

# **Transformación digital de la Metrología**

## **Congreso Español de Metrología 2022**

### **28.9.2022**

Toni Ventura-Traveset

DATAPIXEL  
Innovalia Metrology

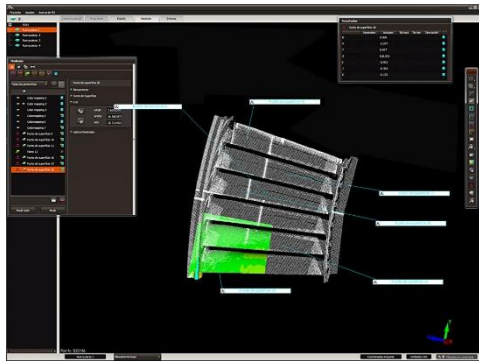
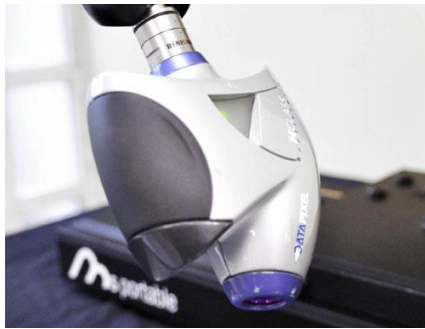
*Congratulations!*

*Thank You*

27, 28, 29 DE SEPTIEMBRE DE 2022 (SESIÓN DIVULGATIVA PREVIA 26 SEPTIEMBRE), ÁVILA

**LA METROLOGÍA EN LA ERA DE LA DIGITALIZACIÓN Y LA SOSTENIBILIDAD**

Logos: GOBIERNO DE ESPAÑA, MINISTERIO DE INDUSTRIA, COMERCIO Y TURISMO, CEM CENTRO ESPAÑOL DE METROLOGÍA, Junta de Castilla y León, m<sup>i</sup> congreso español de metrología m 22



[Toni.ventura@datapixel.com](mailto:Toni.ventura@datapixel.com)

**Computer vision, Machine Vision, AI**

**Metrología dimensional**

**Transformación digital de la industria**

**I+D+i**



DATA

INTELLIGENCE

Data Economy

Cognitive revolution

Digital Transformation

IoT, IoE, SloT

CONNECTION



# Digital Transformation of Metrology for Decision Intelligence in Manufacturing

Congreso Español de Metrología  
2022  
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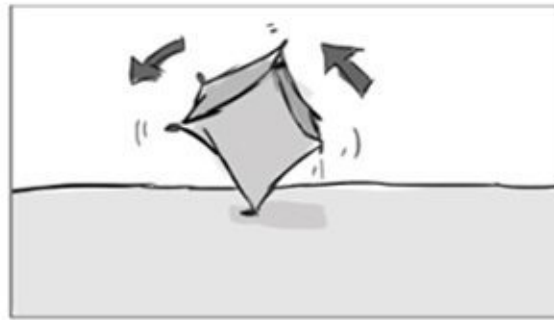
Toni Ventura-Traveset

DATAPIXEL  
Innovalia Metrology

## Digital Transformation of Metrology for Decision Intelligence in Manufacturing



Digital Factories  
in 2022



Reframing digital  
transformation



Metrology for  
digital factory

## Digital Transformation of Metrology for Decision Intelligence in Manufacturing

shot 01



Digital Factories  
in 2022



Reframing digital  
transformation







Metrology for  
digital factory

What about digital transformation in manufacturing in 2022?



### Keywords for National Policies Regarding the Fourth Industrial Revolution

Germany	USA	China	Japan
			
Industry 4.0	Advanced Manufacturing	Made in China 2025, Internet Plus	New Robot Strategy
Cyber Physical System (CPS) smart factory	Manufacturing reshoring	Integration of informatization and industrialization	Robot-based new industrial revolution

# How to accelerate?



2014...



