Systems and Software Engineering Required - A Platform of Discipline and Digitization

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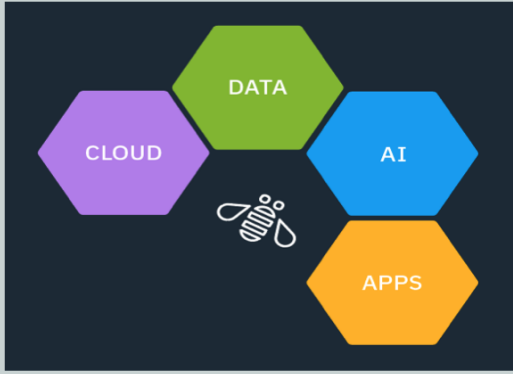
Agenda



- Why - The industrialization of information technology is creating opportunities or disruptions
- How – Digital Transformation done professionally
- What – Efficiencies, product development and customer intimacy
  - Discipline built into a Platform (open, resilient, secure, sustainable)
  - Cloud, IoT, Artificial Intelligence, RPA, additive manufacturing, data sciences
  - An Secure and Resilient Enterprise Platform

Top companies use technology creating a platform that is sustainable and flexible.

Why is system and software engineering needed more than ever… agility, quality and resource optimization.

274,000 estimated worldwide startups each day

2017 Global Market Capitalization Leaderboard = Tech = 40% of Top 20 Companies…100% of Top 5…

Rank	Company	Region	Industry Segment	Current Market Value ($B)	2016 Revenue ($B)
1	Apple	USA	Tech – Hardware	$801	$218
2	Google / Alphabet	USA	Tech – Internet	680	90
3	Microsoft	USA	Tech – Software	540	86
4	Amazon	USA	Tech – Internet	476	136
5	Facebook	USA	Tech – Internet	441	28
6	Berkshire Hathaway	USA	Financial Services	409	215
7	Exxon Mobil	USA	Energy	346	198
8	Johnson & Johnson	USA	Healthcare	342	72
9	Tencent	China	Tech – Internet	335	22
10	Alibaba	China	Tech – Internet	314	21
11	JP Morgan Chase	USA	Financial Services	303	90
12	ICBC	China	Financial Services	264	85
13	Nestlé	Switzerland	Food / Beverages	263	88
14	Wells Fargo	USA	Financial Services	262	85
15	Samsung Electronics	Korea	Tech – Hardware	259	168
16	General Electric	USA	Industrial	238	120
17	Wal-Mart	USA	Retail	237	486
18	AT&T	USA	Telecom	234	164
19	Roche	Switzerland	Healthcare	233	51
20	Bank of America	USA	Financial Services	231	80
Total				$7,207	$2,497

KLEINER PERKINS

Source: CapIQ. Market value data as of 5/26/17
Note: For public companies, colors denote current market value relative to Y/Y market value. Green = higher, red = lower.

Will you disrupt or be disrupted?

A study by Deloitte and the Manufacturing Institute found manufacturing executives rated 70 percent of current manufacturing employees as deficient in technology and computer skills. - Seattle Times February 7, 2018.

1/3 of the top 20 companies in every industry will be disrupted over the **next 3 years**

- IDC FutureScape, Nov 2015

Since 2000, 52% of companies in the Fortune 500 have either gone bankrupt, been acquired or ceased to exist.

72% are vulnerable to disruption within three years

54% of CxOs expect more competitors from outside their industry

EXTERNAL THREATS

Born-on-digital companies that steal market share or rewrite customer expectations

New business models that reinvent our industry and change the game altogether

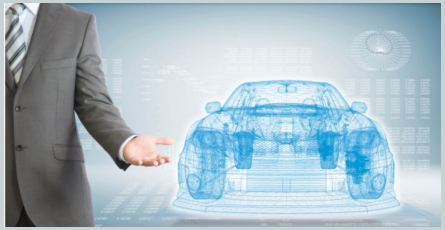
INTERNAL THREATS

Siloed data and systems expand on the wrong platform

Gaps in expertise and skills

Inability to react quickly

The new platform of Digital Twins: Improving Innovation and Operational Performance



As Designed

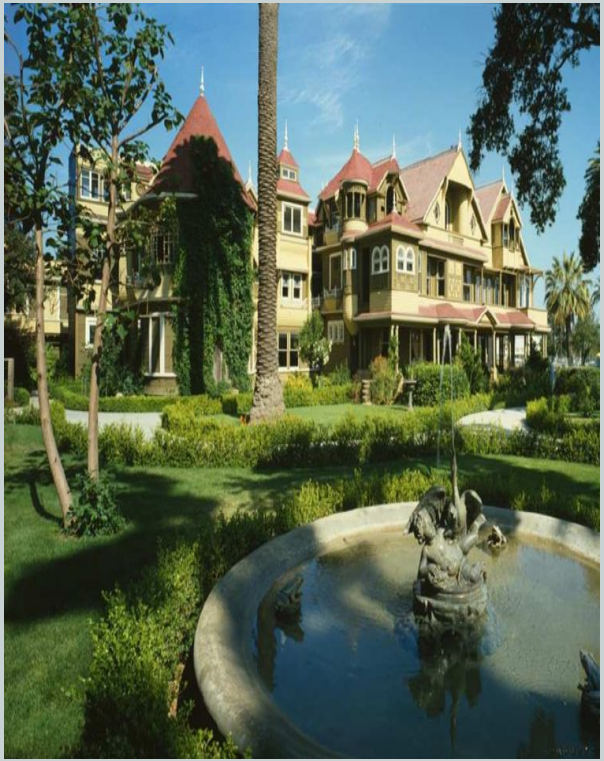
As Built

As Operated

- Quickly identify root causes and cascading impacts
- Enables end to end “What if” analysis across the lifecycle
- Leverage Operational insights to improve product development
- Automate discovery of new knowledge and insights
- Enable new business models
- Enable new user experiences and differentiation

Digital systems should apply disciplines learned in the industrial domain. Elements have to be organized on a foundation or platform.

