The Role of IT in Enterprise Transformation

Presented by
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Massachusetts Institute of Technology
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Today

• A brief history of Computing
• Deciphering the Alphabet Soup
• Strategic Frontiers
  • Information Systems
  • Enterprise Architecture
  • Software Development
That’s a Computer?
Now that’s a Computer!

- 1945 - 1955
  - vacuum tubes, plug boards
- ENIAC
Historically Interesting Quotes

"This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us."
Western Union internal memo, 1876.

"Computers in the future may weigh no more than 1.5 tons."
Popular Mechanics, forecasting the relentless march of science, 1949

"I think there is a world market for maybe five computers."
Thomas Watson, chairman of IBM, 1943

"I have travelled the length and breadth of this country and talked with the best people, and I can assure you that data processing is a fad that won't last out the year."
The editor in charge of business books for Prentice Hall, 1957

"But what ... is it good for?"
Engineer at the Advanced Computing Systems Division of IBM, 1968, commenting on the microchip.

"There is no reason anyone would want a computer in their home."
Ken Olson, president, chairman and founder of Digital Equipment Corp., 1977
Moore’s Law In Action

Hardware Costs

Software Costs

Service Costs

1970

2000
Toffler’s Three Waves of Change

• Agriculture
• Industrial
• Information

“In 'The Third Wave' we wrote about the so-called commanding heights of industry, and that was the slogan of the Labor Party in Britain at the end of the war. 'We must capture the commanding heights.' Well the commanding heights they captured are no longer the commanding heights of industry, they were yesterday's commanding heights. The new commanding heights are knowledge-based, and that's why you see companies like Microsoft suddenly emerge out of nowhere and become huge” – Alvin Toffler*

*http://iranscope.ghandchi.com/Anthology/Alvin_Toffler98.htm
Layers of Transformation

Discussion: Where are we Today?

Degree of business transformation

High

1. Localised exploitation
2. Internal integration
3. Business process redesign
4. Business network redesign
5. Business scope redefinition

Low

Evolutionary levels

Efficiency
- Automate

Revolutionary levels

Effectiveness
- Informate

New business
- Transformate

Range of potential benefits

Low

(Source: MIT90s)
Emergence of a complex networked enterprise

Small, local enterprises  Centralized hierarchical enterprises  Complex Networked Enterprises

1900  1950  2000

Source: Thomas W. Malone, “Inventing the Organizations of the New Economy,” Presentation at the Lean Aerospace Initiative Plenary Conference (March 2001)

web.mit.edu/lean

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Deciphering the Alphabet Soup

• **IT** - structurally and operationally enable and facilitate information systems

• **ITC** - structurally and operationally enable and facilitate information systems AND communication

• **IS** - An organized combination of people, physical devices, information processing instructions, communications channels, and stored data that gathers, stores, uses and disseminates information in an organization
The Pooh Analogy

Here is Edward Bear, coming downstairs now, bump, bump, bump, on the back of his head, behind Christopher Robin. It is, as far as he knows, the only way of coming downstairs, but sometimes he feels that there really is another way, if only he could stop bumping for a moment and think of it. - Winnie-the-Pooh, A.A. Milne, 1926

Opinion Poll: How many people here feel that way?
Components of an Information System

- Data
- Hardware
- Software
- Telecom
- People

Information System
Evolution of IS

Inward Focus

• Operations Support Systems
  • TPS – Transaction Processing Systems
  • PCS – Process Control Systems

• Management Support Systems
  • MIS - Management Information Systems
  • DSS - Decision Support Systems
  • EIS - Executive Information Systems

Outward Focus

• EWSMS - Enterprise Wide Strategic Management Systems
The IS Timeline

<table>
<thead>
<tr>
<th>Era</th>
<th>Characteristics</th>
<th>When?</th>
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| Data Processing (DP)                     | **Operational control systems**  
Transaction processing                                                               | 1960’s → |
| Management Information Systems (MIS)     | **Control & planning systems**  
Problem solving and decision support                                                 | 1970’s → |
| Strategic Information Systems (SIS)      | **Systems critical to business operations & competitive advantage**             | 1980’s → |
| Enterprise Wide Strategic Management Systems (EW-SMS) | **IT/IS embedded in the organization**  
**Inseparable from enterprise**  
**Delivers sustainable competitive advantage**                                    | Now? → |

*Adapted from Ward & Peppard, Strategig Planning for Information Systems, John Wiley & Sons 2002*
Current State Assessment

Source: Gregoire Ferre, “IT Management In the Aerospace Industry”, SM Thesis, MIT 2004

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Top 3 Risks in IS Implementation

• Lack of top management commitment to the program
• Misunderstanding the requirements
• Failure to gain user commitment

“Like other chief executives, I feel I'm being blackmailed. Not just by the suppliers, I expect that. But by my own IT staff who never stop telling me what the competition are spending ...”


