

The Knowledge Workforce in the Global Economy: Some Thoughts*

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Shenzhen 1985, 1995, 2004

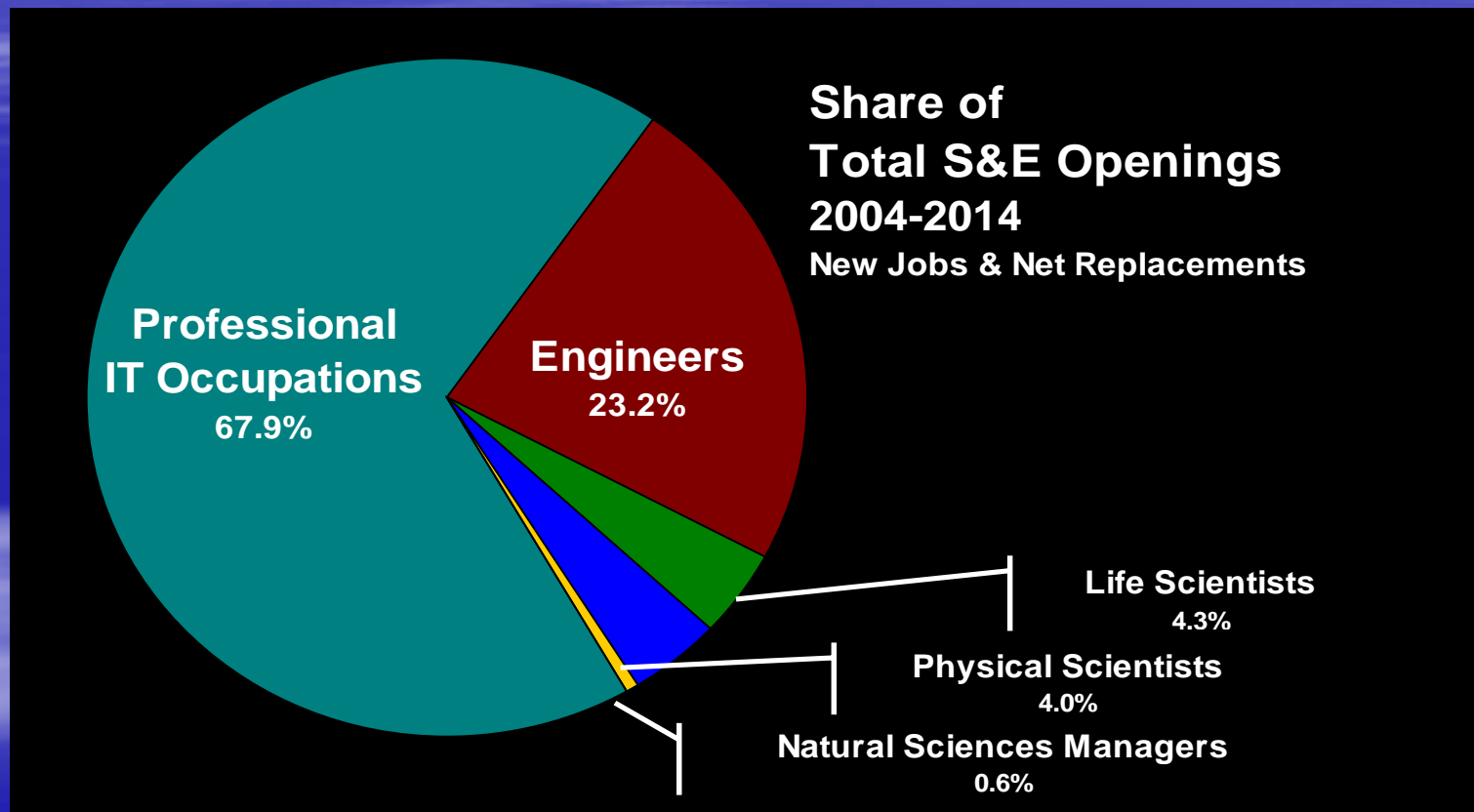


Kun Chen 2004

Outline

- **Is the Location of Jobs Threatened**
 - **Engineering Graduates Debate**
- **Patenting**
- **Where is R&D being done?**
- **The Engineering Graduates Debate!?**
- **China**
- **India**
- **Biopharma**
- **Concluding Thoughts**

New Jobs and Net Replacements, 2004-2014



Source: BLS slide by John Sargent, Senior Policy Analyst, Technology Administration, U.S. Department of Commerce 2007

Is the Location of Jobs Changing: A Sampler?

- Blinder (2007) suggests that up to 20 million jobs may be relocatable
 - Explicitly recognizes this will include college-educated S&T workers
- MGI (2005) potentially offshoreable by 2008 (eight industries)
 - IT services:
 - 44% % of all jobs in IT services, 47-56% of software and hardware engineers and associated middle-level managers, 45-55% of analysts working on software/IT architecture or market research
 - Software:
 - 60-78 % of the professional engineers and associated middle-level managers
 - Automotive Design:
 - 44 to 45 % of the R&D workers and engineers
 - Retail:
 - 3.2% entire sector
 - **34% of all jobs in online retail!**
 - 54% of engineers

Is the Location of Jobs Changing: A Sampler?

- Mowery and Macher (2007) edited book on eight industries examining the location of “inventive” activity find from patent analysis little threat in most sectors
 - In IC design, Mowery et al see little immediate threat of advanced R&D. My caveat: the Indian entrance is less than five years old.
 - Sasken, an Indian IC design firm, employs +2,000 doing outsourced IC design work
 - Wipro has in excess of 2,000 persons in its contract IC design section
 - Intel, Broadcom, Qualcomm, Motorola, and TI have IC engineers in India (and, to a lesser degree, China, Russia etc.)
 - In SW R&D, Arora et al. see little immediate threat largely on basis of SW patent analysis. My caveat: R&D labs being built in various low income nations **AND** much of what is being done is software development not R&D – but this requires university-educated persons
- Lynn and Salzman (2007) case studies of US offshoring
 - In a few cases, since all the new hiring is in India the Indian engineers are using the newest SW programs, while U.S. engineers are doing legacy work. This is “routine” work not R&D.