- Winchester House: number of rooms: 160
- Number of windows 1,257 (look upon a wall, one into floor!)
- Number of doors 467 (Many open up into a wall)
- Number of fireplaces: 47
- Number of chimneys: Presently 17 with evidence of 2 others
- Number of kitchens: 5 or 6
- Number of staircases: 40 (some leading to ceiling)
- **Blueprints available: No, Mrs. Winchester never had a master set of blueprints, but did sketch out individual rooms on paper and even on tablecloths**



Winchester Mystery House 1884 – 1922 (24*7)

For example, the true potential of IoT lies not in “connecting” physical assets but in the data generated from them together to form a responsive system

Most of the data generated today is unused

90% Of data created over the last 10 years was never captured or analyzed

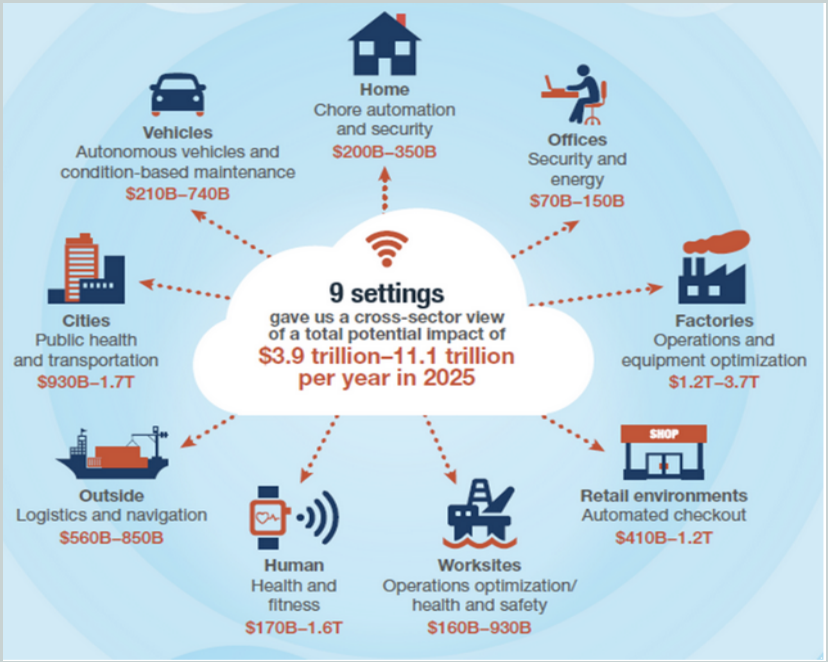
60% Of valuable sensory data loses value in milliseconds

Industrial and commercial assets

IoT applications have the potential to unlock new value-creation possibilities from this “Dark” data by leveraging advanced analytics and cloud computing capabilities

Source: IBM Global Technology Outlook 2015

How IT technology can unlock economic value



Source: McKinsey Global Institute, 2015
“Unlocking the Potential of the Internet of Things (IoT)”

Systems and Software Engineering is foundational and is required to manage technology (product) and process innovation.

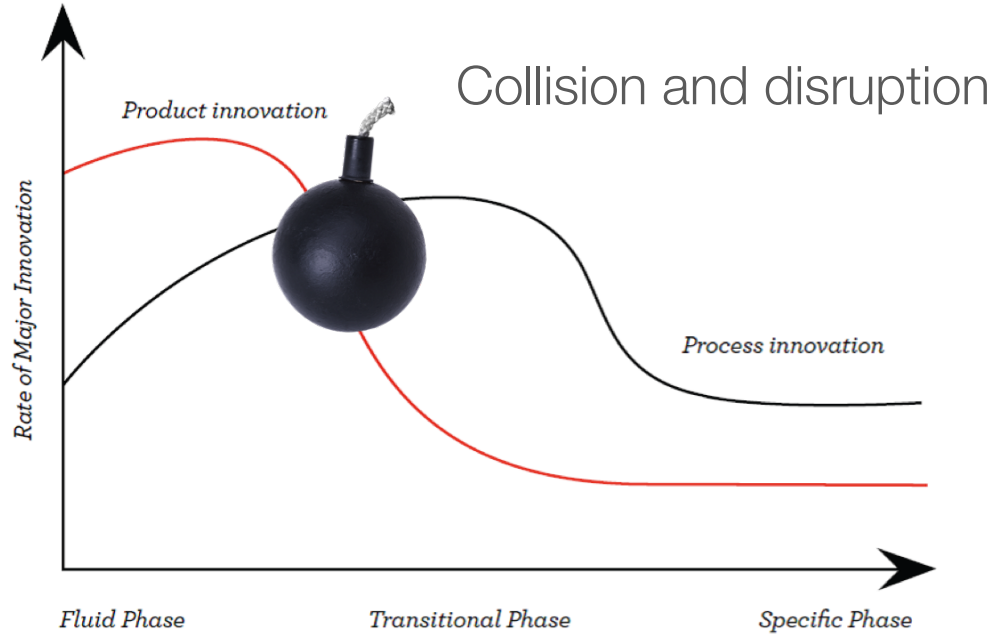


FIGURE 1 *An industry evolves over time according to the pattern described in figure 1 (Utterback, 1994). It prospers around a product innovation and, in the first phase, extensive experimentation takes place. As the dominant design emerges, the focus shifts towards process innovation and incremental improvements. Over time, the overall rate of innovation decreases and the firm becomes vulnerable to technological change.*

Systems Thinking moves forward

- The name change aligns Institute of Industrial and Systems Engineering (IISE) with the changing scope of the profession that, while keeping its industrial base, has seen more industrial and systems engineers (ISEs) working with large-scale, integrated systems in a variety of sectors. The change also is consistent with department names in many universities, as two-thirds of the top 65 schools ranked in U.S. News & World Report have incorporated systems into their department names.

- ABET Accreditation includes Systems Engineering as a technical requirement for engineering skills.

No longer can 75% of digital projects miss budget, time, or performance (Standish Group). The industrial world started quality standards and performance expectations.

Computer, Software Engineers Take Special Oath

They say imitation is the sincerest form of flattery. The Pledge of the Computing Professional seeks to duplicate for software and computer engineers what the Order of the Engineer has done for nearly five decades.

