

**system design &
management**

Establishing a Systems Engineering Organization

MITsdm

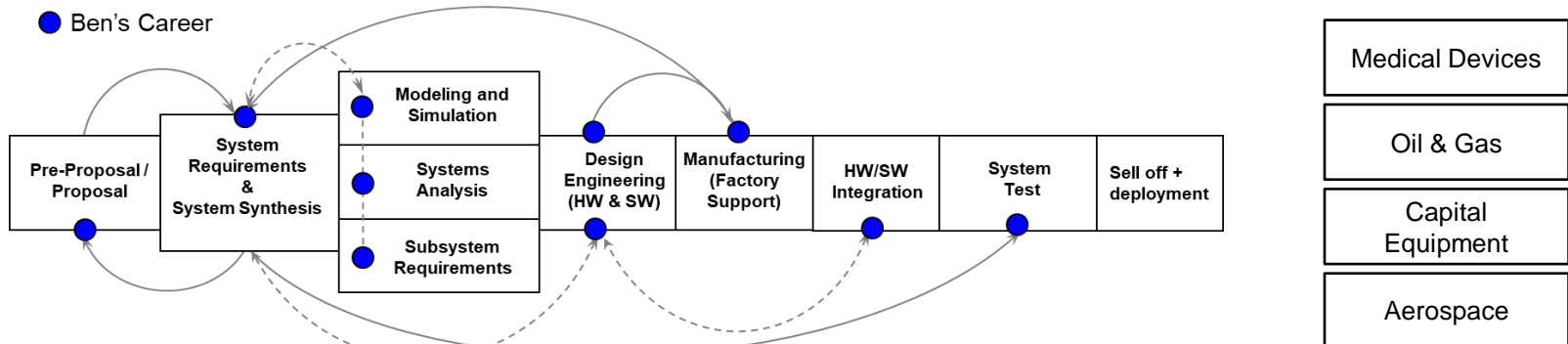
Ben Levitt
Technology Strategy Partners

My background

Raytheon

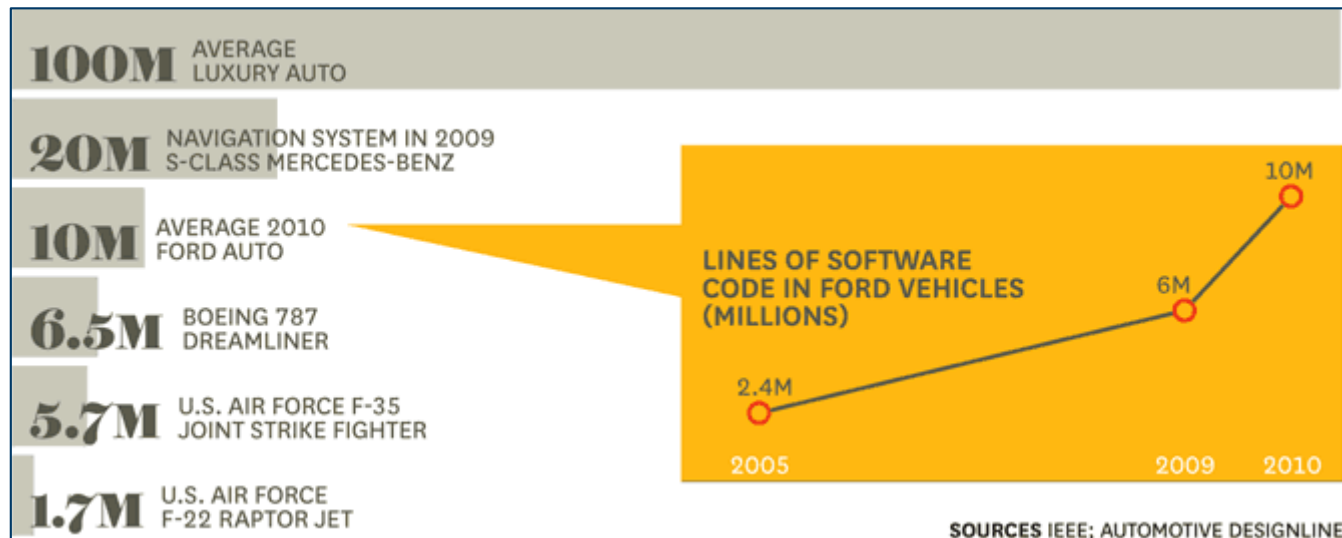
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TSP *Technology
Strategy
Partners*



The Challenge

New technologies, big data, and the demand for customization have made system integration increasingly difficult.