Is the Location of Jobs Changing: A Sampler?

- Levy and Goelman (2006) suggest that radiology not likely to be moved in large numbers
 - Micro case study showing how legal and other obstacles can have powerful effect inhibiting transfer
 - The fascinating case of telemedicine

Engineering Graduates Debate!?

Whose Numbers Are Right?

- Varying estimates of the number of S&E graduates
 - Gereffi and Wadhwa (2005) estimate that in 2004
 - China graduated about 350,000 engineers and 290,000 with 3-year
 - United States graduated about 140,000 and 85,000 with 2- or 3-year
 - India graduated about 112,000 and 103,000 with 3-year*
 - Massive training programs take non-engineering grads and convert them to programmers

My guess:

- Neither India or China will run out of individuals that can do engineering and managerial work
- Quality may be an issue, but much of the work will need not the very highest quality, but say they are 80% as good.

Further, they will get experience.

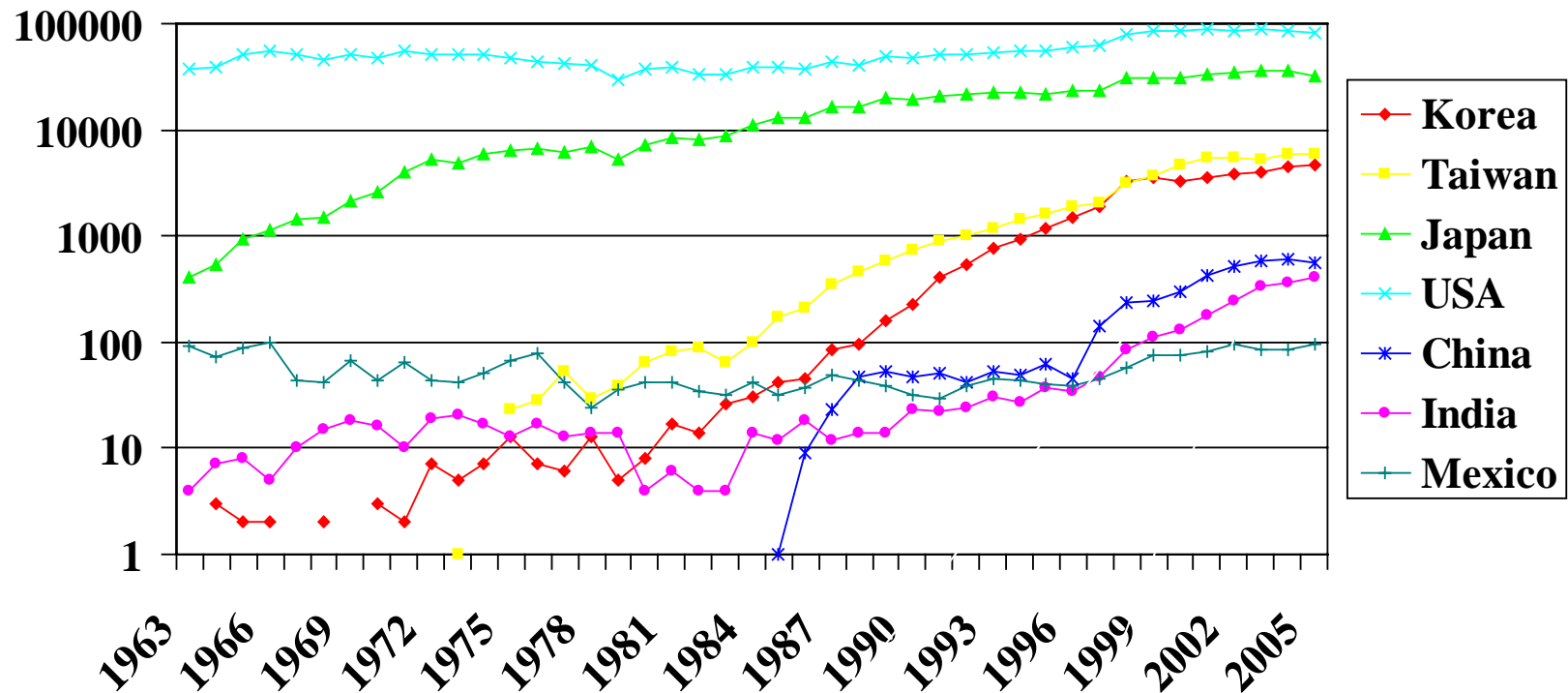
There is controversy regarding the 3-year degrees in India as apparently they have not been offered since the early 1990s.

Is the Engineering Debate the
Right One or Is It Much Broader?