Professor Ken Christensen of University of South Florida and Professor John Estell of Ohio Northern University were inspired to create an organization—patterned after the Order of the Engineer—to foster the ethical obligations of graduates of computer science, computer engineering, information technology, and software engineering programs. The Order was established to encourage engineering graduates and licensed engineers to uphold the standards and dignity of the engineering profession and to serve humanity. In ceremonies held at universities and the NSPE annual meeting, participants take an oath and receive a silver ring as a symbol of their commitment.

In 2009, Christensen and Estell reached out to 17 colleagues at universities and technology firms to develop the program and pledge. Graduates who take the pledge as a professional rite of passage are expected to adhere to a sense of moral obligation and ethical responsibility throughout their professional careers. Participants receive a pin and a certificate as part of the pledge ceremony.

In 2011, the first induction ceremonies were held at Ohio Northern University, the University of South Florida, and McNeese State University. By 2013, the pledge ceremony had expanded to 25 educational institutions. The organization has received backing from the Association for Computing Machinery's Committee on Professional Ethics for its efforts to raise awareness of the ethical responsibilities of those in the computing profession.

The Pledge of the Computing Professional

I am a Computing Professional.

My work as a Computing Professional affects people's lives, both now and into the future.

As a result, I bear moral and ethical responsibilities to society.

As a Computing Professional, I pledge to practice my profession with the highest level of integrity and competence.

I shall always use my skills for the public good.

I shall be honest about my limitations, continuously seeking to improve my skills through life-long learning.

I shall engage only in honorable and upstanding endeavors.

By my actions, I pledge to honor my chosen profession.

Learn more about The Pledge of the Computing Professional at http://computing-professional.org.

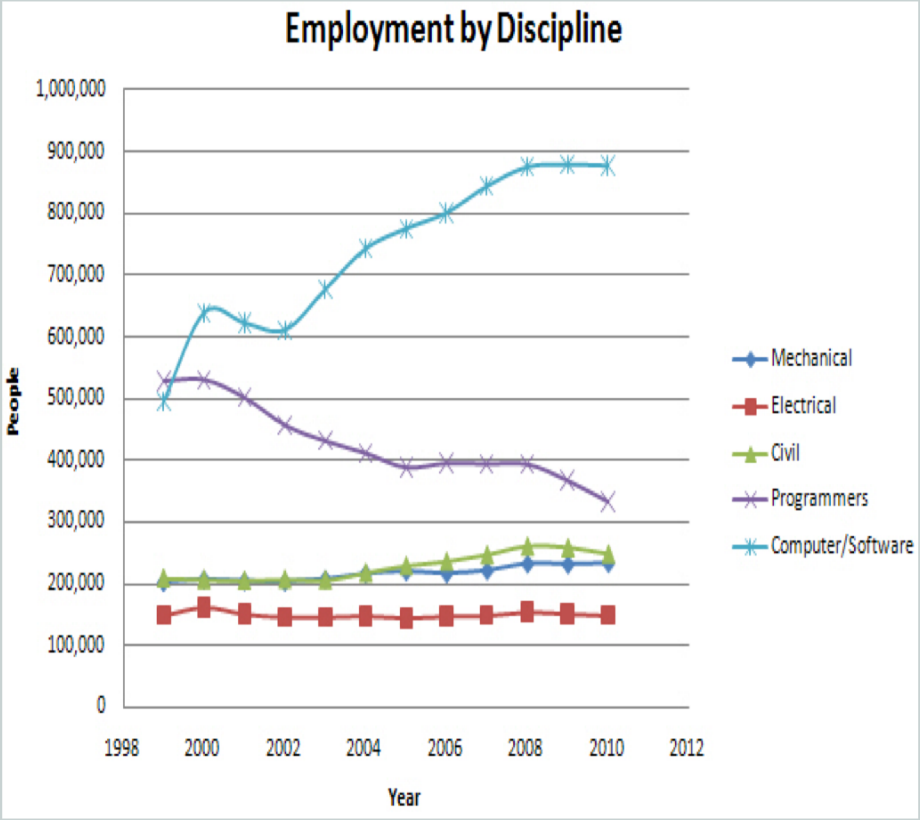
Engineers require systems skills in the current curriculum as part of ABET criteria to protect public health, safety, security, and environment

The Atlantic

TECHNOLOGY

Programmers: Stop Calling Yourselves Engineers

It undermines a long tradition of designing and building infrastructure in the public interest.

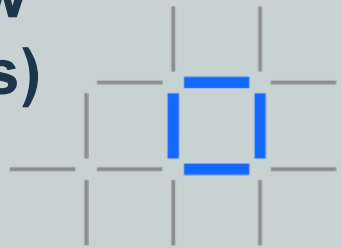


"Technical competency is important in designing systems, but professional responsibility is fundamental in delivering solutions to humanity."

Instead, the project …squandered investment larger than the state's $8 billion annual budget. Westinghouse Corporation and other contractors allegedly used unqualified and unlicensed individuals to design aspects of two nuclear reactors at the V.C. Summer site, placing the public health and safety at risk.

Filed by the United States on behalf of the EPA on January 4, 2016, and amended on October 7, 2016, alleging that these vehicles are equipped with defeat devices in the form of computer software designed to cheat on federal emissions tests. The major excess pollutant at issue in this case is oxides of nitrogen (NOx), and is a serious health concern.

“the leadership of Uber’s self-driving car unit has frequently been described as troubled, with high levels of engineer attrition.” There may have also been pressure on the autonomous vehicle developers to bring a road-ready system to market as soon as possible in order “to square the financial circle” of Uber’s finances “by taking driver pay out of the equation” and helping to build profitability at a company that “regularly posts quarterly losses with few historical parallels.” Fortune (3/24, Morris)



More than ever, systems and software engineering is needed.

Part of that evolution is an increased need for computing and software engineering, **which have not traditionally been a major part of engineering work**. Every installation is a little bit different. It takes a lot of software to determine if each system is working as expected."

