will continue to work with India to promote free and fair trade – and fuel economic growth in both countries.”
### Business Development for Minnesota Companies

#### Aerospace:

<table>
<thead>
<tr>
<th>Company</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWA</td>
<td>Partnership with Indian Carriers</td>
</tr>
<tr>
<td></td>
<td>Additional MRO facility in India</td>
</tr>
<tr>
<td>Mesaba</td>
<td>Purchase SARAS when available</td>
</tr>
<tr>
<td></td>
<td>Next-Gen Regional Carrier under development by HAL</td>
</tr>
<tr>
<td>Goodrich</td>
<td>Commercial Sensors sales and source of supply</td>
</tr>
<tr>
<td></td>
<td>Already in India - partner with HAL</td>
</tr>
<tr>
<td>Lockheed Martin NESS</td>
<td>Commercial Avionics</td>
</tr>
<tr>
<td>ATK</td>
<td>Co-development with ISRO on Space systems</td>
</tr>
<tr>
<td>Cirrus Design</td>
<td>HANSA and SARAS Licensing Partnership with HAL</td>
</tr>
<tr>
<td>3M</td>
<td>Filters, materials, etc.</td>
</tr>
<tr>
<td></td>
<td>Global R&amp;D Facility in India</td>
</tr>
</tbody>
</table>
Aerospace Example – Cirrus Design

• Scenario:
  • Cirrus wants to expand into US DOD marketplace with a light trainer for Air Force Preliminary Flight Training
  • Cirrus is currently developing their own jet but they also want to expand its product line for Corporate and Regional Carriers – they need a twin engine commercial design.

• Moves:
  • Cirrus partners with HAL in India to offer the following:
    • SARAS Multi-role Light Transport
    • HANSA-3 Composite Light Trainer
  • Cirrus has sales and distribution in the USA
  • Gives Cirrus an immediate Product line extension

• Tech Transfer both ways:
  • Co-production in the USA
    • HAL sends kits for final assembly in US
  • Cirrus integrates their unique Parachute Recovery System into HANSA to for product improvement. This better positions the system to win the Air Force Contract. Previous system (Firefly) had multiple CLASS A Mishaps which led to permanent grounding of the system.
## Business Development for Minnesota Companies

### Defense:

<table>
<thead>
<tr>
<th>Company</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ATK</strong></td>
<td>Buy ammunition</td>
</tr>
<tr>
<td></td>
<td>Co-develop Space systems</td>
</tr>
<tr>
<td><strong>BAE Systems</strong></td>
<td>Sell cannons</td>
</tr>
<tr>
<td></td>
<td>Subcomponent Source of Supply</td>
</tr>
<tr>
<td><strong>Goodrich</strong></td>
<td>Sell sensors</td>
</tr>
<tr>
<td></td>
<td>Co-develop with Indian Govt. Labs</td>
</tr>
<tr>
<td><strong>Lockheed Martin NESS</strong></td>
<td>Subsystems for 3 major LMT pursuits</td>
</tr>
<tr>
<td><strong>Honeywell</strong></td>
<td>Already a large presence in India</td>
</tr>
<tr>
<td></td>
<td>Export version of JDAM</td>
</tr>
<tr>
<td><strong>General Dynamics</strong></td>
<td>“Spider and Matrix” in Kashmir</td>
</tr>
<tr>
<td></td>
<td>Co-production in India</td>
</tr>
<tr>
<td><strong>Polaris Industries</strong></td>
<td>ATV sales to India</td>
</tr>
<tr>
<td></td>
<td>Subcomponent Source of Supply</td>
</tr>
<tr>
<td><strong>U of MN</strong></td>
<td>“Throwbot” collaboration</td>
</tr>
</tbody>
</table>
Defense Example – ATK Civil Ammunition

• Scenario:
  • ATK would like to expand capacity to account for their new Global Strategy
  • They need capacity off-shore for good quality small arms ammunition
  • ATK Civil’s R&D staff is at max-capacity – finding ammunition Design Engineers is difficult

• Moves:
  • ATK buys ammunition from the Indian Ordnance Factories
  • Imports some to US to help support commercial demand for .223 Rifle
  • Uses majority of ammunition to open markets in Europe and Far-East
  • ATK forms Memorandum of Understanding (MOU) with India Defense Research and Development Organization (DRDO) for ammunition design (Direct Foreign Investment)
    • ATK gains off-set credits for fulfillment of other opportunities in India or trade with other US Defense Contractors that have incurred an offset obligation

• Tech Transfer both ways:
  • ATK gains capacity and could transfer technology to improve the Indian Factory capacity
  • ATK would structure MOU with DRDO so that the designs we co-develop could be used for the Indian MOD (Govt. Purpose Rights – no export)
# Maintenance, Repair, and Overhaul (MRO) Market

<table>
<thead>
<tr>
<th>Year</th>
<th>India</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimated market</td>
<td>Estimated market</td>
</tr>
<tr>
<td>2004</td>
<td>$615 million</td>
<td>$8100 million</td>
</tr>
<tr>
<td>2010</td>
<td>$1174 million</td>
<td>$12179 million</td>
</tr>
<tr>
<td>2020</td>
<td>$2606 million</td>
<td></td>
</tr>
<tr>
<td>Annual growth rate</td>
<td>10%</td>
<td>6.9%</td>
</tr>
</tbody>
</table>

Source: Report on MRO / AeSI, May 06
Joint Ventures – A Key to Success

• Joint ventures / partnerships between key MRO players across OEM, third parties, etc.

• Provide an optimal route to fulfilling key factors with respect to:
  • Extending service portfolio
  • Broadening global logistics
  • Global management infrastructures
  • Leveraging existing marketing asset pool, existing customers
  • Leverage an acknowledged strong brand positioning

• ROM Estimate for Establishing Independent MRO Facility in India
  • Air frame MRO: $60 – 80 M US
  • Engine MRO: $80 – 100 M US
  • Component MRO: $15 – 20 M US
Another Observation

Reinventing the Wheel?
Macro Issue of S&T

• India:
  • Recommend moving away from use of Russian systems
  • Increase collaboration with US/India Joint Ventures
  • ISRO collaboration with NASA should run deeper into NASA’s supply chain
  • Look to co-production and co-development of Aerospace and Defense systems
  • Consider “Indirect offsets” (infrastructure?)
  • Boeing and Honeywell offer excellent case studies on India

• USA:
  • US State Department has stated they are willing to grant more Technical Assistance Agreements (TAA’s) and Manufacturing License Agreements (MLA’s) in India.
  • “Integrating Indian private sector companies into the global supply chain of US defense manufacturers, combined with co-production, will help remove insecurity about the reliability of US defense supplies.” (US India CEO Forum)
Useful Resources for Doing Business in India

• [http://mod.nic.in/dpm/welcome.html](http://mod.nic.in/dpm/welcome.html)
  - India’s MOD procurement publications
  - Mandatory reading

  - Tenders of all types/all agencies for Govt. of India

  - Tenders for DRDO

  - List of technologies spun off to commercial sector

  - International collaboration with DRDO
Sources

- Interviews with multiple State Department and DOD personnel at US Embassy, Dehli

- “US India Strategic Partnership”, US India CEO Forum, March 2006 Report

- Interview with Member of India’s Ordnance Factory Board
IT
Site Visits - Infosys, Wipro, SAP, Google

• Culture of the 4 organizations
• CMM – New level of Maturity
• Commonality observations in these 4 companies
• Captives vs. Outsourcing
• IT Infrastructure

• Question
Why is Google the #1 company to work for in the U.S.?
IT

Site Visits - Infosys, Wipro, SAP, Google

Questions to ask

• Long term sustenance of the outsourcing model
• Labor Shortage – How is it being addressed?
• Attract and retain best employees
• New thinking in staff management
• Measurement and Metrics
• Turn around time for Projects
• What about In sourcing?
Other Sectors

Growth in other sectors

• Technology
• Pharmaceuticals
• Healthcare
• Banking
• Hospitality
Macro Economics

• Buying Power of the middle class
• Trickle down economics
• Real Estate Market
• Exclusive Products
• Life Style
Innovation Centers and R&D in India: Connecting to Minnesota
Project Focus

• This project reviews and analyzes opportunities and challenges inherent in R&D and Innovation Centers in India.

• The project will explore collaborative opportunities for Minnesota companies and educational institutions to grow globally.
Executive Summary

• The R&D Pros for India include access to:
  – deep talent
  – low costs
  – wide ecosystem
  – vast markets
  – English is common language
  – attractive to expatriates
Executive Summary

The R&D Cons for India include:

– Higher Education Issues:
  • Too few Engineering Ph.D.s in India
  • Inadequate incentive structure for the faculty
  • Innovation education gap

– Private Sector Issues:
  • employee attrition
  • rising compensation costs
  • IP
  • Dependence on expatriate talent.
  • Poor Infrastructure

– Government Policy Issues:
  • India’s R&D expenditure rate, at 0.8% of GDP, is low.

And yet, India is now the preferred destination for new multinational R&D spending.
Why R&D in India? Cost Savings is NOW

• Cost
  – R&D cost savings may be in the range 15% - 28%.
    • Salaries, construction costs low.
  – However, McKinsey reports that, by 2015, total compensation for U.S. and India research scientists will be roughly equal.

<table>
<thead>
<tr>
<th>Nation</th>
<th>Salary (Annual Average USD, 2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>70000</td>
</tr>
<tr>
<td>China</td>
<td>25690</td>
</tr>
<tr>
<td>Russia</td>
<td>15120</td>
</tr>
<tr>
<td>India</td>
<td>13580</td>
</tr>
</tbody>
</table>
Why R&D in India? Talent

• India has considerable educated, experienced yet young talent.
  – Indian graduates are world-class.
  – Studies show that Indian graduates tend to work longer hours than their German and U.S. peers.