1st iTunes Phone - Motorola ROKR (2005)



Amazing Idea, right?

Steve Jobs calls Ed Zander to congratulate him on his new position as Motorola CEO – a joint-venture is born.

Hold ups at Apple... ROKR launch rumored for January 2005. February, March, April...

Apple hedges with the release of the iPod Nano, a super slim new iPod with more capacity.

Hybrid device combining two of the market's coolest products: Apple iPod and Motorola RAZR

ROKR is finally launched in September with Cingular, the biggest US Carrier.



January 2004
iPod and RAZR



Cingular launches
the ROKR



September 2005
Apple iPod Nano

Misunderstood systems can lead to disaster

- **Could not download songs using a cellular connection**
 - Apple enforced computer only syncing – feared cannibalizing the iPod and a loss of digital music rights
 - Decision created a strategy conflict with carriers whom benefit from high data traffic
- **Painfully slow at loading songs from iTunes**
 - Motorola-iTunes data interface management issue

Q: Slow Upload with rokr

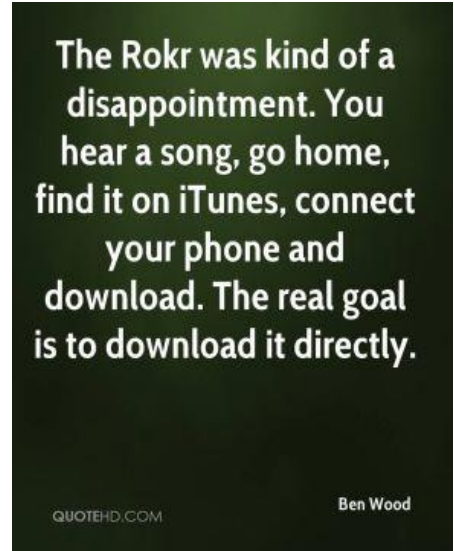
Has anyone experienced a slow update of songs onto your rokr?? This only started recently when I downloaded itunes 7. It is a bit better this morning with the 701 patch that apple released. However, it's still not a quick upload.

Before the patch, it took an hour to upload 5 songs. Also, it deleted all the songs on my phone. To make it worse, I finally got around to loading 60 songs on my phone coz I left it connected to itunes overnight for two nights in a row and then it started re-update again when i needed to leave the house leaving me with no other choice than to eject and now I have only 20 songs again.

Anyone else experiencing this??

Windows XP

Posted on Sep 28, 2006 6:45 AM



Source: Wired: Battle for the Soul of the MP3 Phone

Systems engineering organization must begin with a clear motivation and rationale