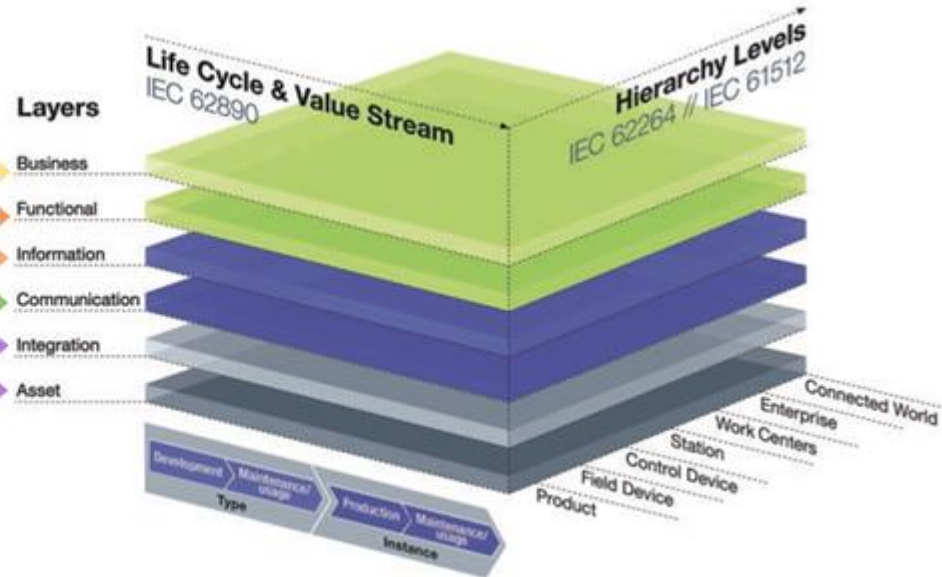
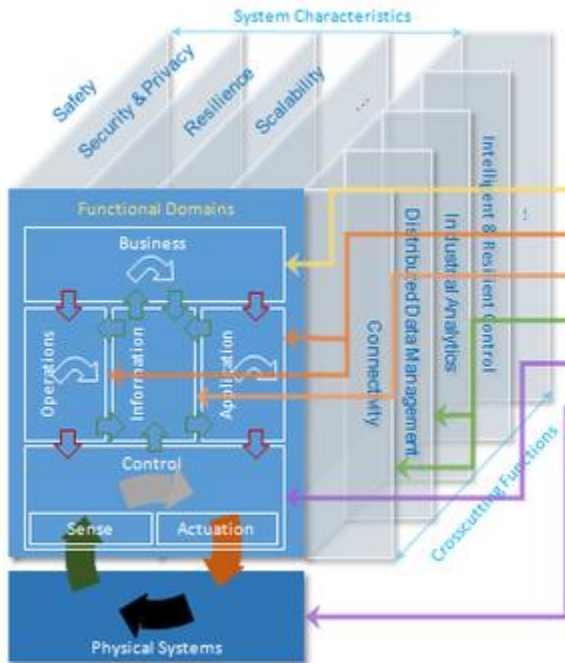
2011...





Industrial Internet Reference Architecture (IIRA)

Reference Architecture Model Industrie 4.0 (RAMI 4.0)



# Digital Factory Alliance



**Global Lighthouse Network**



Industrial Digital Twin Assoc



STANDARDIZATION  
COUNCIL  
INDUSTRIE 4.0

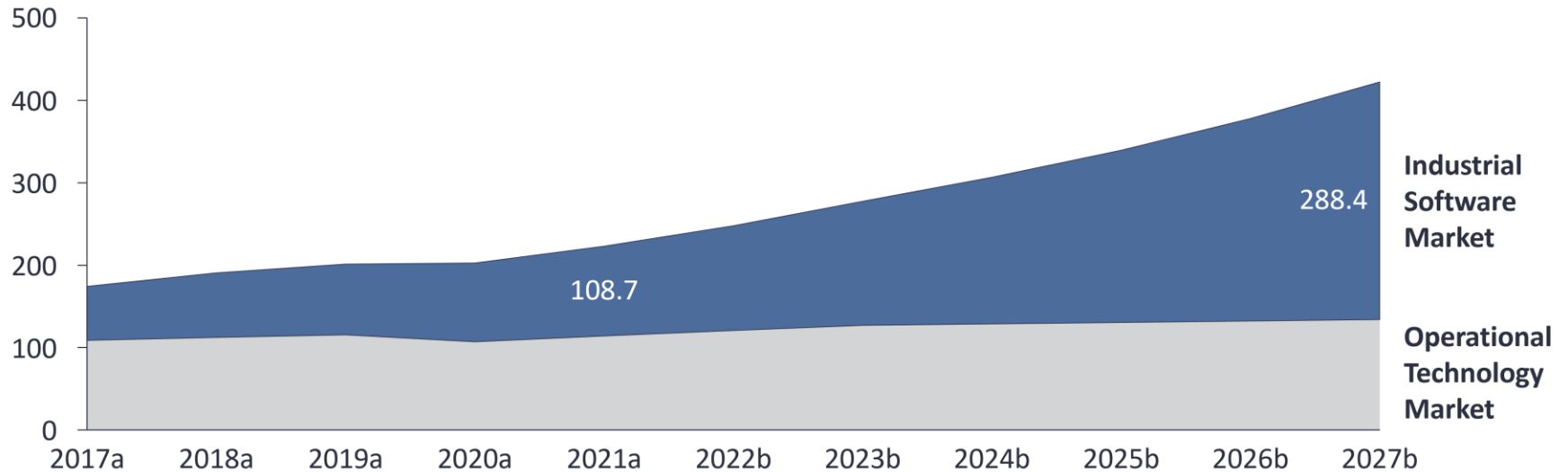
Market?