• Availability of Masters level talent is sufficient, but Engineering Ph.D. level talent is scarce.

• English is a required language for higher learning.

• Indian R&D centers are benefiting from the return of the Ph.D. diaspora.
  – Many Ph.D.s are returning to India as wages increase, as challenging jobs become available, and as housing and infrastructure improves.
Why R&D in India? Local Market Access

- Local Market Access
  - India is one of the world’s premier software clusters.
    - India, is a “software development market,” which informs, energizes, and, for its part, *needs* software R&D.
  - India is also a vast market in traditional terms benefits from physical proximity.
    - 300 million strong middle class continues to grow. (8 million cell phone users being added every month.)
India Universities: Limited Supply?

• Physical infrastructure
  – 7 IITs, which have about 15,500 undergraduate and 12,000 graduate students.
  – 4 new IITs were recently proposed to remedy the gap. Target completion during this 11th 5-year plan.
  – Estimates show India had about 184,000 engineering grads in 2004, of which about 6,000 were Ph.Ds.

• India does not turn out enough Ph.Ds to meet market demand
  – Demand of Ph.Ds is a new phenomena.
  – The incentive, to students, is far too small to continue to a Ph.D. because good jobs readily await undergraduate Master degree graduates.
  – Output of Indian Ph.D. is not meeting today’s needs.

• Faculty
  – Professors can do consulting but have to share up to 40% of the fee.
  – Concentrate on teaching; the time devoted to research often lags international standards.
Culture: Creativity Gap?

- Indian disposition toward conformity, lack of individualism and aversion to change in education system.
- Indian disposition toward fear of failure. Most R&D projects fail.
- Limited innovative traditions; only in private sector.
- Organizational and cultural reliance on hierarchy and procedural learning.

Challenges and open questions:
- Can India do truly disruptive R&D?
- Can Indian R&D expand past product development?
- How quickly can culture evolve; what incentives exist?
Private Sector R&D Efforts

• “A McKinsey survey of 5,500 senior corporate leaders of large corporations worldwide (each with revenues of at least one billion dollars) revealed that India is the preferred destination for investments in R&D.”

• R&D is conducted in India through:
  – in-house R&D
  – collaboration with other companies
  – contracts

• The private sector has “contributed significantly to a sharp rise in patent filings from India in the 2000s.”
  – India “has adopted the IP regime formulated by the World Trade Organization (WTO) in 2005.”
India Government: Limited Support

- Although India’s percentage R&D ranking is low, “spending levels are indeed substantial on a purchasing power parity (PPP) basis.” PPP adjusted, India ranks 7th.
India Government: Limited Support  (Continues)

- “The government’s role in S&T has...gradually shifted towards a greater emphasis of commercially oriented R&D and private-public sector partnerships.”

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (Millions)</th>
<th>Researchers in R&amp;D (people per million)</th>
<th>Expenditure on R&amp;D (% of GDP)</th>
<th>IT Expenditures (% of GDP)</th>
<th>IT Expenditures (per capita USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>1,080</td>
<td>120</td>
<td>0.85</td>
<td>3.8</td>
<td>24</td>
</tr>
<tr>
<td>China</td>
<td>12,926</td>
<td>633</td>
<td>1.23</td>
<td>4.4</td>
<td>66</td>
</tr>
<tr>
<td>U.S.</td>
<td>294</td>
<td>4,526</td>
<td>2.66</td>
<td>9.0</td>
<td>3595</td>
</tr>
</tbody>
</table>
Challenges of Innovation and R&D in India

• The attrition rate is high – 15% - 20%.
  – Google, for example, might offer 4x the salary to lure away a Ph.D. because they only need four resources to start with.
  – R&D staffing can be dependent on the technology diaspora.
  – IBM CEO Samuel J. Palmisano: ”The biggest issues fro us are: How do you retain them? How do you develop them? How do you move work to them or move them to work?”

• The “United States Trade Representative (USTR) has retained India in its ‘Special 301’ watch list of 48 countries on the grounds of inadequate IRP protection.”
  – IP enforcement is weak.
## SWOT Analysis

<table>
<thead>
<tr>
<th></th>
<th>India</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>• Size of India economy and growth rate (8.5%) &lt;br&gt; • Talent capital, <em>including</em> the educated diaspora. &lt;br&gt; • Young population &lt;br&gt; • Flexibility and adaptability &lt;br&gt; • Reverse brain drain (the returning diaspora) &lt;br&gt; • English language skills &lt;br&gt; • Affordable tuition</td>
<td>• Excellent university education, research, and international programs. &lt;br&gt; • Online training &lt;br&gt; • Manufacturing and supply chain specialization &lt;br&gt; • Diversified economy – healthcare, insurance, technology, biomedical, etc.</td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td>• Insufficient numbers of Engineering Ph.D.’s and Masters in India &lt;br&gt; • Infrastructure, water shortage &lt;br&gt; • High attrition rate of employees &lt;br&gt; • Higher education system not adequately broad &lt;br&gt; • Low faculty salary and co-innovation incentives &lt;br&gt; • Weak court protection for IP</td>
<td>• Higher labor costs. &lt;br&gt; • Low cultural awareness and diversity &lt;br&gt; • Low interest and enrollment in S&amp;T &lt;br&gt; • Approaching baby boomer retirement – knowledge loss</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>• R&amp;D solutions drive manufacturing value &lt;br&gt; • Entrepreneurial off-shoots from academia &lt;br&gt; • Growing middle class &lt;br&gt; • Virtual universities</td>
<td>• Affluent society demanding differentiated products &lt;br&gt; • Grow globally by leveraging R&amp;D experience</td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td>• China has more Ph.D.’s and Masters &lt;br&gt; • <strong>Services reliant on global economy</strong> &lt;br&gt; • Regional political instability &lt;br&gt; • Public health crisis &lt;br&gt; • Diminished labor arbitrage due to exchange rate and increasing wages</td>
<td>• Reverse brain drain of international graduates &lt;br&gt; • US recession</td>
</tr>
</tbody>
</table>
## Company Overview

<table>
<thead>
<tr>
<th>Company</th>
<th>Leading</th>
<th>Opportunity (with MN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM – India Research Lab</td>
<td>R&amp;D in services and analytics</td>
<td>Scheduling/optimizing infrastructure repairs Relationship with U of M</td>
</tr>
<tr>
<td>3M Innovation Center</td>
<td>Product Development Flexibility to adapt to local markets</td>
<td>Collaboration on product development Knowledge transfer</td>
</tr>
<tr>
<td>Honeywell Technology Solutions</td>
<td>Linux and Java based Systems &amp; Controls</td>
<td>Security\Communications and medical diagnostics</td>
</tr>
<tr>
<td>SAP Labs</td>
<td>SME Solutions – Business by demand, Mobile solutions for ERP</td>
<td>Partner with U of M computer sciences and IT departments</td>
</tr>
<tr>
<td>Innovation Center (SID) at IISC</td>
<td>IT and Biotech Academia industry collaboration</td>
<td>UMN office for technology commercialization</td>
</tr>
</tbody>
</table>
Company Overview – Our Findings

• Group 2 visited IBM in Delhi and Bangalore, 3M in Bangalore and IISc center for innovation at Bangalore.
• 3M notes huge growth potential by localizing products for the vast Indian market.
• Need to package products based on Indian requirements/use is imperative.
• R&D is not the traditional kind like the U.S., but treated from an Indian perspective.
## Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What and When</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minn Company:</strong> Leverage or grow your brand.</td>
<td>Marketing</td>
<td>Start as soon as you enter India. Make sure you stand behind your corporate ethics and policies.</td>
<td>Market, make products localized to help sell the brand</td>
</tr>
<tr>
<td><strong>Minn Company:</strong> Make knowledge management a discipline.</td>
<td>IT, R&amp;D, CIO</td>
<td>Start before you move to India and make sure it is leveraged with new initiatives.</td>
<td>Knowledge Mgmt System</td>
</tr>
<tr>
<td><strong>Minn Company:</strong> Provide mentoring and collaboration.</td>
<td>HR, Related roles (scientists, engineers)</td>
<td>Leverage experienced scientists as SMEs and more junior scientists for new ideas and challenging the norm.</td>
<td>Knowledge Mgmt system, Brown Bag sessions</td>
</tr>
<tr>
<td><strong>Minn Company:</strong> Provide incentives/benefits that are pertinent to Indian culture.</td>
<td>HR</td>
<td>Need to be established before starting in India. Compare to other companies for competitive potential.</td>
<td>Know the culture to adjust benefits effectively: free lunch, busing to and from work, competitive salaries</td>
</tr>
</tbody>
</table>
## Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What and When</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minn Company:</strong> Capitalize on ongoing trend of reverse brain drain.</td>
<td>HR, Recruiting dept, Head Hunters</td>
<td>Start before needed.</td>
<td>Advertisement, word-of-mouth and recommendation s, leverage universities.</td>
</tr>
<tr>
<td><strong>Minn Company:</strong> Complement off-shored R&amp;D centers with Minnesota R&amp;D organizations. Win-Win.</td>
<td>Partners</td>
<td>Ongoing</td>
<td>Establish partnerships to ensure collaboration.</td>
</tr>
<tr>
<td><strong>Minn Company:</strong> Ensure language and culture training are provided.</td>
<td>HR</td>
<td>Start early so that the sharing of knowledge and ideas is easier. Need to relate at a basic level, at the minimum.</td>
<td>Training programs, immersion. Ensure language and culture training are provided.</td>
</tr>
</tbody>
</table>
## Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What and When</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indian Govt/Educational Inst:</strong> Fund collaborative efforts between industry and educational institutions (such as innovation centers).</td>
<td>Indian government</td>
<td>3 – 5 years</td>
<td>Partner with successful programs</td>
</tr>
<tr>
<td><strong>Indian Govt/Educational Inst:</strong> Provide market-based incentives for students and faculty in Ph.D. programs</td>
<td>Indian government</td>
<td>Start immediately</td>
<td>Explore funding opportunities</td>
</tr>
<tr>
<td><strong>Indian Govt/Educational Inst:</strong> Provide further incentives for Indian expatriates, particularly Ph.D.’s with industry experience to return to India</td>
<td>Indian government</td>
<td>Start immediately</td>
<td>Establish tax and other benefits for qualified professionals and businesses</td>
</tr>
</tbody>
</table>
## Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What and When</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minn Educational Institutions:</strong> Initiate educational exchanges – such as seminars and study abroad programs – for knowledge sharing and collaboration.</td>
<td>University of Minnesota, private colleges</td>
<td>1-3 years.</td>
<td>Establish contacts through Indian educational institutions.</td>
</tr>
<tr>
<td><strong>Minn Educational Institutions:</strong> Sponsor consortia focused on international collaboration between universities or joint Ph.D. programs. Seek industry sponsors.</td>
<td>University of Minnesota, private colleges</td>
<td>2-4 years.</td>
<td>Establish contacts through Indian educational institutions.</td>
</tr>
<tr>
<td><strong>Minn Educational Institutions:</strong> Offer online curricula to Indian students.</td>
<td>University of Minnesota, private colleges</td>
<td>1-2 years.</td>
<td>Tailor distance learning to Indian market demands. Explore options.</td>
</tr>
<tr>
<td>Think Global</td>
<td>All</td>
<td>Now</td>
<td>Keep learning</td>
</tr>
</tbody>
</table>
Acknowledgements