Offshoring Will Affect Other
College Educated Workers, Also

Patenting

USPTO Patenting by Year for Various Nations, 1963-2005



Compiled from US PTO by Martin Kenney

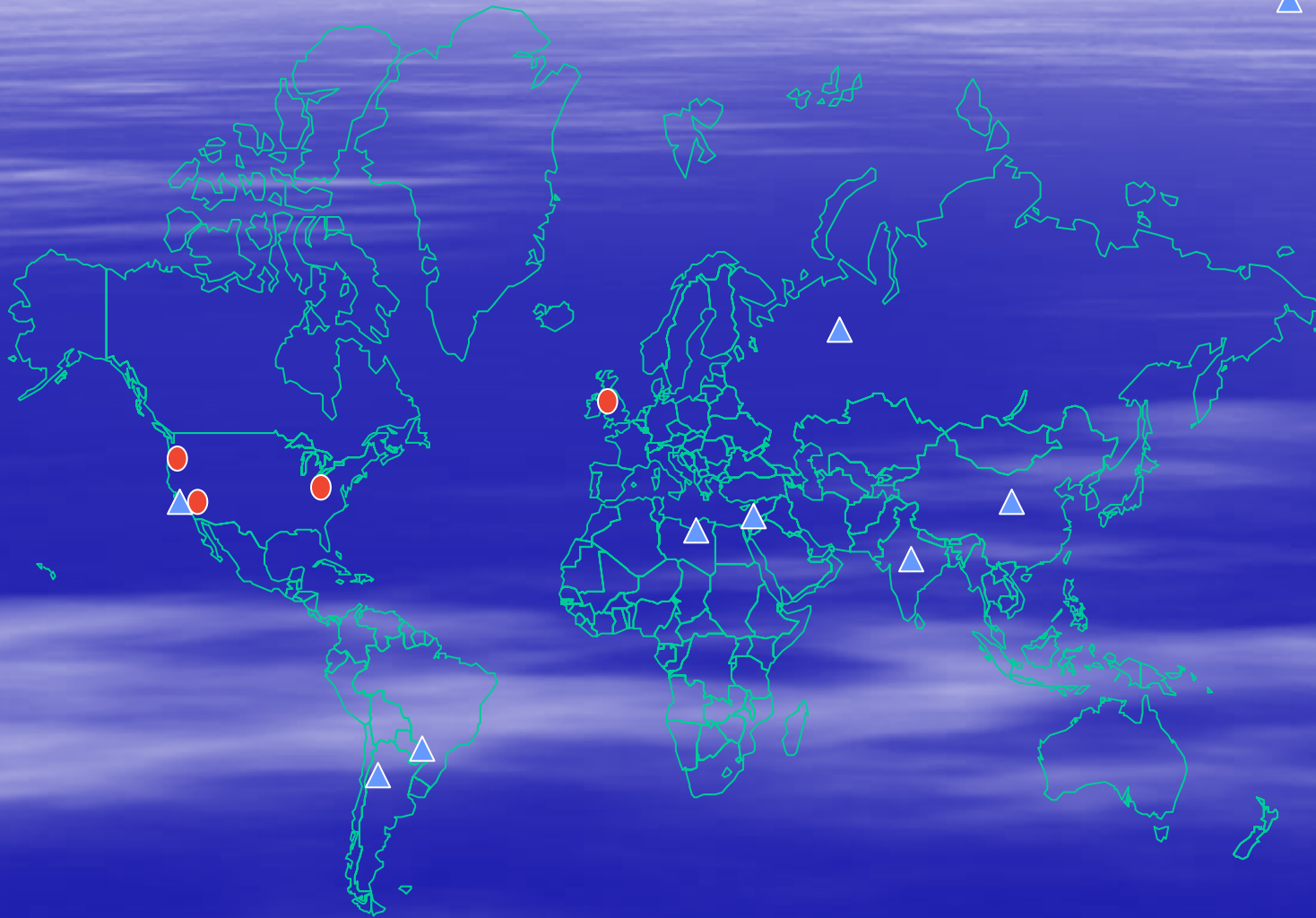
USPTO Patents per 10,000 Persons, 2004

- Taiwan -- 2.5835 (5,938)
- Korea -- .9145 (4,428)
- Japan -- 2.7436 (35,350)
- U.S. -- 2.850 (84,271)
- India -- .00336 (363)
- China -- .00457 (597)

Where Is R&D Being Done?

Intel's Global Research

- Research Labs
- ▲ Development centre



Google's Global Research

- **Google, U.S.**
 - Engineering and research centers in California, New York

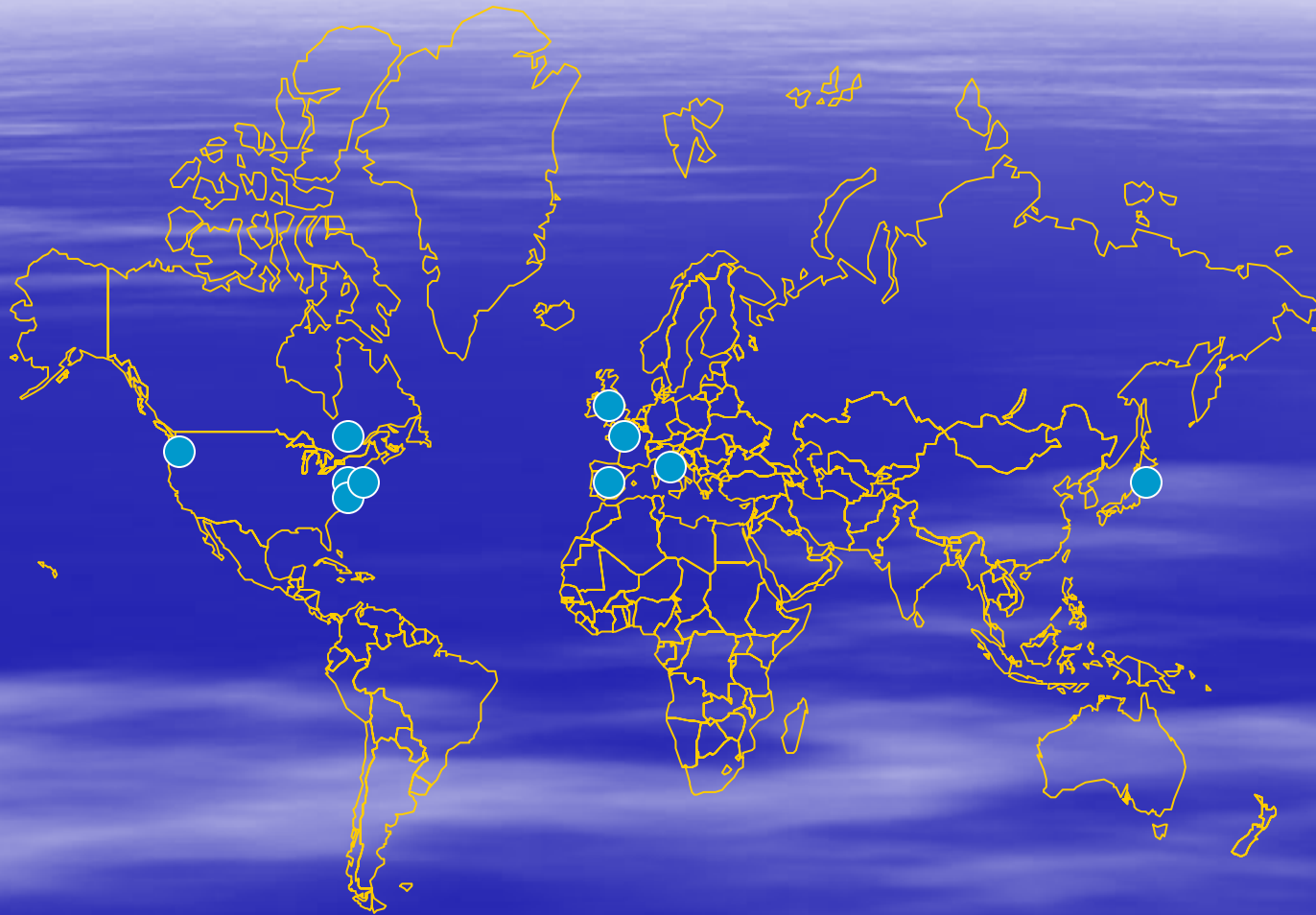
- **Google, Latam**
 - Planned setting of R&D centre in Brazil through acquisitions