# Industrial Software Market vs. Operational Technology Market

Ratio of Software to OT Market

1:1

2:1



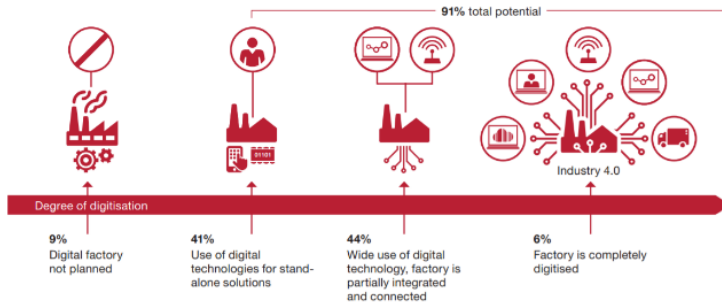
**Note:** The industrial software market includes the following 14 software categories: CAD, PLM, EDA, EAM, MOM, SCM, field service, IIoT platforms, cybersecurity, cloud infrastructure and services, remote access, virtualization, and data and analytics. **OT:** Includes OT hardware and directly related or embedded software. OT hardware is defined as industrial equipment or assets that perform direct monitoring and/or control of industrial processes and events. It includes PLCs, supervisory control and data acquisition (SCADA), DCS, CNC, and related hardware. **(a): Actual (f): Forecast.**  
**Source:** IoT Analytics Research, Industrial Software Landscape 2022–2027. We welcome republishing of images but ask for source citation with a link to the original post and company website.

# Companies?

PwC's survey reports that 91% of industrial companies are investing in digital factories, however only 6% rate their factories as 'fully digitised'.



Fig. 2 Nine out of ten companies are investing in digital factories

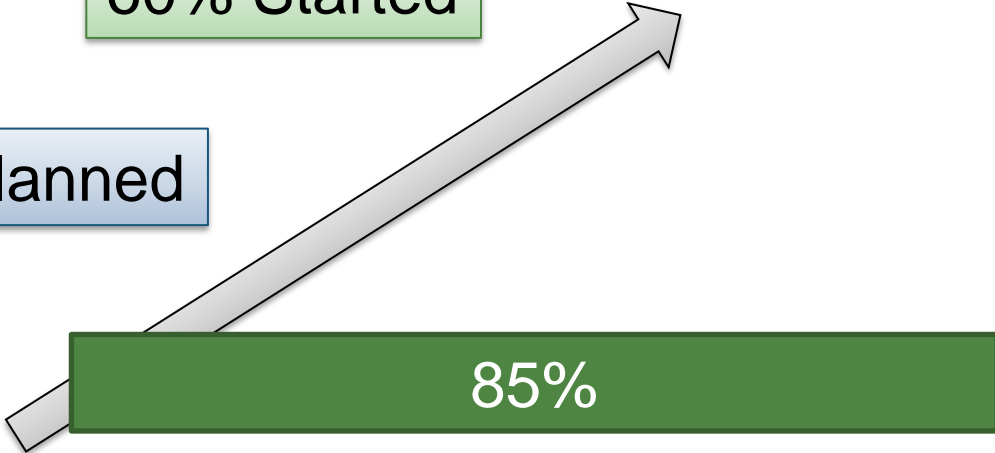


5% Industry 4.0

60% Started

20% Planned

15% Not planned



# COVID 19 digital acceleration?

## COVID-19

A Call for Digital Transformation

How **COVID-19** Is Accelerating the Unprecedented Digital Transformation



- The pandemic has highlighted the possible uses and benefits of Digital transformation