• Group 2 would especially like to thank:
  – Senior Managers at IBM Research Innovation Services in New Delhi and Bangalore, who generously provided us with considerable knowledge and insights during an interview on March 27, 2008 and April 3rd 2008.
  – All of IIT New Delhi and Professors Sushil and Momaya
  – All of IISc and Professor Bala Subrahmanya
  – All of IIM Bangalore and Professor Rishi
  – Senior management at 3M Innovation Center.
  – Prof. C.E. Veni Madhavan, Innovation center, IISC Bangalore.
Annotated Bibliography


6. Interview with Group 2 on 3/27/08 (interview notes available on request). Senior Manager with IBM. Research Innovation Services, IBM India Private Limited, India Research Laboratory, 4, Block – C, Institutional Area,


8. Interview with Group 2 rep on 4/2/08. Senior Mgmt with 3M Solution Center.
Assess Organization Readiness for “World is Flat”
Decision to Outsource: Assess Organization Readiness

- Ability to manage projects
  - Process Readiness
  - Cultural Readiness
Process Readiness

1. What percentage of your large and complex projects come in on-time and on-budget?
2. What percentage of your staff is PMI-certified or equivalent certification?
3. What percentage of projects are managed through a central program?
4. Does the function and business staff use real-time communications, workflow, and content-sharing tools that support distributed projects?
5. Does your organization follow a standardized develop and maintenance process?
6. Does your organization invest in development process disciplines like the Software Engineering Institute Capability Maturity Model?
Process Readiness

7. Does your company use a standardized and formal requirements definition and review process that introduces rigor in the way that business users can request new requirements or change them?

8. Does your organization relay on Service Level Agreements to establish a meaningful level of mutual responsibility for internal projects?

9. What percentage of projects are managed as a portfolio – measured comparatively as to their costs and business value?

10. Does your organization follow a formal sign-off process between business and project releases for system specifications and final delivery?
Cultural Readiness

1. How cost competitive are you compared with your top 3 competitors?
2. Do you have corporate operation in developing countries?
3. Are business sponsors interested in going offshore?
4. What is your firm’s tolerance for change and risk?
5. How much does your company spend on IT, Engineering (for example) as a percentage of total revenues?
6. Does your company pursue or adhere to ISO, Six Sigma, or other process/quality methods?
7. Is your IT or Engineering department distributed or centralized?
8. What is your company’s use of outsourcing?
9. What percentage of your workforce is unionized?
10. To what extent are your business processes regulated?
### Example: Decision to Outsource

<table>
<thead>
<tr>
<th>Rating of Importance to Customer</th>
<th>5</th>
<th>5</th>
<th>6</th>
<th>9</th>
<th>8</th>
<th>4</th>
<th>6</th>
<th>5</th>
<th>7</th>
<th>3</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Inputs</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Pre-existing capability and technical experience</td>
<td>9</td>
<td>9</td>
<td>5</td>
<td>4</td>
<td>10</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>398</td>
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<tr>
<td>Training requirements</td>
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<tr>
<td>Level of interaction with other team members</td>
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<tr>
<td>Scope work</td>
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<tr>
<td>Data transfer capabilities</td>
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<tr>
<td>Project size/duration</td>
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<tr>
<td>Onsite support &amp; project management requirements</td>
<td></td>
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<tr>
<td>Documentation requirements</td>
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<tr>
<td>Business criticality and schedule</td>
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<tr>
<td>Intellectual property concerns</td>
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<td></td>
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</tr>
<tr>
<td>Resource availability for the specific project</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Total Scores:**
- **Onsite:** 398
- **Offshore:** 520
# Sourcing Strategy Matrix

## Where Do We Invest

<table>
<thead>
<tr>
<th>Highly Strategic Capabilities</th>
<th>Less Strategic Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic and we are world leaders</strong></td>
<td><strong>Not Strategic, but very profitable</strong></td>
</tr>
<tr>
<td>Invest</td>
<td></td>
</tr>
<tr>
<td>Focus investment and talent. Treat internal source as preferred supplier</td>
<td>Invest as long as very profitable</td>
</tr>
<tr>
<td>Collaborate</td>
<td>Outsource</td>
</tr>
<tr>
<td>Explore Options such as joint venture, licensing, equity stake. Be a &quot;Smart Customer.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Strategic, BUT we lack the technology and scale to compete effectively</strong></th>
<th><strong>Commodity, and we have no competitive advantage</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Process

• Benchmarking  
  – E.g., GE, Infosys, Tata, etc.
• Define mission/vision and objectives
• Find a partner to work with us to recruit talent and locate a facility
• Hire an Organization Development consultant
• Develop organization structure (Board of Directors, identify a Managing Director, recruit functional leaders)
• Governance (strategic planning and functional direction)
• Develop project tracking systems, receive work commitments
• Develop financial systems
• Implement IT structure
• HR policies for XPAT assignments
• Opening ceremonies...
India Cultural

Enclosed please a find an informative presentation which students in New Delhi and Noida gave me in November 2007 to share with interested colleagues in the U.S.
ABARAT GANARAJYA -REPUBLIC OF INDIA

• A sovereign country in South Asia.
• Second most populous country.
• Seventh-largest country by geographical area.
• Most populous liberal democracy in the world.
• India has a coastline of over 7000 kilometers.
• World’s 12th largest economy at market exchange rates
• 3rd largest in purchasing power
• A pluralistic, multi-lingual, and multi-ethnic society
• Home to a diversity of wildlife in a variety of protected habitats.
FACTS ABOUT INDIA

• Ayurveda - Earliest school of medicine known to mankind was originated in India.
• Chess was also invented in India.
• Algebra, Trigonometry & Calculus - Studies that originated in India.
• Indian Railway System- The largest employer in the world, employing over a million people!
• World's first university was established in Takshila in 700 BC.
• Sanskrit- mother of all higher languages, most precise, and suitable language for computer software.
• The number system was invented by India. Aryabhata was the scientist who invented the digit zero.

There are countless other achievements by India in this world...
• India - A land of great diversity, more heterogeneous than any other country in the world.
• Guests are god.
• True Respect for elders.
• Help each other.
• Multiply and distribute joy & happiness.
• Share sadness and pain.
DANCE FORMS OF INDIA

• In India dance is considered to be divine. The gods & goddesses take great delight in dance & are great dancers themselves.
• Many classical dance forms exist, including bharatanatyam, kathakali, kathak, kuchipudi, manipuri, odissi and yakshagana.
• They often have a narrative form and are usually infused with devotional and spiritual elements.
BHARATA NATYAM - TAMIL NADU

• Bharata Natyam - Poetry in motion.
• Bharathanatyam's blend of the abstract & the emotional.
• It is derived from its fusion of two prime elements, nritta (pure dance) & nritya (expressive dance).
• Bharathanatyam derives much of its intense, dramatic impact from the juxtaposition & contrast with which both elements are utilized.
KUCHIPUDI - ANDHRA PRADESH

• It is the dance drama of Andhra Pradesh, emphasis is on the animation.
• Grammar is derived from the Natya Sastra & in all other aspects it is akin to Bharata Natyam.
• Kuchelapuram in Andhra was the originating centre for this style. Hence the name Kuchipudi.
• It was a male prerogative. In recent years women have taken to it but it is mostly solo.
KATHAK- UTTAR PRADESH

• It has its root in Katha story. A band of story tellers who were attached to temples in North India, narrated stories from epics. Later, they added mime & gesture to their recitation.

• The Kathak dance goes through a regular format mostly concentrating on rhythm, variously called Tatkar, Paltas, Thoras, Amad & Parans.