- **Google, Europe/Middle East**
 - Located in Switzerland in 2004 to tap local talent
 - Planned R&D centre in Israel and Russia in 2006

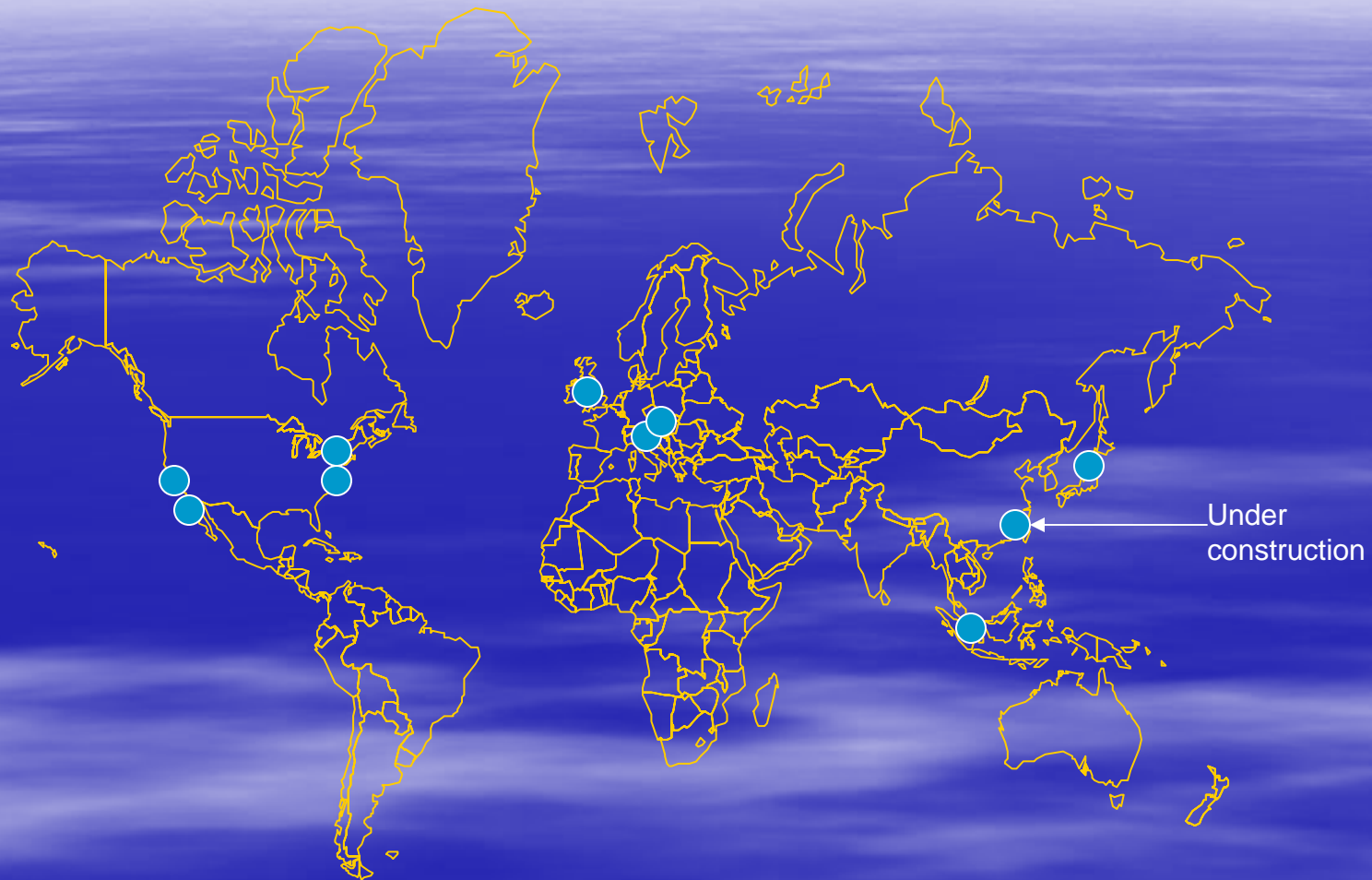
- **Google, Asia**
 - Set up first R&D centre outside US in India to take advantage of the Indian software talent in 2003
 - 2004 – centre located in Tokyo, Japan
 - In 2005, announced plans to set up a R&D centre in China followed by Korea