DISCUSSION: How do we get top management commitment?
IT Governance Archetypes

- Business Monarchy
- IT Monarchy
- Feudal
- Federal
- Duopoly
- Anarchy

DISCUSSION: What really Works and Why?
# Research Findings

## Decision Making

<table>
<thead>
<tr>
<th>Decision</th>
<th>IT Principles</th>
<th>IT Architecture</th>
<th>IT Infrastructure</th>
<th>Business App Needs</th>
<th>IT Investments</th>
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<tr>
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<td>3</td>
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<tr>
<td>Feudal</td>
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<td>Duopoly</td>
<td>2</td>
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</table>

## Input Provision

<table>
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<th>IT Principles</th>
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<td>4</td>
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<td>1</td>
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</table>

- Most preferred pattern within the aerospace segment
- Second most preferred pattern within the aerospace segment
- Most preferred pattern according to surveys analyzed by CISR
- Number of Aerospace Industry companies identified with such a pattern

Source: Gregoire Ferre, “IT Management In the Aerospace Industry”, SM Thesis, MIT 2004
Misunderstanding Requirements

• Technology push versus Strategic Pull

• Lack of internal capability

• Immature system design and development processes

DISCUSSION: How do we get it right?
Technology Push

DEPLOYMENT
Input

ICT Systems
computation inputs
organizational inputs

UTILIZATION
Processing

Human & Machine Intelligence
Mechanistic Information Processing

Data, Information, Models, Rules
Best Practices, Rules, Procedures

Predefined meanings & Action(s)
pre-programmed & controlled

PERFORMANCE
Outcome

Business Environment
Pre-specified Outcomes


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DISCUSSION: How do we get user commitment?

- Parallel
- Direct
- Phased
- Pilot
The Successful CIO

- Attributes of a successful CIO
  - Versatility
  - Vision
  - Quickness
  - Tenacity

- Multi-dimensional
  - A technology champion
  - A business strategist
  - A technologist
  - A leader
  - An integrator
  - A friend to all …
IT View: Enterprise Architecture

- Data-Centric
- Process-Centric
- Secure
- Light-weight/Open
- Pervasive
- Service Oriented
- Needs-based
Enterprise Architecture

“... the set of descriptive representations (i.e. models) that are relevant for describing an Enterprise such that it can be produced to management's requirements (quality) and maintained over the period of its useful life (changed)” - John Zachmann

“an enterprise-wide architecture that captures common architectural decisions that are common and enforced across all applications and data centers within an enterprise” – Open Process Framework

DISCUSSION: What does an Enterprise Architecture Mean?
EA Usage

• Managing the complexity of the enterprise

• Enable better decision making

• Enable better budget prioritization

• Manage change through roadmap creation and monitoring

• IT focused
FEA: Federal Enterprise Architecture

- The Federal Enterprise Architecture (FEA) is a function-driven framework for describing the business operations of the Federal Government independent of the Agencies that perform them.

- The Federal Enterprise Application Framework (FEAF), V1.1 provides various approaches, models, and definitions for communicating the overall organization and relationships of architecture components required for developing and maintaining the FEA.

Source: E-Gov Enterprise Architecture Guidance, FEA Working Group
FEAF Overview

Business Architecture
- Business Reference Model

Data Architecture

Applications Architecture
- Conceptual/Process Model
- Interoperability Model

Technology Architecture
- Technical Models
- Technical Reference Model
- Standards
FEAF Architecture Principles

• Establish Federal interoperability standards
• Coordinate technology investments with the Federal business and architecture
• Minimize the data collection burden
• Secure Federal information against unauthorized access
• Take advantage of standardization based on common functions and customers
• Provide access to information
• Select and implement proven market technologies
• Comply with the Privacy Act of 1974.
DISCUSSION: Who Drives the Creation and Management of the Enterprise Architecture?

DISCUSSION: What are the Guiding Principles for Aerospace?

DISCUSSION: Should it remain an IT Issue?

DISCUSSION: Who should maintain it?
“Wicked problems are problems that are fully understood only after they are solved the first time.”