• Aachan Maharaj, Gopi Krishna & Birju Maharaj are but a few maestros in this
**Kathakali - Kerala**

- The domain of Kathakali is peopled by super-humans, Gods, demons & animals who are presented in a larger than life format.
- Splendor of the costumes, ornaments & facial make-up transform the actor-dancer into a type rather than a particular character.
- A character can be identified by the color he sports.
- Dance is accompanied by the drums & chanting by the singer.
ODISSI- ORISSA

• The origin of Odissi dance is closely linked with the religious movements of Jain, Buddha & Hindus.
• There are ample sculptures from the 7th century A.D. onwards which speak of the technique of odissi style of dance.
• Of late, definitive stylistic differences in Odissi have crept in due to the painstaking efforts by several Gurus.
INDIAN ARTS

• The Indian art and crafts have a very long history. Findings in the Indus Valley, Harappa and Mohenjo-daro stand witness to this statement.
• Indians have crystallized the art forms, art production and art appreciation for more than ten thousand years.
• Indian artists had excellent concepts of beauty, symmetry, strength of line and form. Examples are Caves of Ajanta & Elora.
• Indians have infinite gods, legends, lore and myths in their culture, and artists utilized these to give them beautiful forms like multi-headed and armed gods and goddesses.
• Mute stones are transferred into living expressions.
• The artists attained the highest standard of workmanship, skill and extraordinary imagination.
• India’s heritage of painting dates back to the primitive era when man used to live in caves and rock shelters.
• Painting was initially started for communication by drawing graphics or images. Gradually it took the shape of art, evident from the caves in Hoshangabad, Mirazapur and Bimbekta.
• The urge of humans to capture & preserve the emotion born out of visualizing a spectacle, led to more & more wonderful creations.
• Paintings were advanced and refined as early as the 3rd century B.C as evident from the Indus Valley Civilization, the cave paintings of Ajanta & Ellora using earth & vegetable dyes, etc.
RELIGIONS OF INDIA

• India is a land of multiple religious sects that have grown to live together in harmony, even as some forces tend to divide them.

• Indians understand religious thought as no other country, as India has given the world numerous religious thoughts through religions like Buddhism, Hinduism, Jainism etc.

• Religious concepts of Karma, Rebirth and Ahimsa have all risen from this land.

• Among the major religions of India are: Hinduism, Islam, Christianity, Sikhism, Jainism, Buddhism, Zoroastrianism, Judaism and the Bahai Faith.
Indian cuisine is known around the world for its diversity and its distinctive use of spices in creating a wide range of dishes.

Not all Indians are vegetarian, although most are, which has contributed to the marvelous variety of vegetable dishes found throughout India.

Meat is eaten mainly in the north. Fish and shellfish are popular along the coast, and pork is a specialty in Goa.

Contrary to popular belief, not all Indian food is hot. Dishes vary from region to region - cultural traditions, religion, and geography all play a role in defining a typical Indian meal.
India is the home of one of the Seven Wonders of the world - Taj Mahal. This structure built of marble by the Mughal Emperor Shah Jahan as a love tribute to his wife Mumtaz Mahal would be a dream project of architects for centuries to come.
In April, the temperature ranges from 90 to 100 F.

### City Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Population</td>
<td>6.8 Million</td>
</tr>
<tr>
<td>Area</td>
<td>225 Sq Km</td>
</tr>
<tr>
<td>City Roads</td>
<td>1500 Kms</td>
</tr>
<tr>
<td>Num Properties</td>
<td>6.5 Lakh</td>
</tr>
<tr>
<td>Total Water Supply</td>
<td>950 MLD</td>
</tr>
<tr>
<td>Per Capita Water Supply (BWSSB)</td>
<td>147 PCLD</td>
</tr>
<tr>
<td>Summer Temp.</td>
<td>18°C-38°C</td>
</tr>
<tr>
<td>Winter Temp.</td>
<td>12°C-25°C</td>
</tr>
</tbody>
</table>
Bangalore
City of Flowers
State Capitol – Vidhana Souda / Vikas Souda
Modern IT Park
Click on the Silicon Valley Poster for a larger view with links to all the participating companies. Along with the support of many high tech companies, we have created a visual time capsule for this fast growing city, titled Silicon Valley and created the perfect promotional gift and wall decoration for offices and work areas in the IT industry.

The poster is a Who’s Who in Bangalore IT industry and crystallizes a sense of identity for your company’s name, logo, and locations.
SWOT Analysis: India

Strengths

Weaknesses

Opportunities

Threats
China

Part III*: Education, Patents, Industry, Energy & more

S. Massoud Amin, D.Sc.
Director and Honeywell/H.W. Sweatt Chair in Technological Leadership
University Distinguished Teaching Professor
Professor of Electrical & Computer Engineering

Presentation at the Rochester Signature Series, November 21, 2008

*Parts of this presentation were developed for a graduate course at CDTL’s Management of Technology (MOT) program on Science and Technology Policy (MOT 8920). Considerable input and support from the students in the MOT class of 2006 is gratefully acknowledged.

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Beijing Olympics

- Stunning architecture
- Birds nest stadium & swim center
- Digital building

In Europe - Technologies like Printing, Gunpowder & Compass and the Industrial Revolution created dramatic inflections in the continental economy.
Chinese Economic Development Surges

Technologies including Atomic science, Semiconductors, Computer technology, Lasers and Automation create turnaround in the Chinese economy
Chinese Technology

- Nanotech
- Therapeutic Colloidal Au & Ink of FeOx and HgS
- Decimal System 15th Century BCE
- Cast Iron 3rd Century BCE
- Paper 110 CE
- Compass 200 CE
- Gunpowder 750 CE
- Arched Bridge Construction 600 CE
- Printing 581 CE
- Military Rocketry 1044 CE
- Toilet Paper 1391 CE
- Global Sea navigation 1421 CE

- Chinese technology outpaced Western advances by centuries.
- With a historical leading technology position, why did China fall behind after the industrial revolution of the 19-20th centuries?
Background on China

- Communist country with current structure founded in 1949.
- The world’s fourth largest country in area with 9,596,960 square kilometers (3,705,407 square miles) of total land and water.
- Contains the world’s largest population with approximately 1.3 billion people.
- Currently produces 1.42 trillion kWh and exports 10.3 kWh of electricity.
- Currently produces 3.3 million barrels per day and consumes 4.57 million barrels per day of oil.
- Currently produces 30.3 billion cubic meters and consumes 27.4 billion cubic meters of natural gas.
- Second largest energy consumer after the United States.
- Currently have 263 million wired and 269 cellular phone lines.
- Has the second highest rate of Internet users (79.5 million), just behind the United States (159 million).
- Currently spends about $60 billion on military expenditures.
- Available army of 380 million people with an additional 12.5 million reaching age annually.
Issue Emergence - 1976

- Cultural Revolution Over
- Death of Mao Tse-Tung
Agenda Setting – 1976-1978

• New Premier Deng Xiaoping establishes a radical new direction for the country

• “Four Modernizations” would command improvements in select key segments of the Chinese economy

\[\text{Agriculture} - \text{Industry} - \text{Military} - \text{Science} & \text{Technology}\]

Johnson, C., Foreign Affairs, Fall78, Vol. 57 Issue 1, p125-137
Agenda Setting – 1976-1978

• “Four Modernizations”
  Agriculture
  Industry
  Military
  Science & Technology

"the central committee has stipulated that a system of individual responsibility for technical work be established in scientific research institutes and that the system of division of responsibilities among institute directors under the leadership of party committees be set up.“ Xinhua General News Service, 21 March 1978

'Das lang as it catches mice, it does not matter whether the cat is black or white.'
Alternative Selection – 1979-1982

• “The New Long March
• “The Great Leap Westward.”
• “Revolution within a revolution.”
• Market socialism - Zhao Ziyang

Five Golden Blossoms...

Atomic science – Semiconductors - Computer technology- Lasers- Automation


• Premier Zhao Ziyang; National Science Awards, 1982.
  “uneven development...rivalry...poor management”
Peoples Republic of China
Science and Technology Mission

- To promote and improve innovation
- To strengthen fundamental research and Hi-tech Development
- To guide the transfer of science and technology achievements
- To ensure bilateral international science and technology cooperation and exchange
- To take charge of management of science and technology

Can a centralized Science & Technology Mission of a non-democratic nation succeed?

http://www.most.gov.cn/
“Revitalizing the nation through science and education”

Trend of number of graduates in high education institutions in China

Year

Issue Emergence
Agenda Setting
Alternative Selection
Enactment
Implementation
Evaluation

China science and technology statistics

- 工学 Engineering
- 哲学 Philosophy
- 经济学 Economics
- 法学 Law
- 教育学 Education
- 文学 Literature
- 历史学 History
- 理学 Science
- 农学 Agriculture
- 医学 Medicine
- 管理学 Administration
Law on Science and Technology Progress
• The State Council formulates programs to promote S&T progress and uses S&T as the primary productive force to improve economic construction.
• Promote high-tech research and industries.
• Ensure the continuous and steady development of basic research and applied basic research ($).
• Raise the social status of scientific and technical workers.

Law on Popularization of Science and Technology
• Through science, education and the strategy of sustainable development, redoubling the efforts to popularize science and technology, raising the citizens’ scientific and cultural level and promoting economic and social progress.
• Make it easy for the general public to understand, accept and participate.

[Diagrams and text not fully transcribed due to limitations]
Since the economic reform in 1980, China has experienced unprecedented economic growth: GDP has jumped more than 800%. The corresponding growth in primary energy consumption has increased only 278%. The energy intensity, measured in terms of energy consumption in kilogram of coal equivalent (kgce) per economic output in dollar of Chinese yuan, dropped from 1.33 to 0.46. There are many factors contributing to this improvement in the more efficient usage of energy. A major one may be attributed to the fact that the share of electricity utilization (a more efficient means of energy usage in most cases) in the total energy consumption has more than doubled, up from 20.6% to 43.8%. As a result, the growth in electricity has surged 634% since 1980. This figure shows the growth in the economy:
Implementation – Chinese R&D Spending

20% Compound Annual Growth Rate (CAGR) in R&D Expenditures: 1991–2002

Chinese R&D expenditure is 3rd largest globally behind US & Japan
Global R&D Potential (2004 data)

*Size of circle reflects relative amount of annual R&D spending by country noted.