- **Google, Australia**
 - Planned opening of a R&D centre in 2006

Merck's Global Research



Novartis Global Research

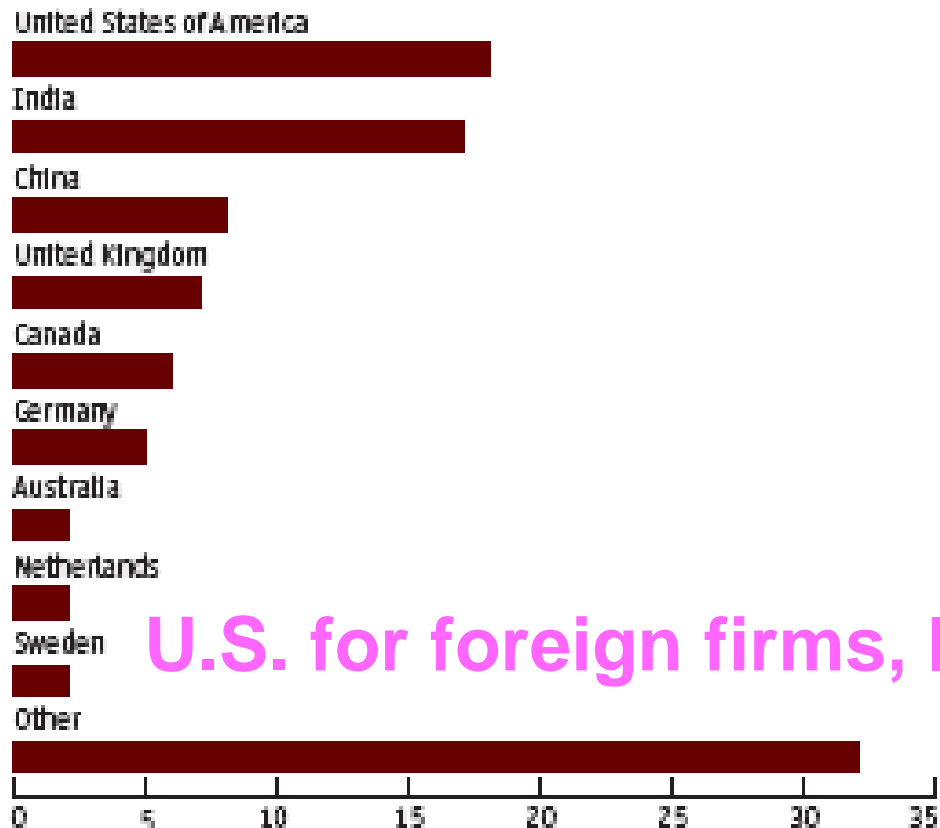


GE's Global Research Operation

- **1900 New York**
 - **1900 FTE's**
 - Undertakes research in all 10 technological platforms and all 6 business areas
 - In 2005, a \$100 million investment made in Nanotechnology and biosciences technologies
- **2000 Bangalore**
 - First and largest integrated, multidisciplinary R&D outside the U.S.
 - **275 FTEs in 2000; 2,200 FTEs in 2007**
 - Large modern infrastructure (50 acre campus)
 - Supports 6 of 10 global technologies and 3 of 6 businesses
 - Led by Guillermo Wille, senior scientist from GE U.S. who relocated to India
- **2000 Shanghai**
 - **150 FTEs**
 - 10 acre facility that currently supports 6 of 10 global technologies and 3 global businesses
 - Presence of global learning center signifies commitment to build local talent
 - Led by Bijan Dorri who relocated from GE U.S. to China
- **2004 Munich**
 - **150 FTEs**
 - Colocated on the Garching campus with University of Munich (4 labs)
 - Focus on 2 of 10 global technologies
 - Recently made additional investment of \$54 million to focus on advanced technologies

Where Highest Portion of R&D Budget Being Concentrated

In which country is the highest proportion of your overseas R&D budget currently concentrated?
(% respondents)



U.S. for foreign firms, India for U.S. firms

Source Economist Intelligence Unit 2007

300 executives interviewed in November 2006

http://a330.g.akamai.net/7/330/25828/20070323181759/graphics.eiu.com/files/ad_pdfs/eiu_IDA_INNOVATION_NETWORKS_WP.pdf

China

Chinese Challenge

- IT equipment manufacturing
- Enormous and growing domestic market for IT products
- Western VC flowing in
 - Some large multiple IPOs and M&A
- Chinese attempts to create global standards
- Massive increases in R&D investment by govt. and Chinese industry. MNCs ramping up R&D
 - How much is high-end R&D?
 - How much is localization work?
- Large # competent engineers

Chinese Tech Firms (Generalizations)

- With the possible exception of Huawei and Lenovo -- Technology is not yet global standard
 - Lately Chinese firms are losing in home market
- VC funded firms show little global-class tech
 - U.S. business model clones (good returns because MNCs need to purchase access)
 - Firms providing solutions for the underserved domestic market (not IT)
- Generally not competitive with India for IT services offshoring

