Presentation to NAE Offshoring of Engineering Workshop

Thoughts on Software-Related Offshoring

Dr. Alfred Z. Spector

Member, NAE, and Independent Consultant

Note: The views herein are my own and not necessarily those of the NAE or former employers.

24 October 2006

Introduction

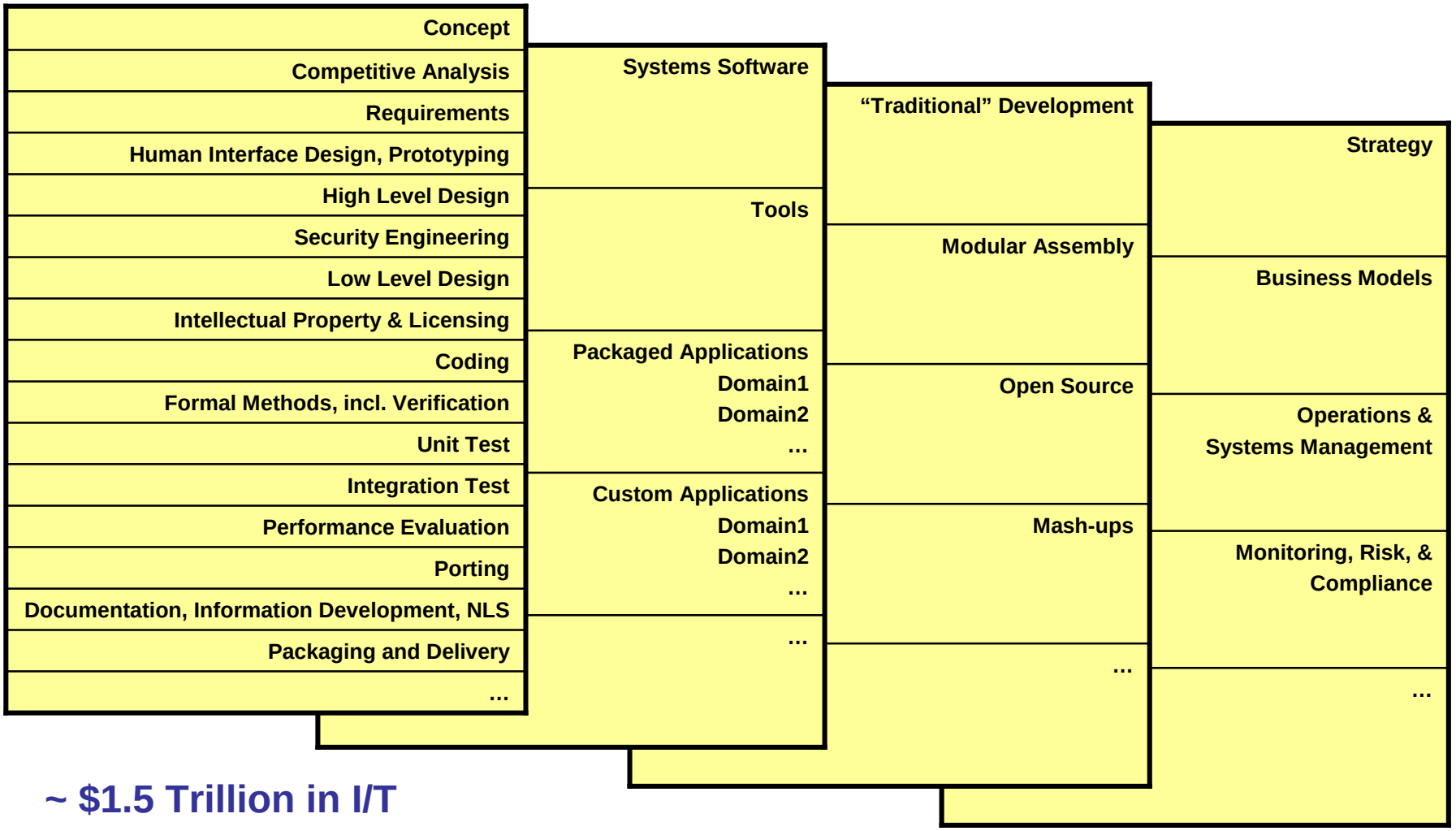
- **Scoping of the talk**
- **4 Facts**
- **Corroborating Experience at IBM**
- **Implications**
- **Conclusions**

Personal Experience

- **Summer of 1973: Programming job working on PPL Language**
  - Between my 1st and 2nd year at Harvard College, Circa 5AM
  - I was in the Aiken Computation Laboratory machine room and the sole user of the Harvard PDP-10
  - The PDP-10:
    - ~400,000 instructions per second
    - Under ½ megabyte memory, a few megabytes of disk storage, DECtapes
    - Networked with a few other computers via ARPANET, the Internet's predecessor
    - Circa $2,000,000 (in 2006 dollars)
- **At the time I was pondering career choices:**
  - Computer Science vs. Economics/Journalism
  - *I explicitly remember thinking that early morning that C.S. had enormous comparative advantage for me, due to unique technology availability in the U.S. and a small number of places like Harvard.*
- **Today**
  - Personal or game computers: 4-5 orders of magnitude faster processors, 3-4 orders of magnitude more memory & storage, networked to 6-7 orders of magnitude more other systems, 4 orders of magnitude less money, & ~4 orders of magnitude more quantity
  - Growth in social networking technologies likely to have additional impacts

Message 1 - Global leveling of opportunity in Software.