Source: R&D Magazine, Battelle, OECD, World Bank, K4D, UNESCO
Global R&D Potential 2004

[Diagram showing the world of R&D in 2004 with various countries plotted based on scientists and engineers per million people and R&D as a percentage of GDP. The diagram highlights the emergence and agenda setting phases, followed by alternative selection, enactment, implementation, and evaluation.]
Global high-technology market share, by selected country/region: 1980–2001

Source: NSF, Science and Engineering Indicators- 2004
Global high-technology export share, by selected country/region: 1980–2001

NOTES: Other Asia includes China, South Korea, Malaysia, Singapore, and Taiwan. Data for 1981–84 and 1986–88 are extrapolated.

Source: NSF, Science and Engineering Indicators- 2004
Free Market Vision

- Zhao Ziyang - China’s greatest liberal
- Market-Liberal Vision
  - Strengthening the socialist legal system
  - Advocated new types of institutions to promote development of a market system
- Required political reform
- Viewed as a threat
  - Ousted from General Secretary position
- How would the world look at or deal with China if the Market-Liberal Vision had been fully implemented?
Science and Technology Mission

• To promote and improve innovation
• To strengthen fundamental research and Hi-tech Development
• To guide the transfer of science and technology achievements
• To ensure bilateral international science and technology cooperation and exchange
• To take charge of management of science and technology

How much innovation has stemmed from China, given its strong S&T Mission?
# S & T Policy & Programs

<table>
<thead>
<tr>
<th>Since</th>
<th>S&amp;T Programs</th>
<th>Implemented through</th>
<th>Goal / Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>National Key Technologies R&amp;D Program</td>
<td>Four Five-year Plans</td>
<td>To address pressing major S&amp;T issues in national economic and social development. The program concentrates on the R&amp;D of key and common technologies that drive technical upgrading and restructuring of industries that promote sustainable social development.</td>
</tr>
<tr>
<td>1986</td>
<td>National High-tech R&amp;D Program (863 Program)</td>
<td>Three Five-year Plans</td>
<td>To boost innovation capacity in the high-tech sectors, particularly in strategic high-tech fields, in order to gain a foothold in the world arena.</td>
</tr>
<tr>
<td>1997</td>
<td>National Program on Key Basic Research Projects (973 Program)</td>
<td>10th Five-year plan</td>
<td>To build up a solid S&amp;T foundation for the sustainable socio-economic development.</td>
</tr>
<tr>
<td></td>
<td>R&amp;D Infrastructure and Facility Development</td>
<td>10th Five-year plan</td>
<td>To strengthen activities involving basic S&amp;T and public interests and to promote international S&amp;T cooperation along with national S&amp;T bases construction.</td>
</tr>
<tr>
<td></td>
<td>Environment Building for S&amp;T Industries</td>
<td>10th Five-year plan</td>
<td>To strengthen policy for environment construction, promote regional economic development, enhance technical services and exchanges, stimulate development of small and medium-sized S&amp;T enterprises (S&amp;T SMEs), vigorously develop S&amp;T intermediaries, and create a sound environment for the commercialization of S&amp;T findings and their industrialization.</td>
</tr>
<tr>
<td></td>
<td>Mega-projects of Science Research</td>
<td>10th Five-year plan</td>
<td>To take favorable positions in the science frontier in the 21st century and achieve significant technical breakthroughs, leading to industrialization in major fields related to national socio-economic development, all within 3 to 5 years.</td>
</tr>
</tbody>
</table>

Analysis of Research & Development

• Primary R&D focus
  – Manufacturing
  – Electronics
  – Information Technology
• National R&D expenditure trends
• Distribution of R&D expenditures
• Comparisons to leading countries
  – United States
  – Japan
  – Germany
  – South Korea
• Future R&D projections
Implementation - Special Economic Zones

Coastal areas receive intensive infrastructure and investment

http://en.wikipedia.org/wiki/Special_Economic_Zone

28% CAGR in ICT Exports

Source: OECD ITS database.
Dominance in Exports of ICT Goods

China is biggest exporter of Information Technology Goods in 2004

OECD: ITS database.

Issue
Emergence

Agenda Setting

Alternative Selection

Enactment

Implementation

Evaluation
Centralized v. Free Market S&T Policy

**Centralized Pros**
- Easier implementation of policies
- Focus on national agenda
- Administrative control
- Centralized wealth pool
- State monitoring and auditing of regions
- Common policies help streamline resources and provide guidance
- Uniform policies guide the nation eliminating dysfunction among the provinces

**Free Market Pros**
- Diversified goal seeking reveals unique opportunities
- Freedom for the investors
- Many choices for all to participate
- Increased foreign investment
- Liberalizing trade agreements
- Increased consumer choices
- Optimized resource allocations
- Broadens global reach

**Diagram:**
- Issue Emergence → Agenda Setting → Alternative Selection → Enactment → Implementation → Evaluation
China’s Future

- Exploding technology, innovation & commercial opportunity
- Sustained high growth & expanding private sector
- Unique pattern of urbanization:
  - Society in transition or...
  - Social upheaval
- Further decentralization of economic decision-making
- Increased disparities in incomes between the regions
- Possible scenarios:
  - Highly assertive China bent on regional & global dominance
  - Defensive China obsessed with preventing foreign intervention
  - Chaotic and uneven growth spurs domestic unrest & revolution
  - China cooperates with the West and enjoys “Peaceful Rise”
Interim Conclusions

- The Black Box...
  - S&T Policy >> 20% CAGR R&D >> 28% CAGR ICT Trade

- China’s 2005 GDP is projected to surpass $1.8T

- 10% GDP growth rate has been spurred and sustained by centralized S&T Policy.

- Wide discrepancy between East and West will need to be addressed to sustain healthy growth

- Centralized policy around education, resources, and science will require balance with Free Market reform.
Focus Area: Power and Energy

Sources: IEEE P&E Magazines, EIA, and Economist
PROSPERITY IS SPREADING...

- Population in Extreme Poverty (billions)
  - Poverty line
  - Millennium goal
  - Low projection

- World GDP per Capita (1990 dollars)
  - High projection

Year:
- 1820
- 1860
- 1900
- 1940
- 1980
- 2020
- 2060

GDP
The Energy Gap

- Half the world’s population subsists on agrarian or lower levels of energy access, and

- Their population density generally exceeds the carrying capacity of their environment
Context: Earth population growth
Context: Cities with 10 million people

- By 2020, more than 30 mega-cities in the now less-developed world. By 2050, nearly 60 such cities.

- Increased population creates need for more resources. World's electricity supply will need to triple by 2050 to keep up with demand, necessitating nearly 10,000 GW of new generating capacity.
Social Conditions and Access to Electricity

- **International Collaboration**
  - Global R&D, global investment, global peace, global technologies

- **Amenities**
  - Education, recreation, the environment, intergenerational investment

- **Basic Quality of Life**
  - Literacy, life expectancy, sanitation, infant mortality, physical security, social security

- **Survival**
  - Food, water, shelter, minimal health services

Source: Dr. Chauncey Starr
... but CO₂ emissions are troubling

- **Annual Fossil-Fuel Emissions** (gigatons of carbon)
- **Year**
  - 1820
  - 1860
  - 1900
  - 1940
  - 1980
  - 2020
  - 2060

- **High projection**
- **Low projection**

Emissions that oceans and land currently absorb
Context: Global Emissions
The richer, the cleaner
Decarbonisation of final energy
Carbon intensities (tonnes carbon/tonnes of oil equivalent)

India
China
France
US
Japan

Source: Nebojsa Nakicenovic and Arnulf Gruebler, International Institute for Applied Systems Analysis

Source: RFF, 2002
Consider the couplings in GDP and electricity use: quadrupling of GDP between 1980-1995, while doubling the economy’s energy demand– due to economic reforms and comprehensive national energy conservation programs since 1980s.
Percentage share of electricity in total energy consumption (increase in the share of electricity in total energy consumption)
Total installed generation capacity in GW (red columns) and annual electricity production in 10 trillion Wh (blue columns)
Energy Demand

http://earthtrends.wri.org/updates/node/274
Projected Energy Growth in China by Energy Source

http://earthtrends.wri.org/updates/node/274
China has nine operating nuclear power plants, including the Daya Bay facility in Shenzhen. They plan to spend $50 billion to build 32 more by 2020. Possibly 300 by 2050.

http://www.washingtonpost.com/wp-dyn/content/article/2007/05/28/AR2007052801051.html
CO₂ Emissions

China surging to No. 1 position

Data about China's greenhouse gas emissions has long been controversial because of the Chinese government's faulty record keeping. But new data indicate that China's emissions began to surge in 2001 and have been rising much faster than expected.