India

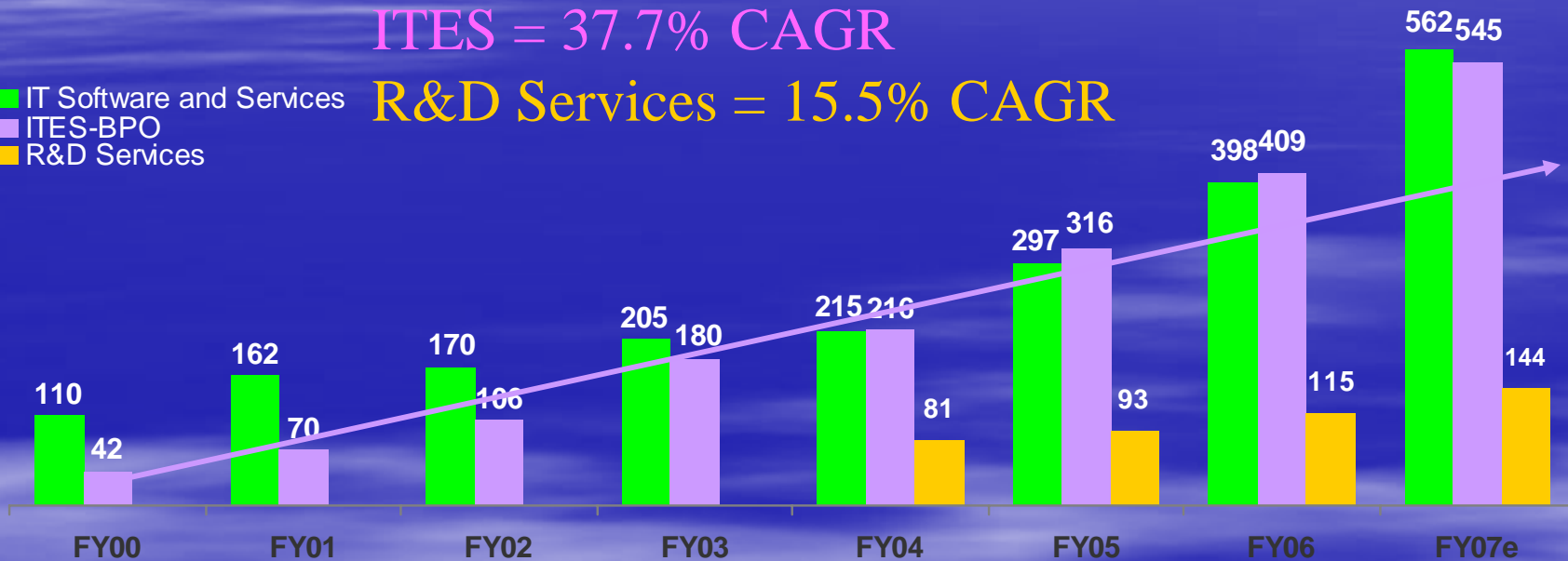
India IT-Related Employment Growth for Export, 99-00 to 06-07e