Rationales for SE Investment

Past failed projects

Automotive accidents, aerospace disasters, and exploding mobile devices

Integration of new tech

Rolling out new sensors, drilling tech faster, and adopting software platforms

Risk mitigation

Means to uncover costly defects earlier in project

Manage more configurations

Increased complexity of delivering more, customized product configurations

SE Investment Areas

Corporate strategy

Architectures that meet corporate goals

Roles and organization that sets up a creative tension

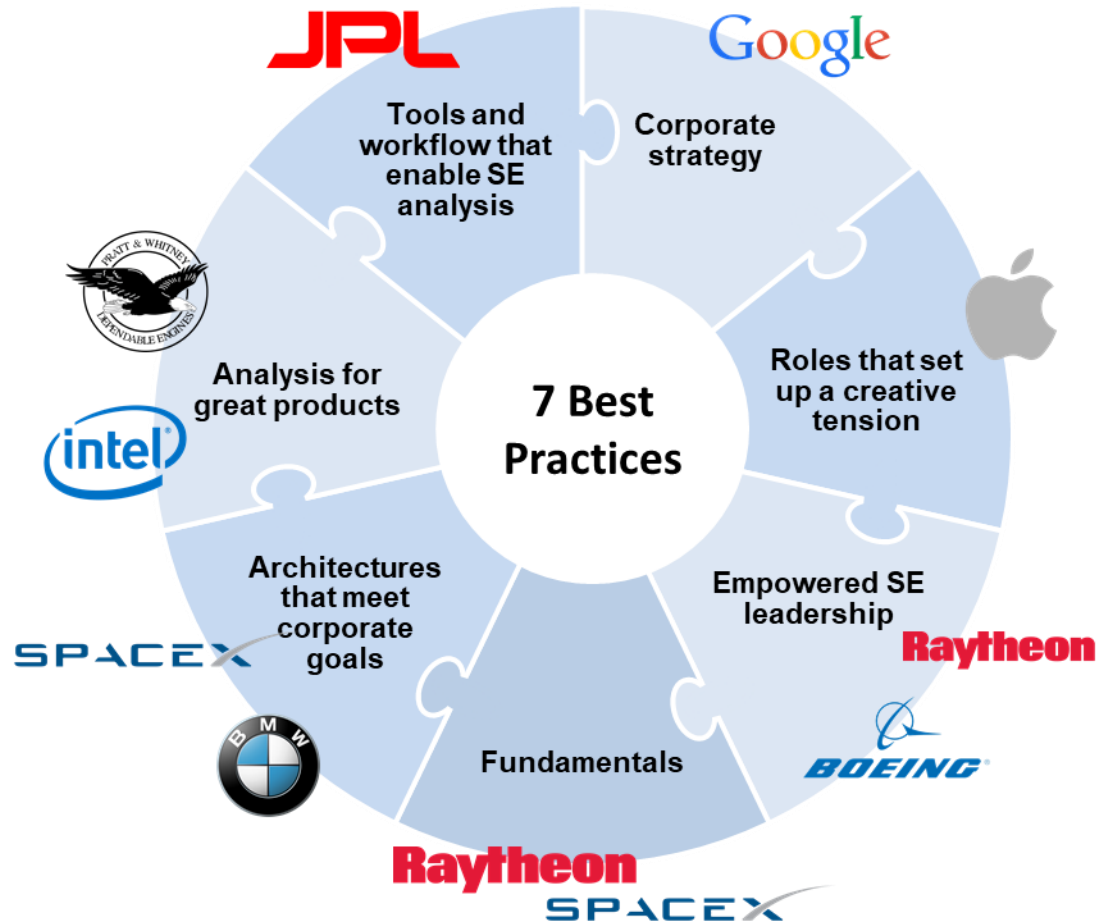
Empowered SE leadership

Fundamentals

Analysis for great products

Tools and workflow that enable strong SE analysis

Systems Engineering Benchmarks



Sources:
 Google Corporate Vision: <https://www.google.com/about/our-company/>
 SpaceX: John Muratore - System Engineering: A Traditional Discipline in a Non-traditional Organization
 BMW: Eric Rebertisch - Integrating Program Management and Systems Engineering
 Apple: Jony Ive: The Genius Behind Apple's Greatest Products
 JPL: Model-based Systems Engineering - JPL MBSE 101
 Intel, P&W - Eppinger - Design Structure Matrix Methods and Applications

Capabilities and behaviors of great SE firms

Empowered SE Leadership

- Technology planning with other functions
- SE integrated with project management
- Interfaces to other corporate functions
- Stage gate leadership

Fundamentals

- Comprehensive needs analysis
- Requirement, validation and verification processes
- Focus on emergent properties
- Configuration management