China surging to No. 1 position

CO₂ emissions from fossil fuels, in billion tons

<table>
<thead>
<tr>
<th>Year</th>
<th>USA</th>
<th>European Union</th>
<th>China</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>2,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
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<tr>
<td>2002</td>
<td>2,500</td>
<td>1,200</td>
<td>1,500</td>
<td>1,200</td>
</tr>
<tr>
<td>2003</td>
<td>3,000</td>
<td>1,500</td>
<td>2,000</td>
<td>1,500</td>
</tr>
<tr>
<td>2004</td>
<td>3,500</td>
<td>2,000</td>
<td>2,500</td>
<td>2,000</td>
</tr>
<tr>
<td>2005*</td>
<td>4,000</td>
<td>2,500</td>
<td>3,000</td>
<td>2,500</td>
</tr>
<tr>
<td>2006*</td>
<td>4,500</td>
<td>3,000</td>
<td>3,500</td>
<td>3,000</td>
</tr>
<tr>
<td>2007**</td>
<td>5,000</td>
<td>3,500</td>
<td>4,000</td>
<td>3,500</td>
</tr>
<tr>
<td>2008**</td>
<td>5,500</td>
<td>4,000</td>
<td>4,500</td>
<td>4,000</td>
</tr>
<tr>
<td>2009**</td>
<td>6,000</td>
<td>4,500</td>
<td>5,000</td>
<td>4,500</td>
</tr>
<tr>
<td>2010**</td>
<td>6,500</td>
<td>5,000</td>
<td>5,500</td>
<td>5,000</td>
</tr>
</tbody>
</table>

* estimated ** projected

Sources: Chronicle research; China National Bureau of Statistics; International Energy Agency; U.S. Energy Information Administration

Iron Ore and Steel
Nationwide grid interconnections of China

ac Interconnection:
Northeast–North–Central China

dc Interconnection:
Central – East China
Central – South China
Central – Northwest
Transmission Capacity Between Regions: 11.4 GW

500-kV ac
2001/05
800 MW

± 120-kV dc
2005/07
360 MW

500-kV ac
2003/09
800 MW

± 500-kV dc
1989/09
4,200 MW

500-kV ac
2001/12
1,200 MW

± 500-kV dc
2004/02
3,000 MW
Geographic map of six regional power systems

NC: North China; EC: East China; CC: Central China; SC: South China; NW: Northwest China; NE: Northeast China
Interconnection of six regional grids in 2005
Nationwide grid interconnections of China

- **ac Interconnection:**
  - Northeast–North-Central China

- **dc Interconnection:**
  - Central – East China
  - Central – South China
  - Central – Northwest
  - Transmission Capacity: 11.4 GW

- **Transmission Capacities:**
  - 500-kV ac
    - 2002/04: 1,000 MW
    - 2003/09: 800 MW
  - ± 120-kV dc
    - 2005/07: 360 MW
  - ± 500-kV dc
    - 1989/09: 4,200 MW
    - 2004/02: 3,000 MW
  - 500-kV ac
    - 2001/12: 1,200 MW
    - 2001/05: 800 MW

- **Regions:**
  - Northeast
  - North China
  - Northwest
  - Central China
  - South China
  - East China
  - Taiwan
  - Tibet
Recently completed hvac/hvdc projects

<table>
<thead>
<tr>
<th>Grid</th>
<th>Location</th>
<th>Type</th>
<th>Capacity</th>
<th>Length</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-EC</td>
<td>3G Gezhouba-Shanghai</td>
<td>±500 kV DC</td>
<td>1,200 MW</td>
<td>1,045 km</td>
<td>1991</td>
</tr>
<tr>
<td>SC-SC</td>
<td>Guangxi-Guangdong</td>
<td>±500 kV DC</td>
<td>1,800 MW</td>
<td>980 km</td>
<td>2001</td>
</tr>
<tr>
<td>CC-EC</td>
<td>3G Longquan-Shanghai</td>
<td>±500 kV DC</td>
<td>3,000 MW</td>
<td>900 km</td>
<td>2002</td>
</tr>
<tr>
<td>CC-SC</td>
<td>3G Jingzhou-Guangdong</td>
<td>±500 kV DC</td>
<td>3,000 MW</td>
<td>950 km</td>
<td>2004</td>
</tr>
<tr>
<td>CC-NW</td>
<td>Henan-Henan</td>
<td>±120 kV DC</td>
<td>360 MW</td>
<td>Back-to-back</td>
<td>2004</td>
</tr>
<tr>
<td>SC-SC</td>
<td>Guizhou-Guangdong</td>
<td>±500 kV DC</td>
<td>3,000 MW</td>
<td>1,000 km</td>
<td>2004</td>
</tr>
<tr>
<td>NC-NE</td>
<td>Hebei-Liaoning</td>
<td>500 kV AC</td>
<td>800 MW</td>
<td>167 km</td>
<td>2001</td>
</tr>
<tr>
<td>CC-NC</td>
<td>Henan-Hebei</td>
<td>500 kV AC</td>
<td>600 MW</td>
<td>210 km</td>
<td>2003</td>
</tr>
</tbody>
</table>

Central to this is the Three Gorges power grid, consisting of 12-GW HVAC from the Three Gorges to the Central China grid and 7.2-GW HVDC to the East China grid. The first HVDC project in China was in 1987 in Zhejiang province with a 100-MW ± 100-kV underwater cable that spans 54 km. The first HVDC line from Gezhouba (Three Gorges) to Shanghai was completed in 1991, and a number of other HVDC and HVAC lines linking regional grids have been completed in the last few years as listed above. Additional planned HVDC and HVAC transmission projects for the 2006–2010 period include: second 3G-Shanghai HVDC link; second Guizhou-Guangdong HVDC link; NC-NE back-to-back HVDC link; NC-CC back-to-back HVDC link; Guangdong-Hainan underwater HVDC link; Yunnan-Guangdong HVDC link; NC-NE HVAC link; NW-NC HVAC link.
PMUs and WAMS central stations in China
Decentralized PMUs and functional modules
Hardware structure of the WAMS central station
Communication delays between the six PMUs and the central station in Jiangsu Provincial

Communication delays between the PMU at Yang Zhou second power plant and the central station: (a) the network is congested and (b) the network is idle.

<table>
<thead>
<tr>
<th>PMU Plants/Substations</th>
<th>Status of Network</th>
<th>Max. Delay (ms)</th>
<th>Min. Delay (ms)</th>
<th>Avg. Delay (ms)</th>
<th>Std. Deviation (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xu Tang</td>
<td>Congested</td>
<td>49</td>
<td>23</td>
<td>39</td>
<td>29</td>
</tr>
<tr>
<td>Huai Yin</td>
<td>Congested</td>
<td>21</td>
<td>8</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Nan Tong</td>
<td>Congested</td>
<td>22</td>
<td>9</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Peng Cheng</td>
<td>Congested</td>
<td>27</td>
<td>11</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Xin Hai</td>
<td>Congested</td>
<td>39</td>
<td>17</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Yang Zhou 2nd</td>
<td>Congested</td>
<td>81</td>
<td>7</td>
<td>14</td>
<td>62</td>
</tr>
<tr>
<td>Yang Zhou 2nd</td>
<td>Idle</td>
<td>20</td>
<td>8</td>
<td>13</td>
<td>12</td>
</tr>
</tbody>
</table>

Communication delay distributions:

(a) Congested network
(b) Idle network
Power oscillation and its online analysis result in the WAMS of Northern—and Central China

(a) the active power along the tie line, and
(b) the frequency spectrum obtained with the online Prony analysis
The three-phase plan of WAMS application in China

Phase I: (2003-2004)
- Online Security Assessment and Control
  (Predecision Making: <5 min)

Existing Functions
- Dispatch Plan, Load/Gen. Prediction
  (Several Seconds to Several Days)
- EMS/SCADA
  (Quasi-Steady, Several Seconds to 10 min)
- WAMS
  (Dynamic, 10 ms to 1 s)
- Protection and Emergency Control Systems
  (Tens to Hundreds of Milliseconds)

Phase II: (2004-2006)
- Dynamic Security Analysis and Control
  Decision-Making (Several Seconds)

Phase III: (2005-2008)
- Real-Time Protection and Control
  (10 ms to 1 s)
Researched and Addressed

Policy Areas to be researched:

– Nuclear Energy Supply
– Energy Transmission and Distribution
– Environmental Pollution
– Localization of Plant Builds
– Nuclear Weapons
Nuclear Energy Supply

Should China continue to build a nuclear energy supply base?

- **Pros**
  - Clean Alternative to Coal, Oil, and Natural Gas
  - Smaller Plants produce more Energy

- **Cons**
  - More Expensive
  - Radioactive Materials
    - Potential Environmental Disasters
  - Public Perception and Sensitivity

- **Cost**
  - $1,200 to $1,500 per KwH
  - Decommissioning costs are high
  - Costs go on well after end of production

- **Benefits**
  - Less Dependence on Importation of Oil
  - Use Less Natural Resources
Current and Proposed Nuclear Power Plants in China
Should the Chinese Government Deregulate the Transmission Infrastructure?

- **Pros**
  - Cheaper Operating Costs
  - Channels Owned by Government

- **Cons**
  - Deregulation of Transmission
  - Potential Terrorist Attacks

- **Costs**
  - Less Cost in Transportation

- **Benefit**
  - Efficiency
Environmental Pollution

Should the Chinese Government Utilize Nuclear Energy to Help Curb Pollution?

• Pros
  – Less Emissions
• Cons
  – Radioactive Waste
  – Raises Temperatures of Local Water Resources
  – Meltdown Potential
  – Harmful to Humans

• Costs
  – High Long-term Costs for Safe Storage
  – Decommissioning Costs
  – Environmental Impact (Clean-up, treatment, etc.)

• Benefits
  – Less problems with extraction of natural resources
Localized Plant Builds

Should the Chinese Government mandate Localized Building of Nuclear Power Plants?

• Pros
  – Monetary gains to local towns
  – Knowledge kept locally

• Cons
  – No influx of new ideas
  – Cannot support demand

• Cost
  – Cheaper to use Chinese resources than import

• Benefits
  – Develop Local Talent
  – Less Dependent on Foreign Technology
Nuclear Weapons

Should China maintain its current policy of “Minimum Deterrence” with regards to Nuclear Weapons?