## How has your perception of Industry 4.0's value changed since the pandemic?

Respondents, %

Industry 4.0 is more valuable

65

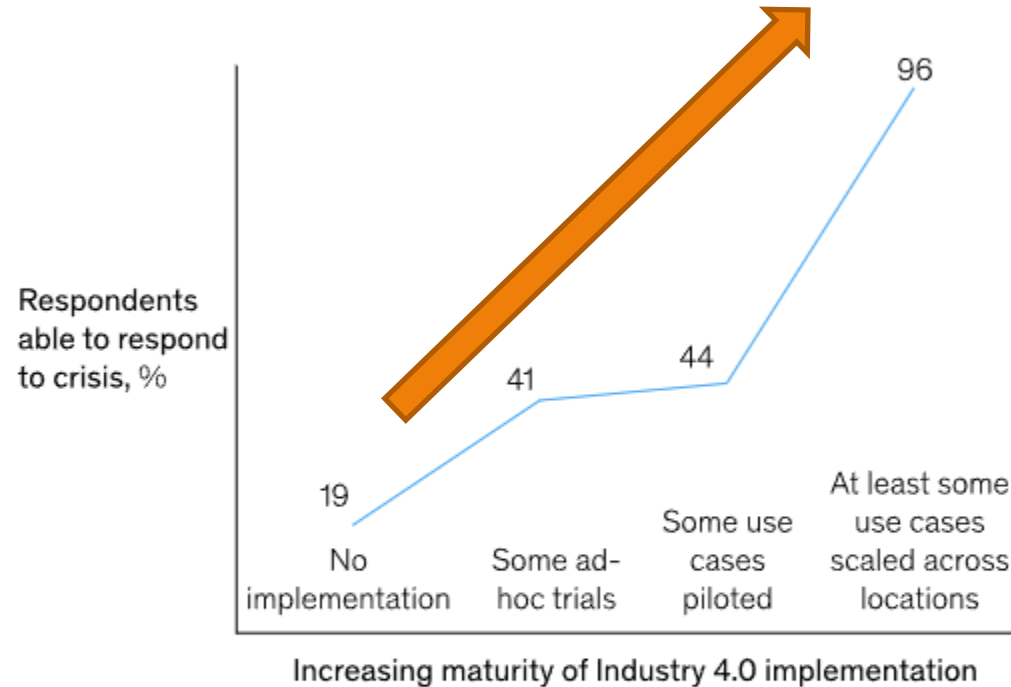
Industry 4.0's value is unchanged

23

Industry 4.0 is less valuable

12

## Companies whose Industry 4.0 implementation is more mature report stronger ability to respond to crisis.



## How has your perception of Industry 4.0's value changed since the pandemic?

Respondents, %

Industry 4.0 is more valuable

65

Industry 4.0's value is unchanged

23

Industry 4.0 is less valuable

12

- The pandemic has highlighted the possible uses and benefits of Digital Manufacturing
- But constraints are imposed because lack of resources and uncertainty situation.

## The crisis forced some companies to halt their Industry 4.0 investments.

### Top two reasons our company is no longer implementing Industry 4.0

Respondents, %

Implementation not possible because of travel restrictions or remote work

39

Pandemic-driven cash constraints

32

Pandemic-driven team-capacity constraints

21

Senior management directive to stop Industry 4.0 implementation

13

Lack of underlying IT/OT<sup>1</sup> infrastructure

7

<sup>1</sup>Information technology/operation technology

McKinsey  
& Company

## Context 2022: Uncertainty clouds



COVID19

.....