- Rittel and Webber, Dilemmas in a general theory of planning, 1983

Software is a wicked problem...


http://www.cnn.com/WORLD/9606/04/rocket.explode/
Motivation

- Software is one of the key determinants of mission capability
- Used as a universal integrator
- Significant gaps between identified problems and corrective action
- CMM good but not sufficient

“Provide an effective framework for managing the acquisition of large-scale software development and maintenance programs that are an essential part of our increasingly complex weapon systems.” — Jennifer Jones
Software Acquisition Guidelines

DoD 5000.1 recognizes that software is a critical element in DoD systems. It states that *it is critical that software developers have:*

- A successful past performance record,
- Experience in the software domain or product line,
- A mature software development process, and
- Evidence of use and adequate training in software methodologies, tools, and environments.
Technical vs. Managerial Complexity

Higher technical complexity
- Embedded, real-time, distributed, fault-tolerant -
- Custom, unprecedented, architecture reengineering -
- High performance -

Lower technical complexity
- Mostly 4GL, or component-based -
- Application reengineering -
- Interactive performance -

Higher management complexity
- Large scale -
- Contractual -
- Many stakeholders -
- "Projects" -

Lower management complexity
- Small scale -
- Informal -
- Single stakeholder -
- "Products" -

SOURCE: RATIONAL.COM HTTP://WWW.RATIONAL.COM/PRODUCTS/WHITEPAPERS/390.JSP
Issues in Software Acquisition

• Ability of the program to establish and adhere to processes to meet program needs
• Requirements management
• Organization management
Software Development Trends

• Flexible

• Open Source

• COTS
DISCUSSION: Does process maturity matter?

DISCUSSION: Does the COTS Mandate help?

DISCUSSION: How do we handle rapid upgrade requirements while meeting -ilities?

DISCUSSION: Is software development a core competence?
Management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization’s objectives.

Strategic planning: process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and disposition of these resources.

Operational control is the process of assuring that specific tasks are carried out effectively and efficiently.
Mapping Information Systems

• Transaction Processing Systems (TPS)
  • Online processing
  • Batch Processing

• Automate repetitive information processing activity
  • Increase speed
  • Increase accuracy
  • Greater Efficiency
Mapping Information Systems

- Management Information Systems (MIS)
  - Managing Information Systems
  - Information for Mid-Level Managers

- Provide reports
  - Key-indicator report, Exception report, Drill-down report etc.

- Examples:
  - Sales forecasting, Financial Management and Forecasting, Inventory Management, Manufacturing Planning etc.
Mapping Information Systems

• Executive Information Systems (EIS)
  • Used at the strategic Level
  • Highly Aggregated Information

• Hard and Soft Data
  • Facts, News

• Examples:
  • Long range planning, Crisis Management
Functional Information Systems

• Decision Support Systems (DSS)
  • Cross Layer Usage

• Designed to support organizational decision making
  • “What-if” analysis
    • For example: Microsoft Excel
    • Text and graphs
  • Models for each of the functional areas
Enterprise Wide Strategic Management Systems

- **Enterprise Wide**
  - Synergizes the organisation and its customers and suppliers

- **Delivers competitive advantage**
  - Built on a platform
  - Cannot be too quickly or easily copied
The Four Virtual Spaces*

Channels for economic agents to display and access company product and service related information

Channels for economic agents to distribute products and services

Channels for economic agents to initiate and execute business related transactions

Channels for economic agents to engage in relationship building activities

*Albert A. Angehrn, 1997; The ICDT Model: Towards a Taxonomy of Internet-related Business Strategies; 97/12 INSEAD/CALT Working Paper No. 5.
The RRA Cube

Richness

Affiliation

Reach

- Low
- Medium
- High
MIT Enterprise Architecture Guide Project

Current State

Context

Principles

Goals

Future State Vision

http://web.mit.edu/itag/eag/
Student Systems Logical Architecture

MITSIS Platform Applications:
- Base Registration
- Housing
- Graduate Housing License
- Off Campus Housing
- Dining
- Medical Enrollment
- Federal Work Study
- Student Accounts
- Academic/Biographic Record
- Classroom Scheduling
- Degree Audit
- Enrollment/Degree Certification
- Grade Processing
- Registration
- Transcripts
- Tuition
- MIT ID Assignment

WebSIS Platform Applications:
- Graduate Admissions
- Special/Exchange Students
- Freshman & RBA Seminars
- Catalog
- Student Scheduling
- Prerequisite Analysis
- Who’s Teaching What
- Independent Activities Period
- Communications Requirement
- WebSIS Student Access
- WebSIS Instructor Access
- WebSIS Advisor Access
- Housemaster Access
- Control List

J2EE Applications:
- International Student Tracking
- Athletics
- ASA (Student Activities)
- Commencement
- Freshman Folder
- Test Score Maintenance
- Graduate Aid

J2EE Portal Platform Applications:
- Undergraduate Admissions

Key:
- System Component
- Related System
- Other MIT System
- External System

Other MIT Systems
In Bound:
- ...
Out Bound:
- ...