• Pros
  – Need to be Provoked
  – Prevents False Alarms

• Cons
  – Potential to be Hit first with Nuclear Weapons
  – Cannot Respond Quickly
  – Trust in Other Countries
  – Complacency

• Costs
  – Life
  – Nuclear Fallout
  – International Relations

• Benefits
  – Smaller Arsenal
  – Less Nuclear Development
Extrapolations & Meanings

• Look at the results upon the GDP and the country’s economic growth
• Understand how and where China’s S & T development is leading the country
• What does this mean to the US and the World?
• What were the measures of success and is China reaching its goals
Discussion

• How successful is China in creating and following S & T policy?
• Are the policies effective?
• Are there other things should China consider to bolster its economic strength?
Change
Engineering bachelor’s degrees by country

2004 Engineering Bachelor’s Degrees (Per 1,000 People)

- Canada: 0.198
- China: 0.498
- England: 1.098
- Germany: 1.100
- India: 0.278
- South Korea: 1.101
- Taiwan: 1.100
- United States: 0.220

- Canada: 6,500/Year
- United States: 65,000/Year
- England: 66,500/Year
- Germany: 90,700/Year
- India: 300,000/Year
- South Korea: 53,500/Year
- China: 650,000/Year
- Taiwan: 25,000/Year
Chinese universities graduate 700,000 new engineers per year (according to recent assessments only about 10%, this percentage is rapidly increasing, are engineers and the remaining are technicians)
Growth in doctoral degrees awarded 1986-1999

1986 = 1
Ordered by 1999

Number of degrees awarded in 1998

<table>
<thead>
<tr>
<th>Country</th>
<th>Citizens</th>
<th>Non-citizens</th>
<th>Japan</th>
<th>South Korea</th>
<th>Taiwan</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>4,800</td>
<td>16,200</td>
<td>9,800</td>
<td>6,600</td>
<td>2,500</td>
<td>900</td>
</tr>
<tr>
<td>US - citizens</td>
<td>4,800</td>
<td>16,200</td>
<td>9,800</td>
<td>6,600</td>
<td>2,500</td>
<td>900</td>
</tr>
<tr>
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<td>900</td>
</tr>
<tr>
<td>South Korea</td>
<td>4,800</td>
<td>16,200</td>
<td>9,800</td>
<td>6,600</td>
<td>2,500</td>
<td>900</td>
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<tr>
<td>Taiwan</td>
<td>4,800</td>
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<td>6,600</td>
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<td>900</td>
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<tr>
<td>China</td>
<td>4,800</td>
<td>16,200</td>
<td>9,800</td>
<td>6,600</td>
<td>2,500</td>
<td>900</td>
</tr>
</tbody>
</table>
Growth in U.S patents invented in Asia – 1986-2003

1986 = 1
Ordered by 2003 value

Number of patents in

- United States: 87,600
- Japan: 35,500
- Hong Kong: 250
- India: 76
- Taiwan: 350
- China: 5,300
- South Korea: 370
- Singapore: 4,000

Source: CHI Research, Inc. International Patent Indicators, 2004,
Growth in U.S patents invented in Asia – 1986-2003

1986 = 1
Ordered by 2003 value

Number of patents in
United States: 87,600
Japan: 35,500
Hong Kong: 250
India: 76
Taiwan: 350
China: 5,300
South Korea: 370
Singapore: 4,000

Source: CHI Research, Inc. International Patent Indicators, 2004,
Issues with IP in China

• Copyright Piracy – $2.5 - $3.8 Billion per year
• Cultural issues - “Impossible to separate the inventor’s activity from the society of which the inventor is part”
• Judges lack of experience in dealing with IP issues
• Struggling with balance between economic development and protection of IP rights
• Law implementation needs improvement.
• Foreign pressure – primarily from governments. Only 5% from foreign companies.
• 95% of product piracy cases involve violations against Chinese companies.

http://www.bizasia.com/intellectual_property_/b38fc/toyota_pursues_intellectual.htm
https://asiamedia.ucla.edu/article.asp?parentid=34148
Specific Examples of IP issues in China

• Software Piracy is unauthorized copying, distributing or downloading of copyrighted software.
• Patent Infringement encroachment upon the domain belonging to a patentee that is described by the claims of her/his patent
• Patent Trolling involves finding and procuring patents, then suing infringers of those patents. Can also be used to look at “unpatented” patents from other countries and establishing them in China or Korea.
What Is Software Piracy?  
(什麼是軟體盜版?)

Three of the most common forms of software piracy are:

- **End-user copying:** Organizations installing or using software on more computers than they are licensed to support.
- **Distribution:** Selling or distributing illegally copied software, including counterfeit products.
- **Downloading:** Making unauthorized copies from the Internet.
Piracy Examples (秘密)

Counterfeit or Authentic?

Which is which?
Piracy Examples (是一部巨大电影)

Counterfeit software: Shot of Microsoft Office 2000 inside jewel case

After you've agreed to the End User License Agreement, you're ready to install.
To Install Office
1. Insert Disc 1 in the CD-ROM drive.
2. Follow the instructions on your screen.
3. After Disc 1 has completed installation, repeat this process for Discs 2 and 3.

For more detailed installation information, please refer to the Help section provided in the Setup program.

More than one third of adult Internet users say they have downloaded commercial software online without paying for all the copies they made. *(Source: “Quantifying Online Downloading of Unlicensed Software – Survey of Internet Users,” IPSOS Public Affairs, May 2002)*

- 25% of users who download software say they never pay for it. *(Source: IPSOS, May 2002)*

- Last year, piracy cost the software industry an estimated $11 billion. *(Source: “2009 Global Software Piracy Report,” International Planning and Research Corp., June 2002)*

- The loss to the economy has significant impact, including more than 111,000 jobs lost, $5.6 billion in lost wages and more than $1.5 billion in lost tax revenue. *(Source: “2001 State Software Piracy Study,” International Planning and Research Corp., October 2002)
## IP Loss Costs for Software

<table>
<thead>
<tr>
<th>Region</th>
<th>Loss Costs</th>
<th>Western Europe</th>
<th>Loss Costs</th>
<th>North America</th>
<th>Loss Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia / Pacific</td>
<td>$1.1 Billion</td>
<td>United Kingdom</td>
<td>$1.2 Billion</td>
<td>North America &amp;</td>
<td>$10.5 Billion</td>
</tr>
<tr>
<td>China</td>
<td>$1.1 Billion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>$1.7 Billion</td>
<td>Germany</td>
<td>$1.1 Billion</td>
<td>Canada</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>$376 Million</td>
<td>France</td>
<td>$964 Million</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Patent Infringement Examples (違反例子)

• General Motors vs. Chery
  – Design, Unfair Competition and Trade Secrets

• Toyota vs. Geely Group
  – Copied logo and deceived customers by claiming its cars used Toyota engines

• Starbucks vs. Xingbake
  – Copied it’s logo and used it Chinese language name

http://www.dega.dk/ref.aspx?id=803
GM Spark

http://www.dega.dk/ref.aspx?id=803
Not yet settled…

Chery QQ

http://www.dega.dk/ref.aspx?id=803
Toyota loses it’s infringement claim against Geely

http://www.dega.dk/ref.aspx?id=803
Starbucks Wins....($50,000)

## Patent Costs

<table>
<thead>
<tr>
<th>Country</th>
<th>Patent Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>$3000-5000</td>
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<tr>
<td>Germany</td>
<td>$14,361</td>
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<td>USA</td>
<td>$14,370</td>
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<tr>
<td>Japan</td>
<td>$30,498</td>
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</table>

Source: [http://www.goodwinprocter.com/publications/frank_s_yearpatent_1_03.pdf](http://www.goodwinprocter.com/publications/frank_s_yearpatent_1_03.pdf)
Patent Trolling

• Unprotected patents are fodder for counterfeiters, competitors and pirates from countries with low IP protections.
• A Great Wall of Patents – filing for patents in China for copied products.
• Japan currently experiencing 17,000 hits per day from China and 50,000 per day from Korea on their patent website
• Issues for U.S. Patents
  – Patent Pendecy taking up to 30 months
  – 18 month rule is handing over IP to China
  – Backlog of over 500,000 patent apps
  – Counterfeiters are directly using US patent information to file their own patents in China.

US Patent and Trademark Office (USPTO) Role

- **USPTO**
  - Initiated STOP initiative which is a program to stop international piracy and counterfeiting and protect US small and medium sized enterprises overseas.
  - Provide toolkits for businesses with IP issues in China, Korea, Mexico, Taiwan and Russia.
  - Created China Road show in FY2005 for businesses contemplating entering the China market. Topics included Chinese laws and regulations regarding IP.
  - Increased technical assistance in China including training on IP judicial infringement interpretation, criminal copyright infringements, and IP enforcement in Southern China.

Patent Reform Act of 2005

• Introduced to the House June 8, 2005
• Bill addresses:
  – Patent Quality
  – Limitation of litigation abuses
  – Harmonization of US patent laws with our key trading partners
  – Proposes shift from first-to-invent to first-inventor-to-file
  – Broadens scope of prior user
  – Limitation on treble damages for patent infringement
  – Publication of all patent applications after 18 months
• Changes continue to original bill as it moves through Congress

Laws and Treaties (法律和條約)

• Chinese Laws
  – Intellectual property rights can be traced back to Tang Dynasty (618-907 AD)
  – First patent-specific law enacted in 1889
  – Modern patent law began in 1950
  – Cultural Revolution in mid-1960’s brought an end to the recognition of intellectual property
  – Adopted trademark laws in 1982
  – Adopted patent laws in 1985
    • “First to File” model
  – Adopted copyright laws in 1986 through 1990

• International Organizations / Treaties / Conventions
  – Became a member of the World Intellectual Property Organization (WIPO) in 1980
  – Became a party to the Madrid Agreement for the International Registration of Trademarks in 1989
    • US is still not a party to the agreement
  – Became a party to Berne Convention for the Protection of Literary and Artistic Works in 1992
  – Became a member of WIPO’s Patent Cooperation Treaty in 1994

http://beijing.usembassy.gov/iprpatent.html
http://www.chanlaw.com/ipinchina.htm
Enforcement (執行)

• Three potential courses of actions for rights holders
• Administrative Adjudication
  – Local officials decide if infringement occurred
  – Quick, but no money to rights holders and very small fines
  – Most popular course of action
• Civil Litigation
  – Civil courts decide if infringement occurred
  – Costly and low damages
  – Increasing in popularity
• Criminal Prosecution
  – Government decides whether or not to prosecute and if infringement occurred
  – Complaints include referral criteria too vague, process permits too much discretion, and minimum evidentiary threshold too high
  – Small percentage of all actions taken
Litigation Awards (享受類?)