Energy cost

Semiconductor shortage

Inflation

Crime and cyber attacks

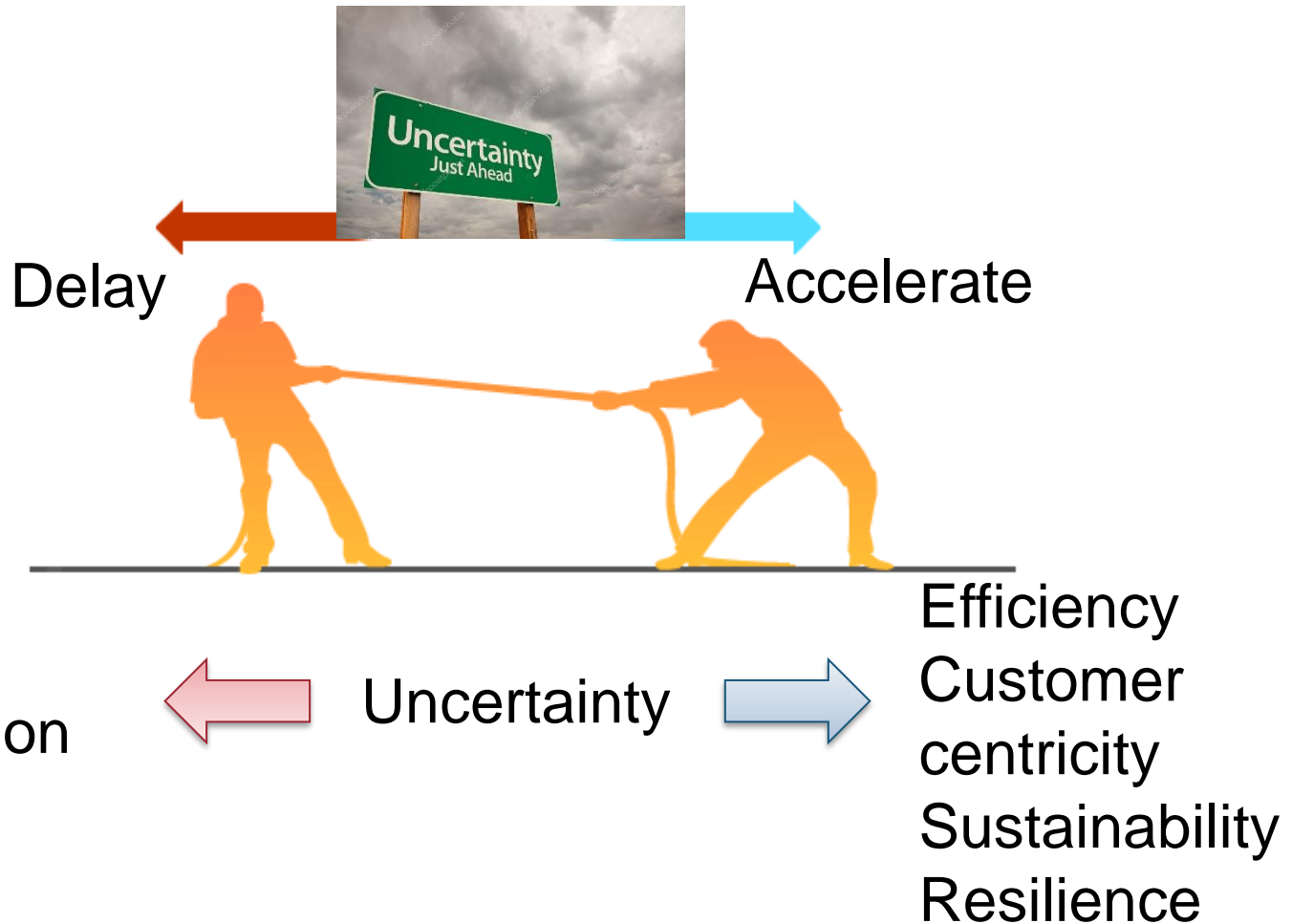
Geopolitical conflict.