Software and systems errors are plaguing the industry. Systems and software are causing variability. In total software requirements, analysis, architecture, and design contribute to about **60 percent of all software bugs or defects accumulate between 30 percent and 40 percent of software costs.**

Keep in mind, the three top cost elements of large software applications are

1. Finding and fixing bugs (many of which originate in paper documents)

2. The process of producing paper documents including requirements, architecture, and design

3. Creating the source code itself

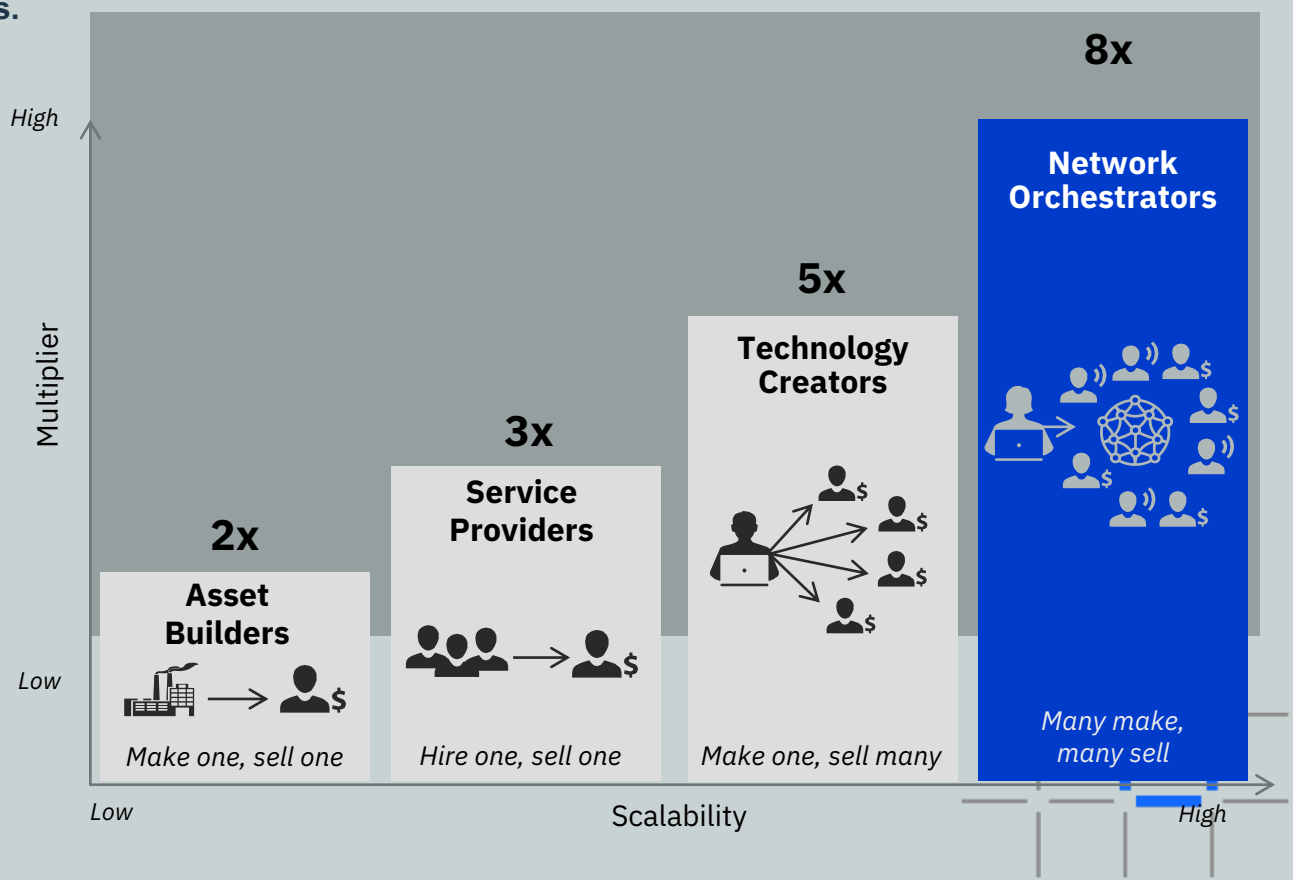
To move beyond the hype, organizations require:

- Clarity in business impact & design
  - Requirements, design, and architecture
- Collaborative – network orchestration
  - Governance
- Demonstrated expertise
  - Education and training
  - Professional standards
- Full lifecycle capabilities
  - Integration and flexibility
- Proven and flexible technology
  - Open, secure and resilient platform

"Have a system, be positive and prepare to expend energy – Scott Adams, Creator of Dilbert"

Blockchain developers now rank second among the top 20 fastest-growing job skills, and job postings for workers with those skills have more than doubled this year. Taking second fiddle only to robotics specialists, blockchain technologists are advertising their services for as much as $115 per hour, according to Upwork, an employment site that specializes in freelance workers.

- **Why a platform?**
- **2%** are gaining a first mover advantage. Non-digital, non-network business models make up more than **98%** of the market
- Network Orchestrators grow revenue faster and generate higher profit margins with **8x** market value multiplier



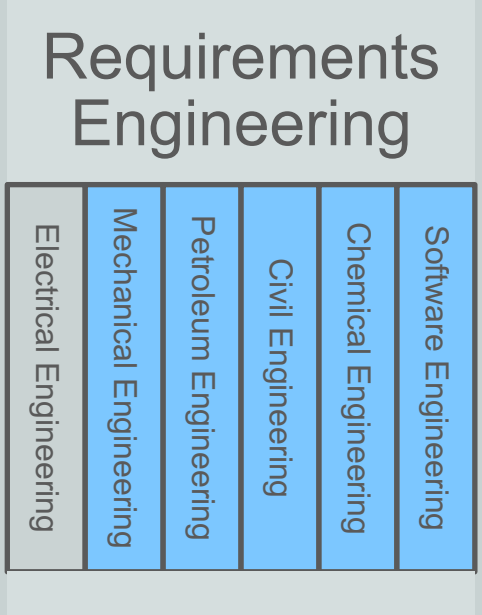
A requirement is a documented agreement

*"The purpose of **requirements management** is to establish a **common understanding** between the customer and the … project ... This **agreement** with the customer is the basis for planning and managing the … project."*

The Capability Maturity Model for Software (CMM®) from the Software Engineering Institute at Carnegie Mellon University. - www.sei.cmu.edu/cmm

Requirements are the foundation of any project

- Requirements engineering is a cross-cutting activity
  - affecting all engineering disciplines
  - spanning engineering roles
  - used across the product lifecycle
  - driving supply chain activities