• A $25,000 infringement award does not mean much to a US company but is a significant fine for the Chinese when compared with average annual income.

Equivalent Value of a $25,000 Infringement Award

<table>
<thead>
<tr>
<th></th>
<th>Average Annual Household Income</th>
<th>Infringement Award</th>
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<tbody>
<tr>
<td>China</td>
<td>$ 793</td>
<td>$ 1,336,492</td>
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<tr>
<td>China (Urban)</td>
<td>$ 1,307</td>
<td>$ 811,007</td>
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<tr>
<td>China (Rural)</td>
<td>$ 406</td>
<td>$ 2,614,407</td>
</tr>
<tr>
<td>United States</td>
<td>$ 42,409</td>
<td>$ 25,000</td>
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</table>

Source: http://www.stats.gov.cn/english/newsandcomingevents/t20060302_402308116.htm
# Risk Assessment Example

(風險評估例子)

<table>
<thead>
<tr>
<th>Project Characteristic Question</th>
<th>Rating</th>
<th>Weight</th>
<th>Score</th>
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<tbody>
<tr>
<td>Correct Chinese IP protection path chosen</td>
<td>8</td>
<td>3.0</td>
<td>24.0</td>
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<tr>
<td>Level of Chinese IP enforcement</td>
<td>6</td>
<td>1.9</td>
<td>11.4</td>
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<tr>
<td>Use of formal channels to protect IP</td>
<td>8</td>
<td>1.7</td>
<td>13.6</td>
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<tr>
<td>Familiarity with Chinese IP system</td>
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<td>1.5</td>
<td>6.0</td>
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<td>Simplicity of IP to be protected</td>
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<td>1.1</td>
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<tr>
<td>Stability of Chinese IP laws</td>
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<td>0.8</td>
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<tr>
<td><strong>Overall Score</strong></td>
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<table>
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<tr>
<th>Overall Score</th>
<th>Risk Level</th>
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<tr>
<td>10-28</td>
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<tr>
<td>29-46</td>
<td>Higher</td>
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<tr>
<td>47-64</td>
<td>Moderate</td>
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<tr>
<td>65-82</td>
<td>Lower</td>
</tr>
<tr>
<td>83-100</td>
<td>Lowest</td>
</tr>
</tbody>
</table>

http://home.cinci.rr.com/estople/omrat/omrat.htm
Risk Assessment Sensitivity Analysis
(几乎完成)

Tornado Diagram
(Single Factor Sensitivity Analysis)

Correct Chinese IP protection path chosen
Level of Chinese IP enforcement
Use of formal channels to protect IP
Familiarity with Chinese IP system
Simplicity of IP to be protected
Stability of Chinese IP laws

http://www.tushar-mehta.com/excel/software/tornado/
How to Protect your Intellectual Property
(怎麼保護您的知識產權)

The best offense is a good defense...and vise versa

• Go on the defense...
  – Employ legal measures...A first-to-file principle
  – Control the production process
  – Focus on human resources
  – Know how to choose suppliers and distributors
  – Keep eye on competitors

• ...And the offense
  – Take legal action
  – Conduct surveillance of suppliers and distributors
  – Control employee turnover
  – Advocate aggressively

http://resources.alibaba.com/article/4117/IP_protection_best_practice_tips.htm
Protecting IP in China

Customs Regulations
(三個另外星期類)

• Articles bearing marks that are counterfeit or inappropriately using a trademark are subject to seizure and forfeiture.

• Travelers are permitted an exemption and allowed to import 1 item of each type provided that the article is for personal use and not for sale for once every 30 days.
  – E.G. Person arrives with 3 purses all different trademarks, or all the same trademarks, would be permitted only one purse.
IP and Globalized Technology Impact

• For developing countries:
  – understanding IP issues is necessary in their efforts to integrate into world economies
  – evolving system of stronger IP rights in new technologies can ultimately lead to gains in innovation and information
  – Wisely managing IP may lead to additional foreign investment, more licensing of high-quality technologies, and more access to advanced knowledge goods

SWOT Analysis: China

Strengths

Weaknesses

Opportunities

Threats
So, Where are we exactly?
The (Economic) Ages of Humankind

• Hunter/Gatherers (~1 Million - ~5K BC)
• Agriculture (~5K BC - ~1850 AD)
• Industrial (~1850 AD - ~1950 AD)
• Information (~1950 AD - ~2040 AD)
• Bio/Nano (~1995 - ~2040)
• Virtual (~2015 - ?)
• Hunter-Gatherer - “Nature Provided”

• Agriculture - Controlled Nature (Plants/Animals)

• Industrial - Mechanized Agriculture
  [1800-97% Farmers, Now-2%]

• IT/BIO/Nano - Automating Industry/Agriculture

• Virtual - Robotization of
  IT/Bio/Nano/Industry/Agriculture

→ Technology MATTERS
Center for the Development of Technological Leadership (CDTL) at the University of Minnesota

- Established in 1987 with an endowment from Honeywell Foundation
- Expertise in the interface of business, strategy, science, technology, innovation, and policy
- Housed in the Institute of Technology (engineering, mathematics, and physical sciences college)
Tactics and Strategies to Help You Lead the Way

Managing and Leading at the Interface...

Institute of Technology Science & Engineering

- Engineering & Applied Sciences
- E.g. Medical Devices, Info. Technology, Manuf.
- Emerging/pivotal Tech: Nano, Energy, Security
- Graduate Programs MS, PhD
- Continuing Education & Professional Training Undergraduate

CDTL*

- Management of Technology (MOT)
- Business Foundation: Marketing, Management, Entrepreneurship, Finance, Operations, ...
- Technology Tracks A B C D E F

Carlson School of Management, Humphrey Institute/Public Policy, Law School, Industry

- Business, Management, Policy, and IP
- E.g., Graduate Programs MBA, JD, PhD
- Continuing Education & Professional Training

*Technology Foresight & Forecasting, Strategic Technology Analysis, Innovation, etc.
What Does CDTL Do?

• Offer UM Regents’ Approved Master of Science degrees
  – Management of Technology
  – Infrastructure Systems Engineering

• Certificate Programs
• Research & Consulting
• Technology Futures Forum
• Foresight After Four
• Signature Series
• Short Courses and Seminars
Leadership and Management at the Interface:

CDTL and MOT “DNA”:
- Technology Foresight & Forecasting
- Strategic Technology Analysis
- Innovation Management
- Strategic Management of Technology
- Technological Leadership

Industry: Applied to technological work and marketplace

Science & Technology Policy/Gov’t & Business
- Management
- Marketing
- Accounting
- Finance
- Entrepreneurship
- Operations
- Economics

- Engineering
- Science
- Technology

IP Management & Protection

CDTL
Entrepreneurship

- Institute of Technology Founders 2005 Survey of alumni who have started businesses:
  - 15,000 alumni responded
  - 3,024 have founded one or more companies
  - 4,150 active companies, worldwide, employing 551,000, with annual revenue of $90B
  - 2,600 active companies in Minnesota, employing 175,000, with annual revenue of $46B
- Faculty also active in start-ups, often with former graduate students.
To unfold the full potential of social progress requires an integrated understanding of the many dimensions of social development, their underpinnings, and the role of science and technology.
Technology as a Hinge

• In the past, we have been unable to account for all areas on the interlocking fan

• Decisions have been made with incomplete information

• New technologies now permit us to identify forcing functions, critical junctures, and pinch points

• Goal: To target our constrained development resources to maximize benefit and minimize unintended consequences
Contrasting Stories of Development

1) Southern Coast of Taiwan: An example.

2) Advanced Industrial Societies.

3) Mali: Another example
   - “Industrial Cuisinart”
   - Grind grain, husk rice, saw wood, pump water, charge batteries
   - Female literacy up -- due to more free time & the need to account for operation, earnings, salaries
   - Meal quality improved
   - Social shifts between men & women
Results of Uneven Distribution of Technology Benefits

In developing nations:
• Population dislocations
• Social upheaval
• Massive debt

In developed nations:
• Crumbling infrastructure
• Environmental pollution
• Unhealthy lifestyles

Observation: We don’t know the tipping point at which conflict over uneven distribution of resources will impact developed nations on a large scale.
Global Transition Dynamics

• The **aim** is to produce an aggregation of the real time interaction of worldwide activities in technology, health, society, ecology, and economics.

• The **concept** is an outgrowth of past efforts of Drs. Starr and Amin to include large system risk analysis into national decision-making.

• The **product** would be an area-specific-probabilistic-vision of alternative key development decisions in each country, including pinch points, and forcing functions and their future consequences.
LEADERSHIP REPORT CARD

- Strategic customer relationships
- Technological health
- Market position
- Global culture
- Process disciplines
- Constant innovation
- Knowledge management systems
In the new normal... growth & sustainable advantage will belong to those who are focused on-

– Accelerating the velocity and relevance of information

• Copyright 1999-2006, M. Wright
SWOT Analysis:
Global Opportunities for Your Organization

Strengths       Weaknesses

Internal
Opportunities   Threats

External
# Short-term Moves

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Who</th>
<th>What and When</th>
<th>How</th>
<th>Cost</th>
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# Long-term Moves

<table>
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Technology is empowered by people:
Technology requires human skills, discipline and creativity to make it worth something
Discussion and the Road Ahead:

• What are the key issues facing increased opportunities and collaborations bridging China with MN, our nation and the world?
  – What is your vision for the future—what will it look like or how will it perform in 2010-2025?
  – What are the difficult challenges to overcome to achieve your vision?
  – What enabling technologies and policies are needed to address these?
  – What critical issues should we consider in beginning plans for 2010 and beyond?
Thank you. May others benefit from your lead.