IT Software & Services = 22.6 CAGR

ITES = 37.7% CAGR

R&D Services = 15.5% CAGR

- IT Software and Services
- ITES-BPO
- R&D Services

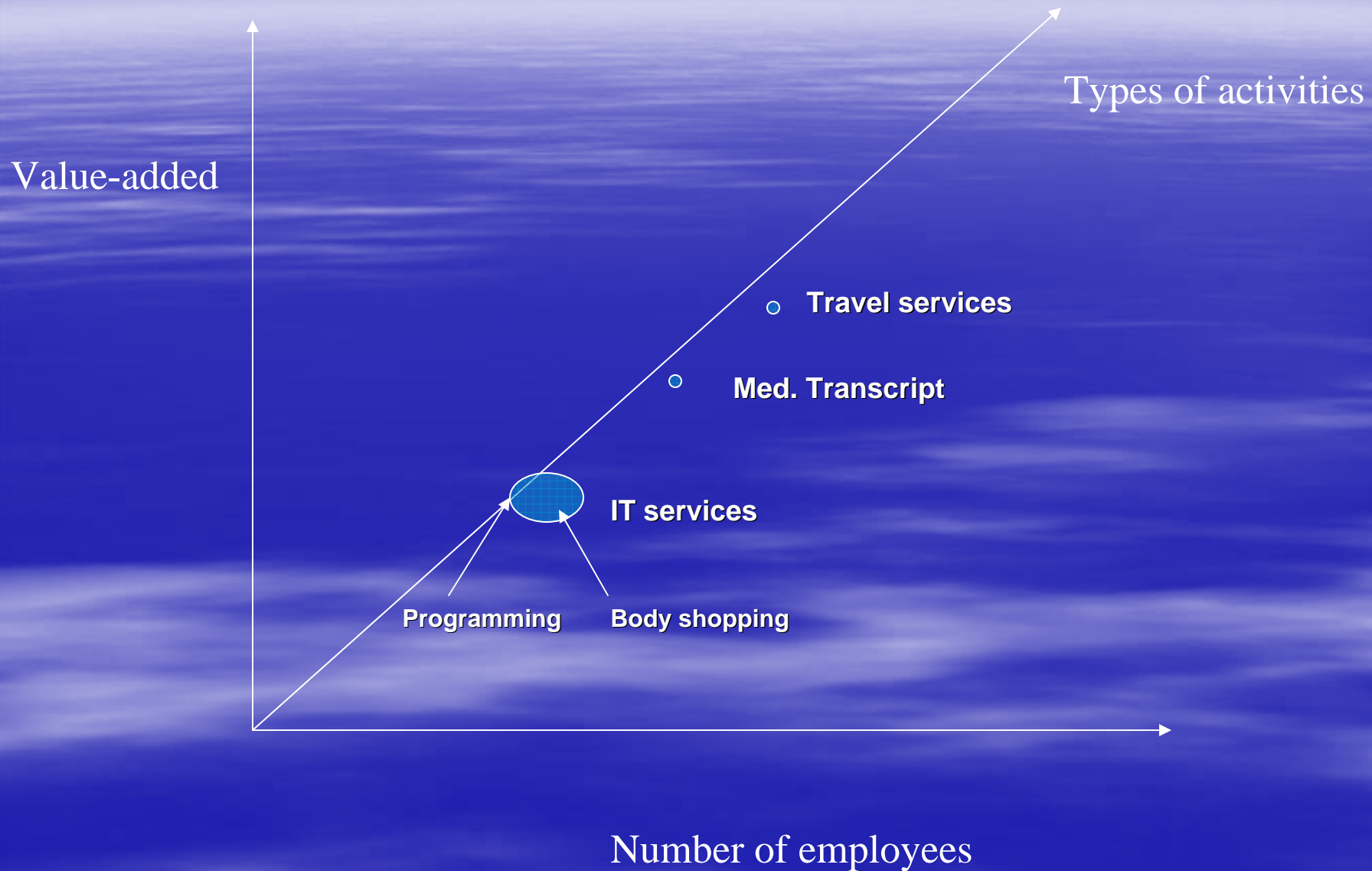


Source: NASSCOM 2007

Employee numbers '000s

US Work Force is ~145M, US IT Workforce is ~3M

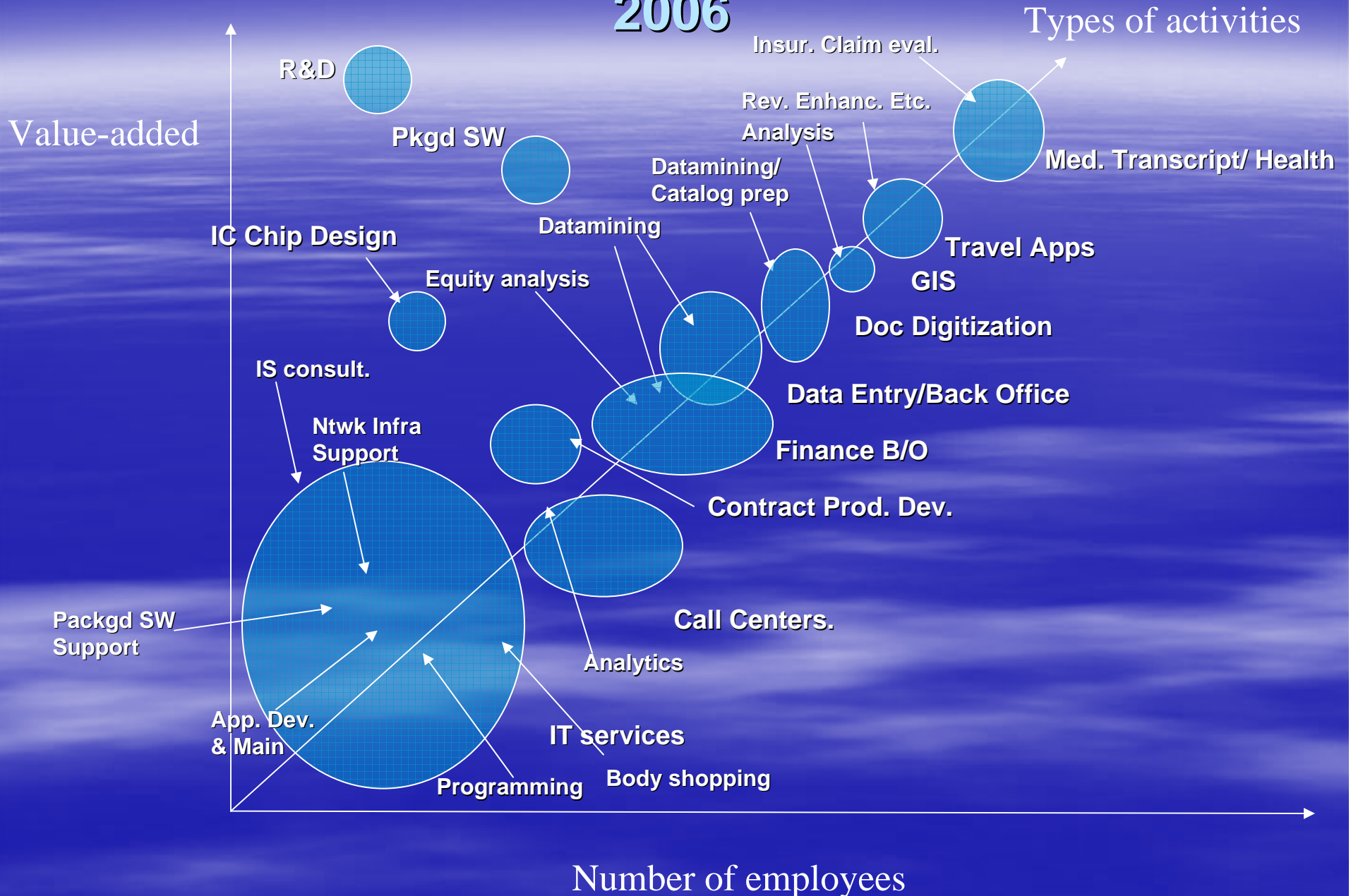
Stylized Representation of Indian Service Provision 1995



Source: Martin Kenney and Rafiq Dossani 2007

Stylized Representation of Indian Service Provision

2006



Source: Martin Kenney and Rafiq Dossani 2007

Employment in India by Selected Large Non-Indian Software and Software Services Firms

Firm	Date Established in India	Nationality	Employment in India (date)	Global Employment 2006	Percent Employed in India
Oracle	1994	U.S.	8,600 (2005)	41,658	20
Adobe	1997	U.S.	750 (2005)	5,879	13
IBM (1)	1992	U.S.	60,000 (2007)	369,277	18
SAP	1996	Germany	3,500 (2006)	38,802	9
Cap Gemini	2003	France	12,000 (2006)	75,000	16
Accenture		U.S.	35,000 (2007)	117,000	19
Veritas	2002	U.S.	900 (2004)	17,250	5
Microsoft	1998	U.S.	4,000 (2006)	57,000	7
EDS (2)	1996	U.S.	45,000 (2007)	117,000	>38

1. Reentered India 1992 for domestic market

2. In 1996 served GM India from India

Source: Compiled by authors from various news reports and corporate Securities and Exchange Commission filings.