External Systems
In Bound:
- ...
Out Bound:
- ...

Drop Box
Telnet Service

Print Services
SIS Database (Oracle 7.3.4)
Mainframe Admissions Database (Adabase)
Admissions Database (Oracle 9)

Sync'd File Feed
Sync'd File Feed

Apache Web Server
WebLogic Portal Server 8.1
WebLogic Server 5.x, 6.x, 7.x
WebLogic Server 8.1

Telnet
 Telnet Service

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MIT Enterprise Architecture Guide

• Scope of Enterprise Architecture:
  • Business processes and products, applications and data (Process)
  • Software and hardware infrastructure (Technology)
  • Knowledge and expertise (People)

• Current State Assessment:
  • Documentation review
  • Interviews with ITAG and departmental technology staff
  • Workshops to validate information gathered

• Future State:
  • Workshops (1/2 day) to cover:
    • Future State Context
    • Future State Principles
    • Logical Architecture Framework
    • Technology Standards
    • Services Matrix
    • Project Review process

• Future Phases:
  • Roadmap and Planning
  • Build-out
Architectural Principles

• Security: applications should ensure data and access security
• Ownership: clear and explicit ownership of enterprise data
• Leverage assets: leverage existing services and capabilities
• Accessibility: be aware of the needs of all users (location & disabilities)
• Real-time: Minimize latency of data updates
• Standards: promote consistency using standards
Enterprise Architecture Deliverables

Current State

- System Context Diagram
- Context
- System Logical and Physical Architecture Diagrams
- Key Systems Inventory
- Integration Inventory
- Business Process Flows and Scenarios
- Systems on a Page

Future State

- Technology Standards
- Business Strategy
- Future State Services Matrix

Future State Logical Architecture Vision

Road Map

- Architecture Migration Maps
- List of Initiatives
- Prioritization Model
- Short Term Roadmap
- Long Term Roadmap

Timeless/Evolutionary

- Enterprise Data Model
- Architectural Review Process
- Architectural Principles
- IT Governance Process
Future State Context

• SAP will continue to be the primary ERP system
• The MIT Data Warehouse will be the central repository for administrative data that is of interest to more than one DLC.
• The MIT community will continue to be global, 24x7 and evolving
• There will be increased integration between MIT and other universities
• The MIT environment is heterogeneous
• The MIT network will evolve to support needs of the enterprise
  • We may have many research networks
  • We will have an IPv6 network and we will need differentiated services to better support user needs
## Enterprise Integration Options

<table>
<thead>
<tr>
<th>Concept</th>
<th>Strengths</th>
<th>Weaknesses</th>
<th>When to Use</th>
</tr>
</thead>
</table>
| **EAI**       | • Publish/Subscribe mechanism  
• Most suitable for real time data needs  
• Loosely coupled | • Custom code for each integration need  
• Suitable for complex integration needs  
• Tightly coupled | • Real time data is important  
• High volume, low footprint data exchange  
• Many consumers of the same data |
| **Point to point** | • Reliability (guaranteed delivery)  
• Enables real-time business decisions  
• Out of box adapters for many enterprise systems | • Familiar technologies and processes  
• Many point to point integrations already exist  
• No major up front investment required | • Should be rarely used  
• When defined enterprise strategy cannot work  
• Proto typing |
| **Web Services** | • Standards based integration  
• Most suitable for inter-organization integration  
• Loosely coupled | | • Integration model is request/reply  
• Real time requirements  
• High volume, moderate data |
| **ETL**       | • Suitable for large volumes of data  
• Generally used to move data between two or more databases | | • In conjunction with a data warehouse |
Audience and Value of the EA Guide

• Project Sponsors and Departmental Leadership

• Understand institute investments in technology

• Understand architectural governance process

• Provide technical direction to guide their investments

• Provide a way to assess architectural risks on projects

• IT Architecture Group

• Common understanding of architecture

• Frames architectural review process for projects

• Inform gaps in the architecture and where we need to evolve

• Provide a way to assess architectural risks on projects