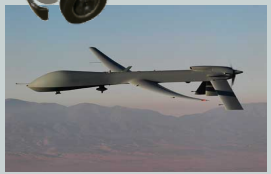
Different industries have different needs …

- Safety
- Regulatory compliance
- Functionality
- Performance
- Development timescales
- Project scale
- Project life
- …

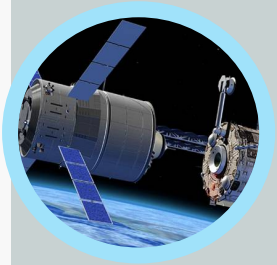
Formality	Industry
Informal	Consumer Products
	Mobile Networks / Devices
	Power grid
	Aerospace & Defense
Formal	Nuclear Industry





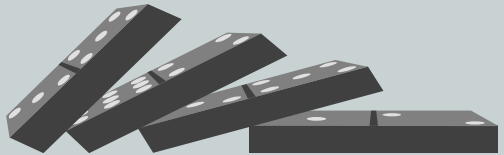






Challenges for the requirements consumer

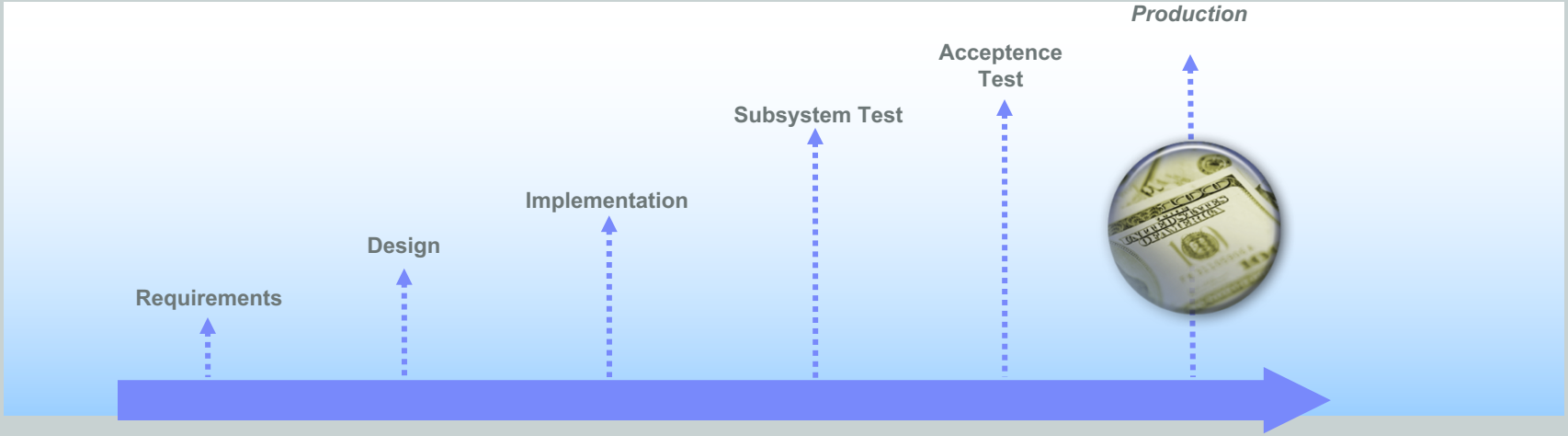
- Misunderstood requirements by stakeholders and analysts
- Poorly expressed requirements
- Misunderstanding or omission by product teams
- Missed test coverage
- Not understanding the impact of changed requirements



Business and engineering challenges

- Governance of all requirements, status, change, and access control
- Responding to change, from the business, regulation, and engineering needs
- Managing the entire requirement structure across all phases of the system lifecycle
- Supporting business and engineering decisions with better insight into requirements and their relations to assets, architecture, development, verification, and security
- Avoiding rework caused by misaligned inspection scenarios and verification criteria

Poor requirements management impacts your business



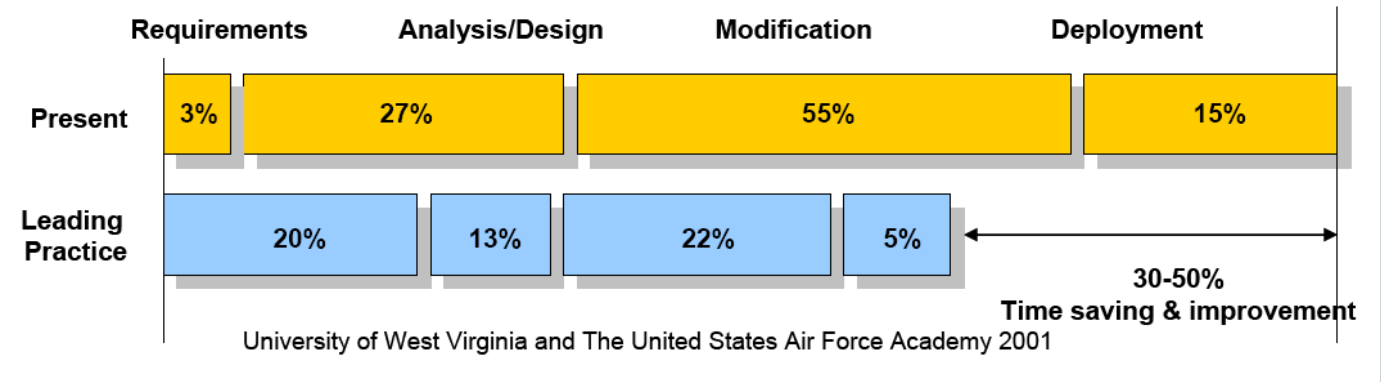
Product Lifecycle

Errors can cost 20 times more to fix in Production compared to Requirements

Independent studies conducted by GTE, TRW, IBM

Good requirements management improves outcomes

- The cost of design, implementation, deployment, and management is reduced when the project evolves with a strong requirements foundation



Agile teams are more likely to accumulate technical debt

- *Technical debt* refers to the eventual consequences of a poor requirements and architectural foundation. The key part of technical debt is that, like financial debt, it must be paid at some point in the future.