Architectures that meet corporate goals

- Architectural decisions clearly articulated
- Deliverables of the architect
- Product updates on consistent architecture
- Prioritize functional analysis

Roles and organization that sets up a creative tension

- The right SE roles
- Org structure and balance of power
- Building an SE talent base
- Intervention process and talent

Results:

More upside

New products & features

Reduced downside

Fewer defects & test failures

Analysis for Great Products

- Concepting and innovation is a source of competitive advantage
- Identification and management of trades
- Methods and systems modeling

Corporate strategy

- SE enables corporate strategy objectives
- Financial decisions supported by SE
- Competitive benchmarking

Systems Behaviors

- Ability to see the big picture and enable system-wide connections
- Comfort with uncertainty and unknowns
- Management buy-in and “walk the talk”

Tools and Workflow that enable strong SE analysis

- SE development through data and analysis
- Model based system engineering (MBSE)
- Prototyping and modeling culture

Empowered SE Leadership

Raytheon



Dr. Ellen Ferraro

Director of System Architecture
Design and Integration

Raytheon IDS

Architectures that meet corporate goals



Elon Musk ✓

@elonmusk

Following



It's starting to feel kinda normal to reuse rockets. Good. That's how it is for cars & airplanes and how it should be for rockets.

9:49 PM - 3 Jun 2017

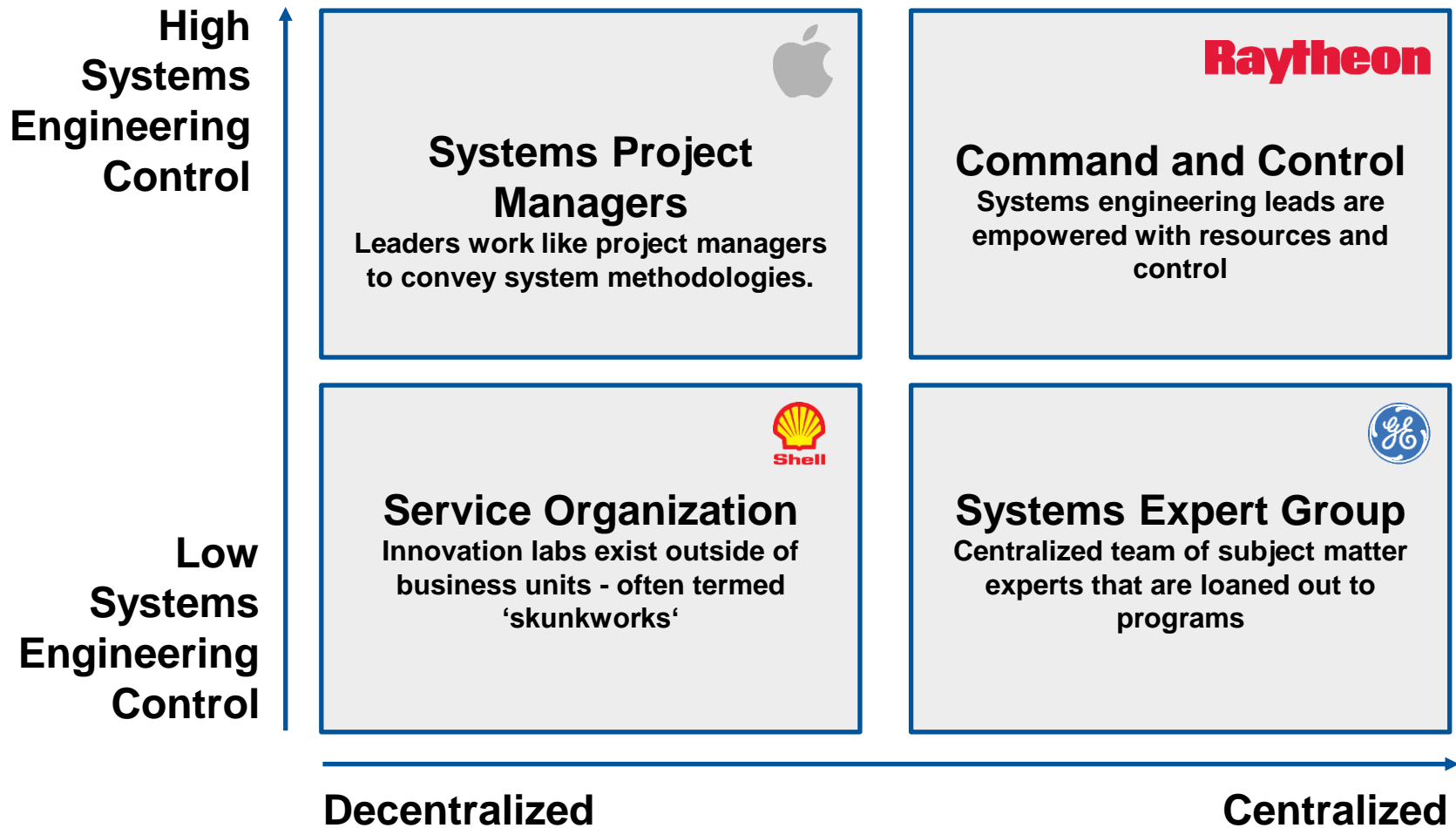
Tools and workflow that enable SE analysis