Software and I/T: A Very Diverse Field of Endeavor



~ $1.5 Trillion in I/T

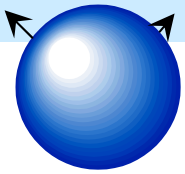
Message 2 – Great variability in objectives, job types, and practices.

Software – Unbounded Opportunities

- **Software is at its core a synthetic discipline with operational aspects surrounding it:**
  - Software is an expression of logic
  - The logic can encode virtually anything
- **Hence, virtually no limit on what we can create: the target domain is entirety of all human endeavor and mechanical activity**
  - Considerably broader domain than most engineering fields
  - E.g. Even in traditional spaces, the backlog of projects & requirements to fulfill, is very large
  - E.g., Plethora of contemplated uses seem to inexorably become feasible
- **Computing, Storage and Networking:**
  - Plenty of capability today
  - Capability will continue to improve geometrically
- **Limiting factors to growth rates:**
  - Design and engineering costs
  - (Not marginal cost of production)
  - Management/Operation Costs
  - Innovation

Message 3 – High Elasticity (Price and Innovation) of Demand.

Software – The Expanding Field



- In 10/04, I presented "Research on the Edge of the Expanding Sphere" at Harvard
  - Traditionally, Computer Science scope was modest; e.g., the late 70's Stanford core:
    - Algorithms, Complexity, Software & Systems, A.I.. Numerical Methods, Architecture
  - The field's has grown rapidly in two ways:
    - Density in the core, or sphere
    - Size of the sphere

Growth in the sphere (density)

- Processor architecture & Exploitation of Parellism
- Distributed systems
- Graphics
- Information retrieval
- NLP & Voice processing
- Networking
- Numerical methods
- Operating Systems
- Programming languages
- Trust, Security, Malleability

Growth in domains of application

- Art
- Bio- and Medical informatics
- Business process modeling and integration
- Computer-mediated human collaboration & Social networking
- Entertainment/gaming
- Robotics
- Sensor networks; e.g., Empirical Science
- Societal infrastructure
- Transportation and Telematics
- …

- Immense opportunity for innovation occur in both domains.
- Not due to any plateauing of the traditional, new spaces are likely to generate greater growth.

Message 4 – $\forall X_i$ (CS + X_i) will be very important, indeed central to the future.

Corroborating Experience from My Time at IBM

- **Software Group**
  - IBM Software has more than 20,000 developers worldwide
  - IBM Software has had labs worldwide for decades
    - By population, ~2/3rds domestic development. Trad. non-U.S labs: Canada, Engl., Germany, Japan
    - IBM Growth in India
      - Samuel Palmisano, IBM's CEO reported in 6/06: 43,000 / 340,000 IBM employees in India, 1,400 developers in IBM Software
    - Somewhat larger IBM Software employment in China
  - Factors influencing globalization
    - Talent and experience/maturity
    - Organizational capability including managerial/technical leadership
    - Diversity of activities and implications on location
    - Cost of labor
    - Example effort:
      - A somewhat repetitive, but high skill, high profile effort, moved to India
      - IBM had a new product mission for original team
      - Result cannot be predicted but expectation is rev. growth w/more employment in both countries.
    - *My biggest worry was about leadership*
- **Research Division**
  - Research labs 8 labs (depending on how you count): 2/3rd in U.S., 1/3rd outside
    - Traditional external labs Zurich, Tokyo, Haifa
    - Rapid growth in India and China, but still modest numbers.
  - By population, research is ~2/3rd in U.S., 1/3rd outside
  - Similar issues with heavy emphasis on need for perspective and all aspects of leadership

Implications

- **4 Facts:**
  1. Global leveling of opportunity in software
  2. Great variability in objectives, job types, and practices
  3. High elasticity (price and innovation) of demand
  4. $\forall X_i$ (CS + X_i) will be very important, indeed central to the future
- **Implications (my views)**
  - Great elasticity ensures there is vast opportunity (3)
    - There is sufficient benefits to technology to provide employment to many populations with no obvious limit
  - Variability in the field (2) makes it easier for some populations to have comparative advantage: that is, to excel at certain jobs
    - Opportunities for differentiation include: talent, experience, capitalization, location, trust, risk, etc.
    - Applications of CS to other fields and vice-versa will play an increasing role in opportunities for differentiated innovation (4)
  - Ability to lead in I/T and its applications is important for our broader economy (4)
  - Levelling means Americans cannot take software leadership for granted (1)

Musings on Impact of Offshoring

- **Scenario 1:**
  - Certain activities (e.g., testing, integration testing, etc.) become much less expensive due to offshoring, good proceduralization, etc.
  - Elasticity of demand is high and U.S. talent available
  - Will not freed up dollars and talent be used for high value activities that grow overall output and employment?
- **Scenario 2:**
  - Even if employment in certain sub-disciplines slowly migrates offshore will not the field continue to change fast enough to generate new sub-disciplines or “super-disciplines”?
- **Scenario 3:**
  - Certain activities move offshore
  - The student population takes this to mean that opportunity is drying up
  - Gradually, U.S. talent dries up.
  - While there may be elasticity of demand, we will be able capitalize on it?

My Conclusions

- **Given that software is central to societal, government, business innovation**
  - Education
  - Efficient and responsive government
  - Business creativity and efficiency

    IT is a crucial fulcrum for American prosperity
- **Hence, leadership in software-related innovation is necessary**
  - Software leadership doesn't require dominating all elements of software
  - Software leadership is not incompatible with significant offshoring
  - However, U.S. should aim for significant areas of differentiated value
- **To this end, we must foster and attend to our workforce: Three topics come to mind:**
  - Both deep and interdisciplinary education
  - Immigration
  - Economic incentive must remain