- Technical debt accumulates. As products and markets evolve, the need to increase functionality and performance increases. A poor or shortsighted architecture leads to increasingly wasteful workarounds and a potential need for redesign.

- Technical debt represents risk to the project - risk that will prevent timely delivery of a product that meets stakeholder expectations.

Blockchain, should use. . . Requirements, Design, Testing, and the integration of process is vital; otherwise failure.

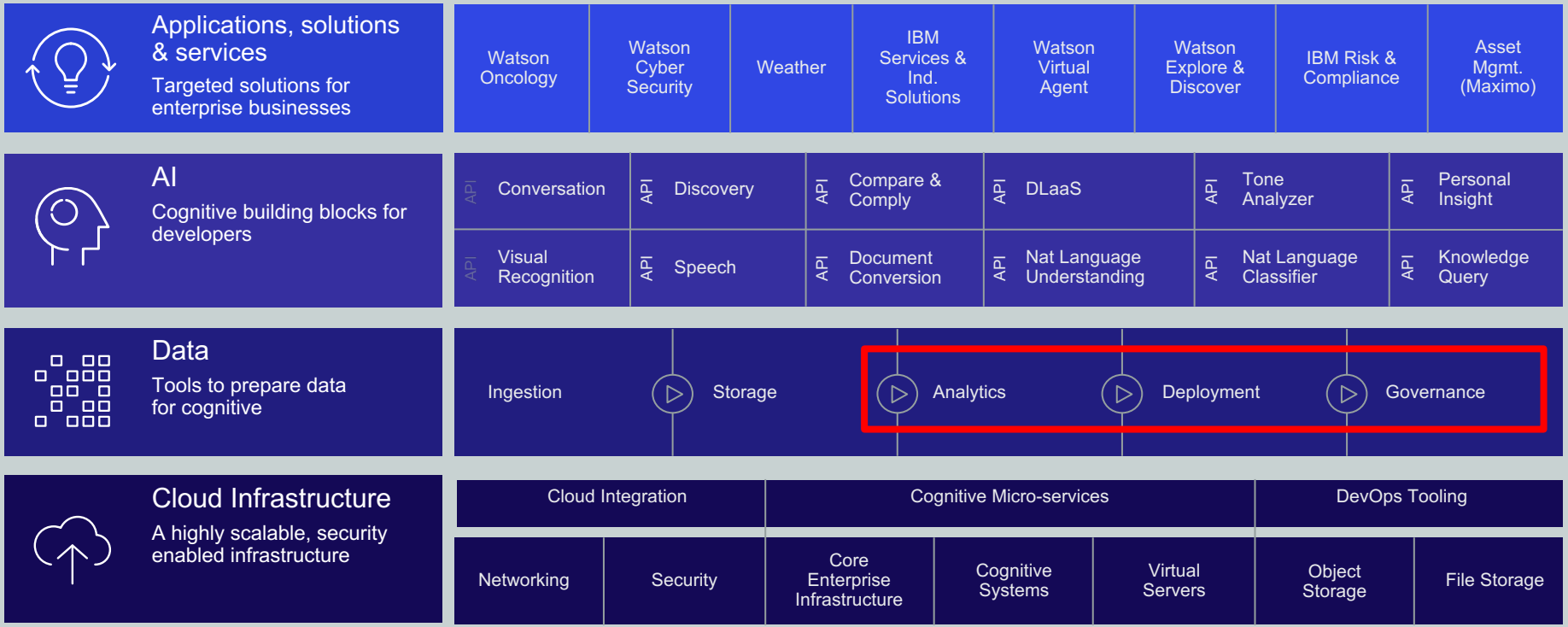
NEGATIVE Indicators – Requirements not met

1. Need high performance (millisecond) transactions
2. Small organization (no business network)
3. Looking for a database replacement
4. Looking for a messaging replacement
5. Looking for transaction processing replacement
6. Process and metrics are not clear within the ecosystem
7. Value, velocity and/or variability are not present

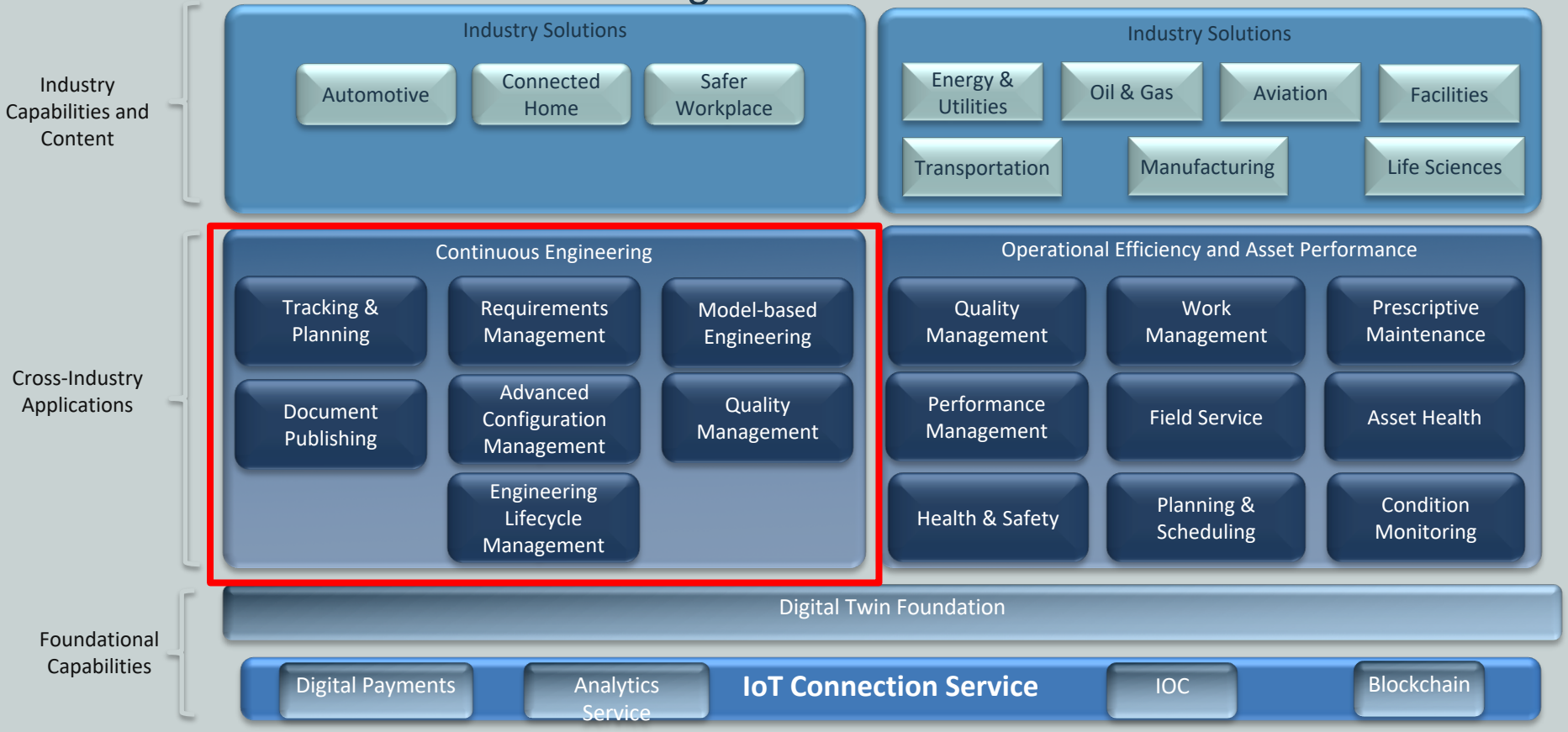
The most valuable element is the governance rather than the technology alone