MBSE Lessons Learned - JPL Orbiter System Engineer Todd Bayer

- 1. Investment is crucial*
- 2. Unity of leadership is essential – Management must be willing to pay the startup costs and give time for the effort to pay dividends*

Delivering systems engineering balances control and organization structure



An organization's structure and culture should guide its systems engineering actions

Key Capabilities

Delivery Method

Organization Action

**Fundamentals
Empowered SE leadership**

Command and Control

Create a directorate and a power structure that empowers SE leadership

**Analysis for great products
Roles that set up a creative tension**

Systems Project Managers

Convey systems methodologies via project managers

Architectures that meet corporate goals

Systems Expert Group

Form an organization of experienced system architects who are available to assist the profit and loss programs

Tools and workflow that enable SE analysis

Service Organization

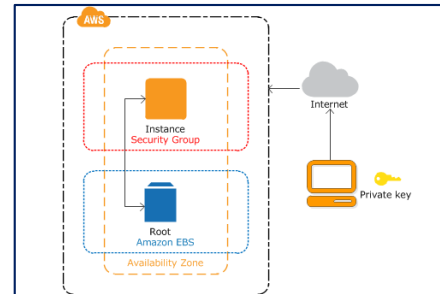
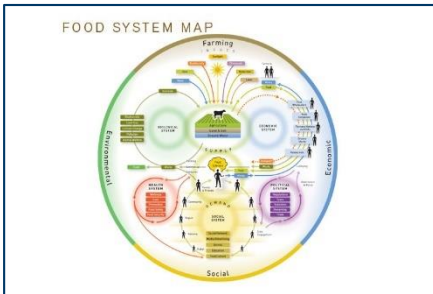
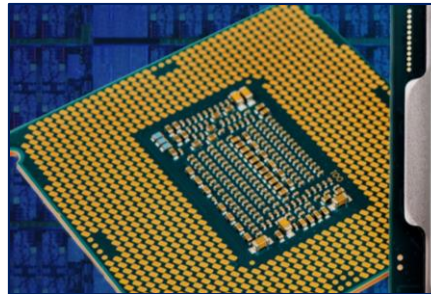
**Build an innovation lab outside of business units
or
Buy a 'skunkworks'**