A 2007 Job at Intel India (abbreviated)

- Description
- In this position, you will be a System Validation Engineer in CPU System Validation group within Platform Validation and Enabling (PVE) organization in Bangalore. Your responsibilities will include but not be limited to:
 - Designing, developing, interfacing with other groups within Intel
 - Acting as a member of Emulation and/or Debug Tools development team and working with other groups such as processor design and architecture teams, SV test development and execution team, and BIOS teams to help successful launch of new products for DEG. The primary languages will be Assembly, C/C++, TCL / Perl scripting
 - Becoming very familiar with the custom SV environment as well as familiar with the low level interfaces
 - Your contributions will directly help ensure the successful build and launch of new processors on Intel Architecture within DEG
- Qualifications
- You should possess a Bachelor or a Master of Science degree in Computer Science or Computer Engineering with work experience of two to six years in large projects and customer interaction. Additional qualifications include:
 - Experience with synthesis for emulation, register-transfer level (RTL) coding for synthesizability, remodeling of embedded blocks' RTL for compliance with emulation guidelines including their verification using simulation, and providing in-circuit support to emulation customers
 - Experience with processor based emulation like Cadence* Palladium*
 - Worked with industry standard synthesis tools like synopsys*
 - Fluency and experience with the Assembly, C and C++, Perl / TCL programming languages
 - Well-developed problem solving and communication skills (both verbal and written) as well as solid teamwork and organizational skills
 - Ability to interface with design team to study and/or define architecture and define emulation strategies
 - Knowledge of verilog* and/or VHDL

**What this means is harder to say.
Moved from U.S. or add-on?**

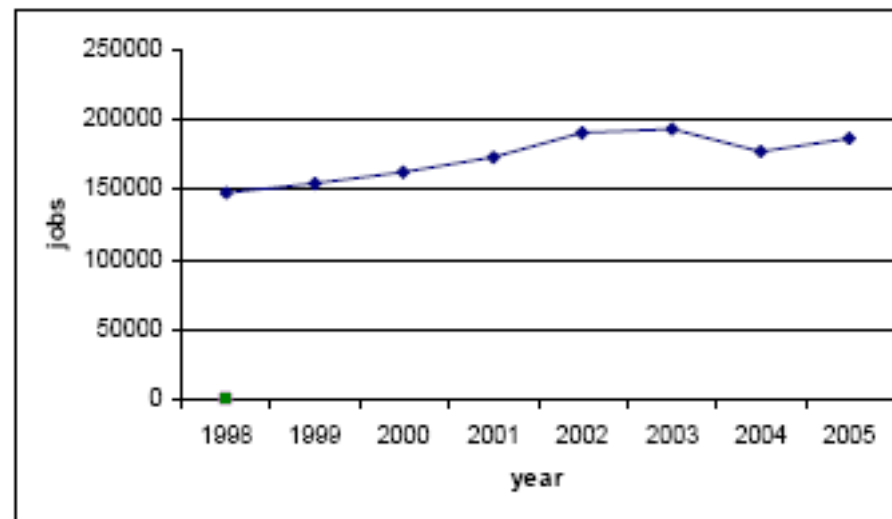
Biopharma Globalization

Generalizations: Bio/Pharma

- Developed nations especially U.S. continue to have a strong advantage based on:
 - Government funded R&D
 - Top class universities/med schools
 - Huge markets
 - Apparently sticky know how
- Employment growth likely to be limited, though it will be high value-added
- The portions of the value chain most likely to be offshored are
 - Clinical trials
 - Trial data analysis
 - Limited amounts of R&D (with great care because IP is so important)

Biotechnology -- Repeating Fiona's Point

Finally, when unpacking the globalization of biotechnology, it becomes apparent that this is ***NOT*** a regional jobs strategy



However, compensation per employee is very high (> \$70K)

Concluding Thoughts

Conclusions on Offshoring

- The growth of services offshoring has been rapid
 - Most statistics used by economists are rearview mirror
 - U.S. govt statistics on services offshoring of little value (GAO reports)
- Offshoring of knowledge workers will be significant
- Many IT, finance, retail and other MNCs already have significant headcount abroad (esp India)
 - Investments are enormous, no turning back and managers will have to solve problems
- Cannot depend on large “U.S.” MNCs to have the much concern about U.S. employment. Shareholders are only stakeholders
- New markets emerging abroad, but might be slower than downsizing here
 - Expect massive downsizing at IBM, EDS, and Accenture
- Naïve to expect overseas labor costs to increase quickly enough to stanch offshoring

Some Reasons for Concern

- U.S. government policies
 - Drying up free flow of information due to real or imagined terrorism threats
 - Budget deficits that will have to be brought into line at cost to what programs?
 - No talk about education or academic attainment
- Income distribution
 - Transitional (permanent?) losers
 - Will do little about this problem
- Less open society
- New startups doing less of their growth in U.S.

BOTTOMLINE: Good things can be swallowed up by larger developments such as endless wars

Our wealth and much engineering talent being wasted on wars

Reasons for Optimism

- Entrepreneurial society
 - Innovation somewhere else does not mean innovation can't happen here
 - Software and IT are not stagnating
 - So many new and exciting things still to do
 - Mashups
 - Open source
 - Ad infinitum
 - **Biopharma** is likely to only slowly offshore
 - Still the most innovative startups in the world are being established and funded in the U.S. especially CA and MA
 - Flexible labor and financial markets, cutting edge consumers
 - Great universities creating new knowledge and grads
 - We are capable of reacting quickly, if vision is articulated
- Bottomline: Still enormous strengths and capabilities**

Suggestions for Tomorrow's Knowledge Worker

- Education is the key. Can't compete with know-nothings (even in-person services)
- World is becoming more IT intensive, many opportunities for those who can identify and solve problems and create new value
 - More IT training in pre-college. Like high school shop in my era.
- Creativity, entrepreneurship etc. to be encouraged
- All university students should be required to have at a minimum, one quarter abroad.
- Teach Americans what quality is. Whole sectors of our country are a mediocre quality society
- There is little future for U.S. workers that cannot be knowledge workers (even in manufacturing)
 - They will require transfer payments or they will be relegated to poverty

Thank you!

A Few Readings

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