- **Accelerate the initiation and activation of new blockchain networks**
  - Collectively manage rules and policies for network by preventing any one member exclusive control
  - Grow elastically as new smart contracts, network members and transaction channels evolve
  - Pre-built, native tools and policies enable faster onboarding, customization and activation

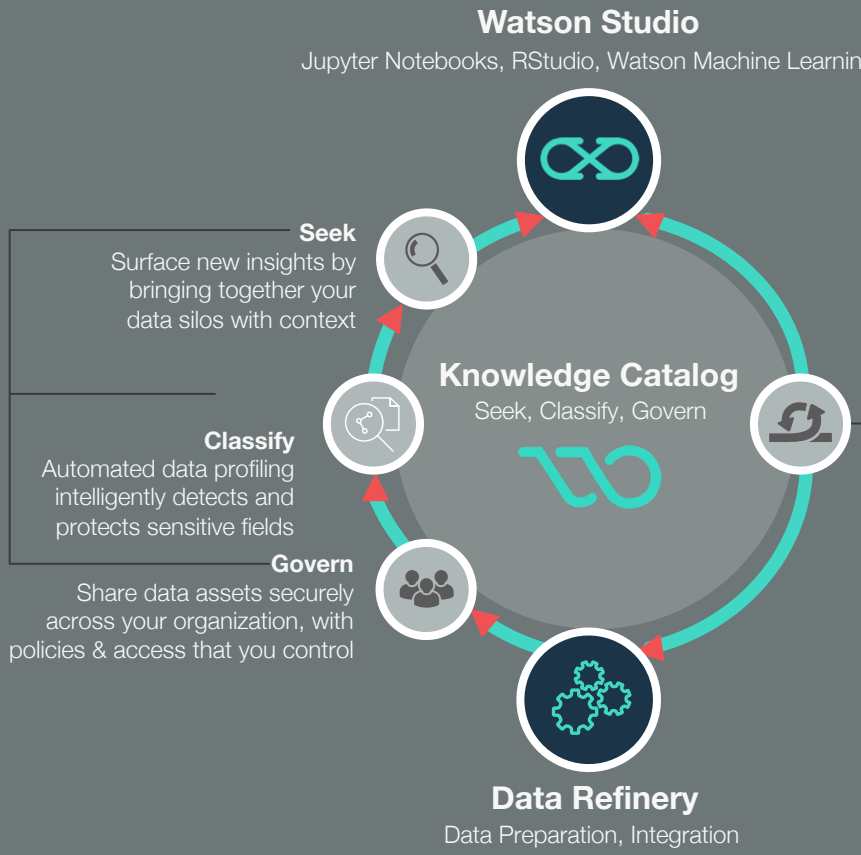
The IBM Platform (Public and Private) is designed so that the technologies power Innovation for the enterprise for systems and software engineering.



Data Tools to prepare data for cognitive computing is deployment and governance.



One Unified Platform



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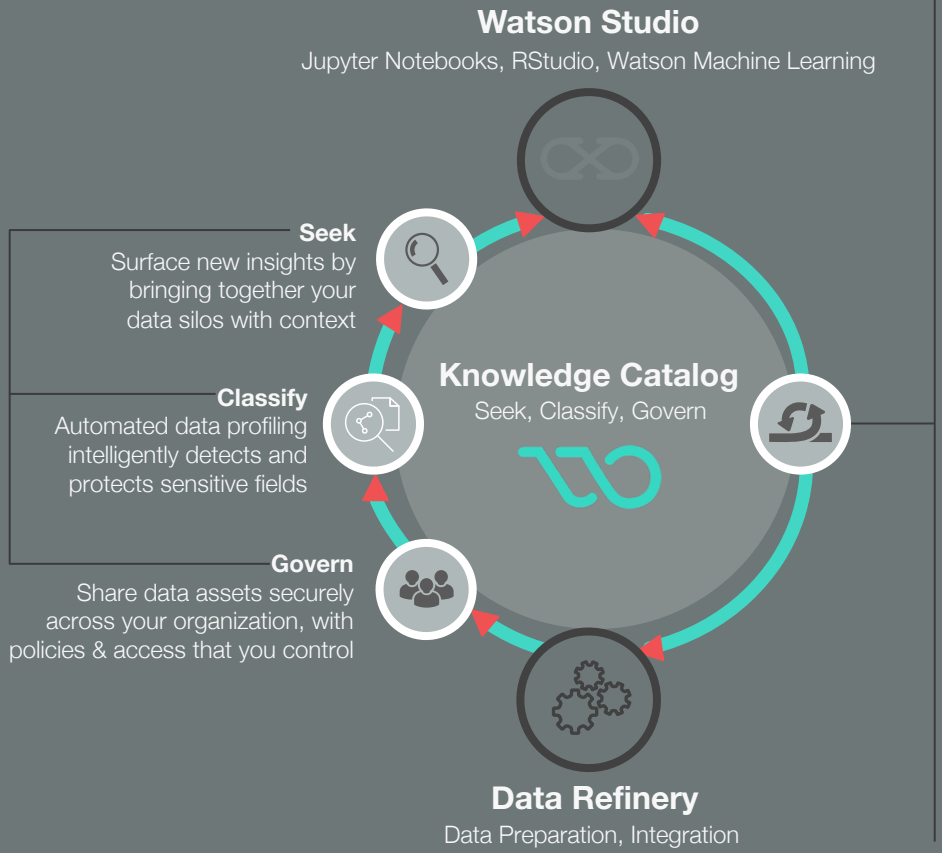
Knowledge Catalog