Climate change

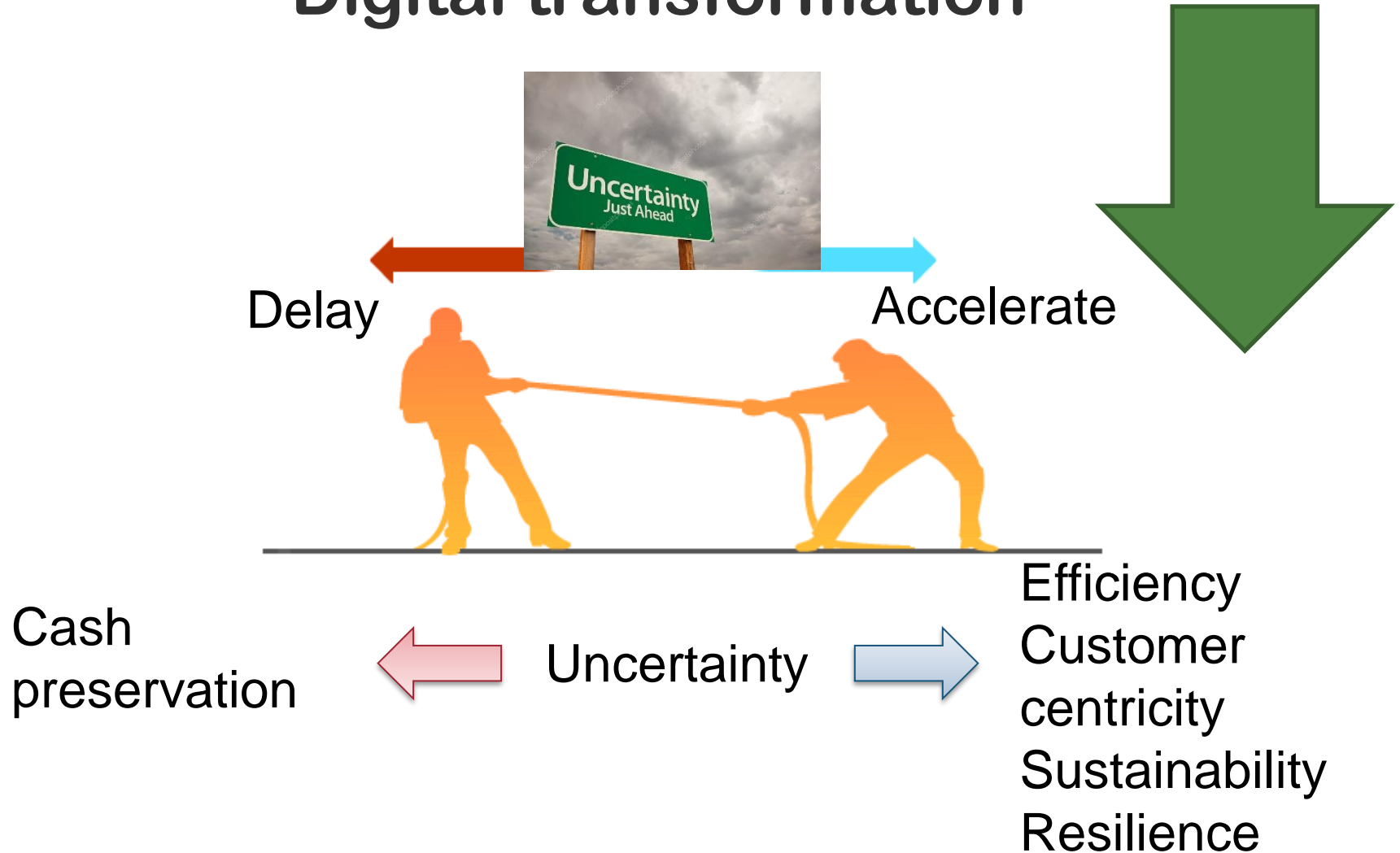
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Is a recession looming?