Systems organization that fuels corporate strategic objectives

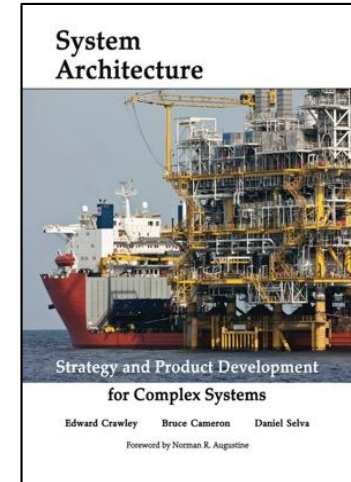
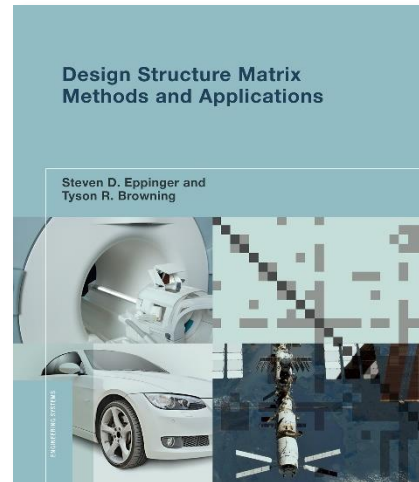
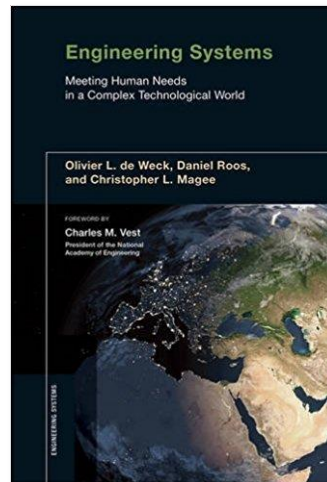
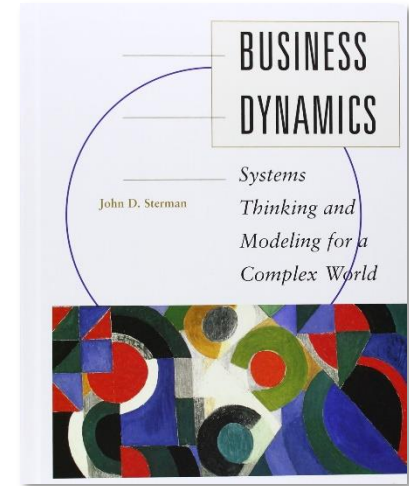
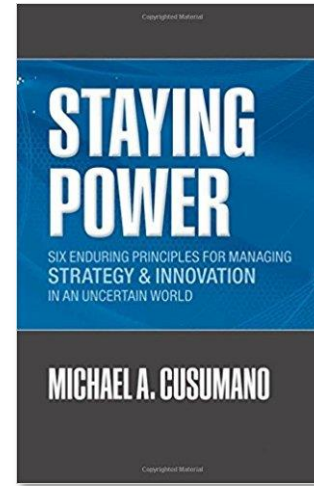
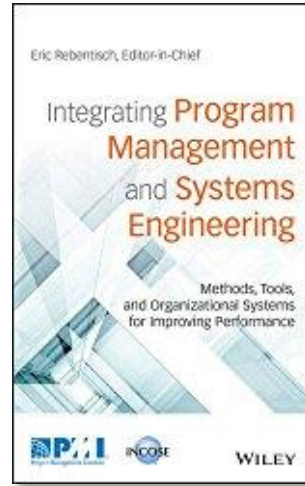
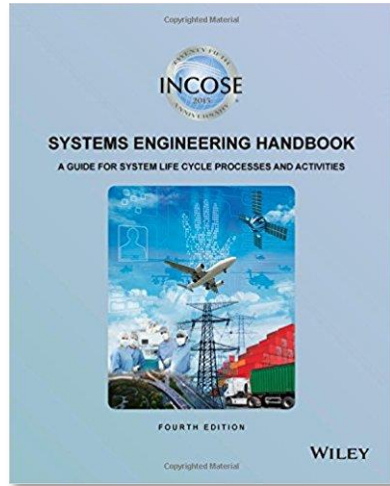
Essential for all delivery methods

Ensure leadership drives systems to impact strategic objectives

Next steps: Expanding systems engineering to new industries



Reading material and areas of further study





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High Tech
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