Data Discovery

Find and discover data across both on-premises and cloud sources. **Rediscover** value in isolated assets and catalog new data feeds — wherever they sit.

Data Governance

Control access to data with automated policy enforcement. Intelligent data cataloging, classification, and profiling. Enterprise-grade and **GDPR-ready** regulatory compliance.

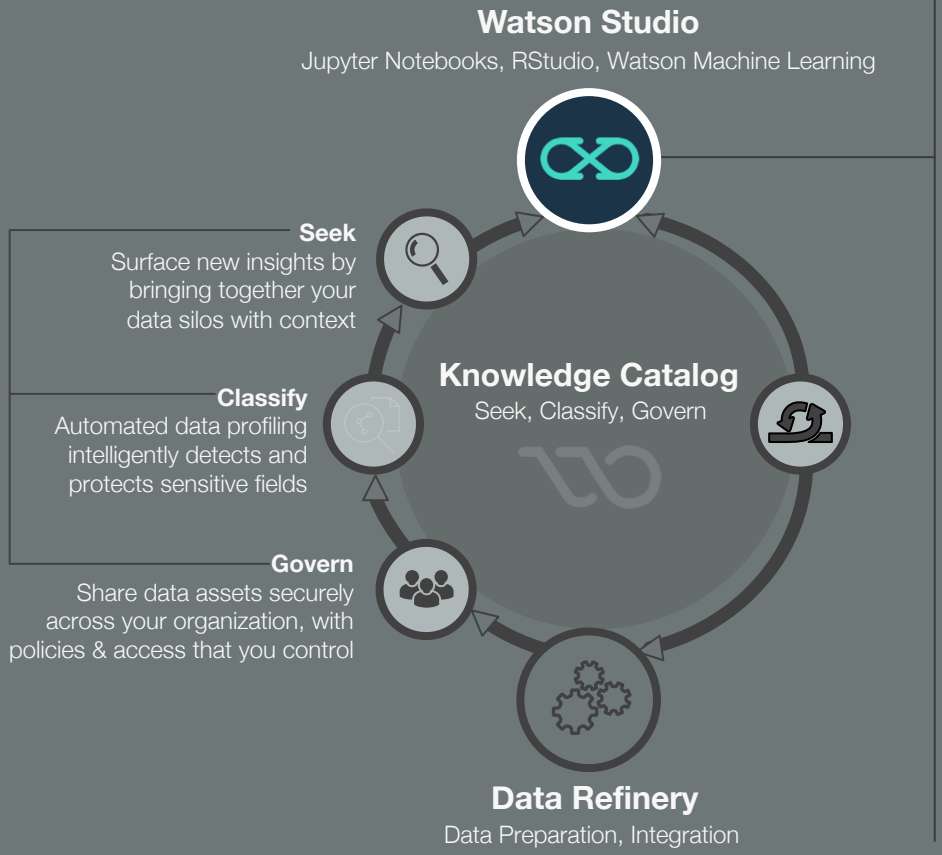
360-Degree Business View

Access and review all of your data assets. Bringing together data provides context. Intelligent **metadata** unlocks the full richness of your company's assets.

Integrate Data and AI

Enrich your data with **Watson APIs**— AI designed for business —with industry-specific knowledge and assurances that data is protected end-to-end.

Watson Studio



Machine and Deep Learning

Craft models and compare results. Run experiments backed by automated lifecycle management. Direct integration with **Watson Machine Learning** for the latest in deep learning techniques.

Open Source Technologies

Powered by Jupyter **Notebooks** and Apache Spark. Supports your favorite languages & tools: Python, Scala, and R.

Easy Visualizations

Design and train machine learning models without a single line of code. **Visual modeling tools** allow you to quickly identify patterns, gain insights, and make decisions faster.

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Collaborate across teams by bringing together data & talent under one roof. Deploy your models directly to the web with application-friendly APIs.

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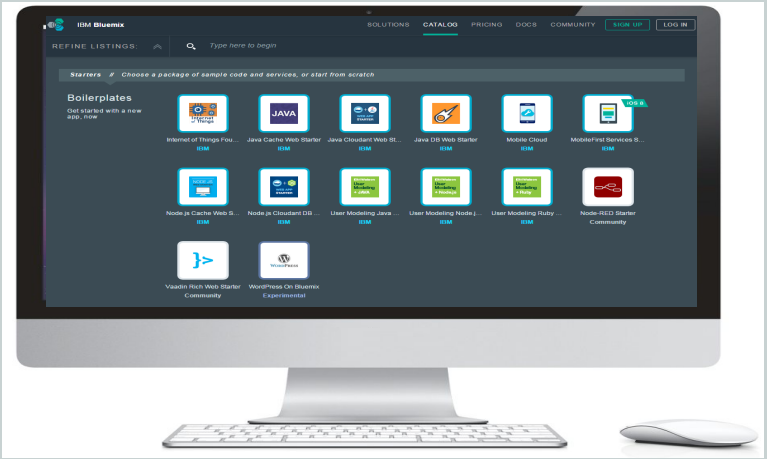

https://www.youtube.com/watch?v=OD1NP-Yk2BI
https://www.youtube.com/watch?v=ZR_jDitw0Sc

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- Business Analytics

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Deploy and scale

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Industry Resources

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Thank you!

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