# Digital transformation

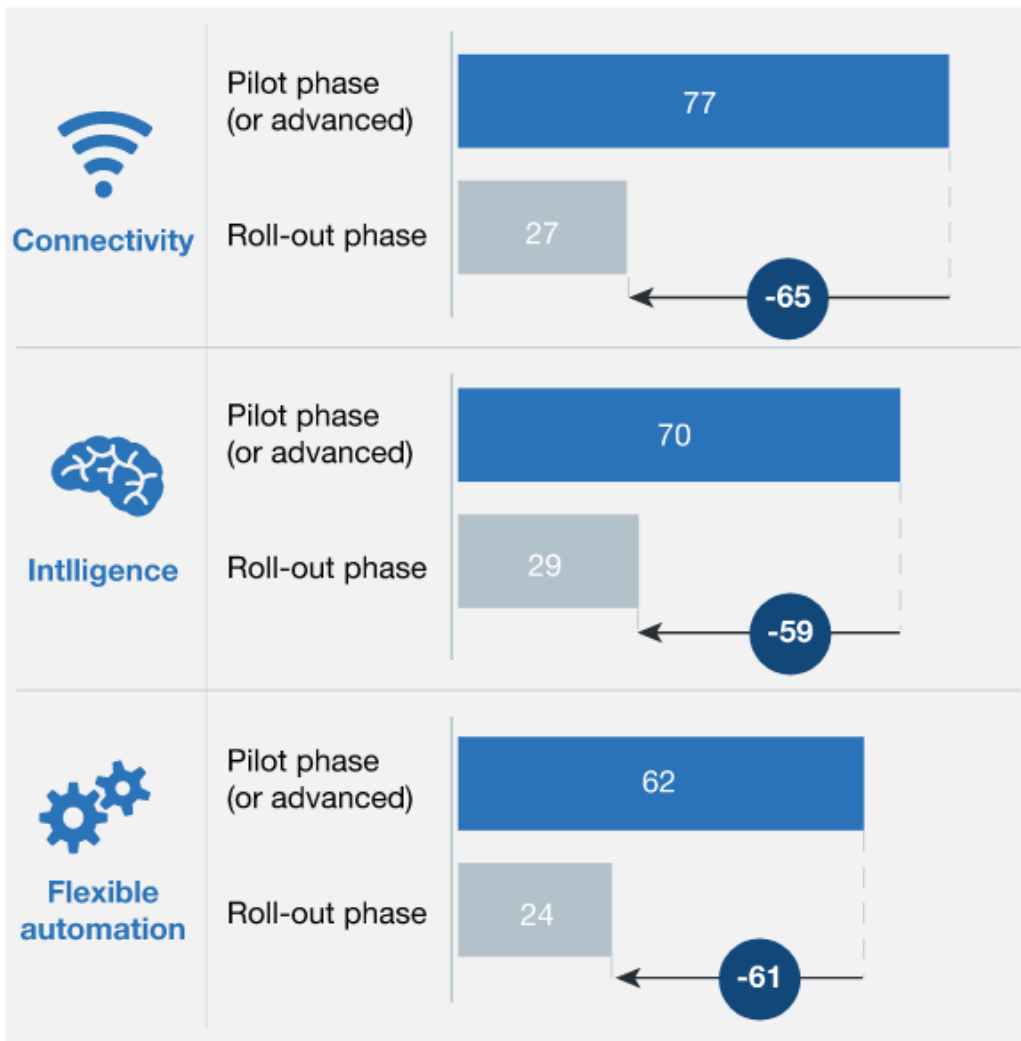


# Digital transformation



- The pandemic has highlighted the possible uses and benefits of Digital Manufacturing
- But constraints are imposed because lack of resources and uncertainty situation.
- After starting their Digital journeys, most companies remained stuck in a pilot purgatory

Percent of solutions by type at each stage of development



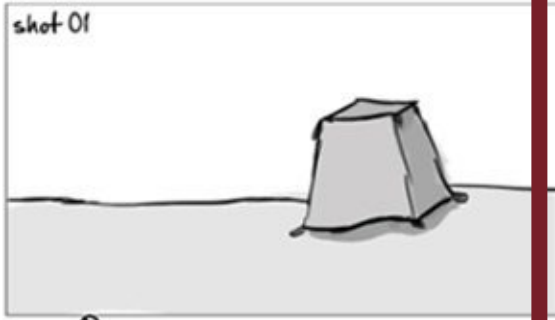
**Lacking impact at scale** – Only ~30% of relevant solutions in company-wide roll-out



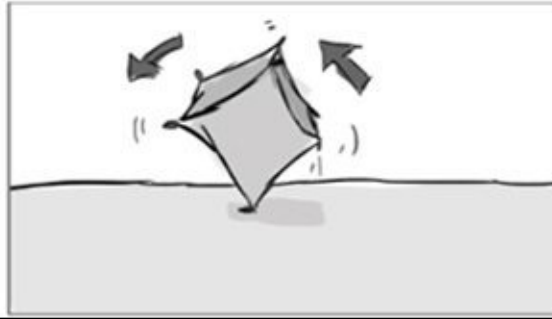
- **Complexity:** heterogeneous environment. A typical medium-size plant > 200 pieces of equipment of a variety of suppliers and ages.
- **Unconnected machines, legacy software:** 90% of data is purged/lost during the first 30 days.
- **Security concerns:** reluctance to store the data in the cloud.
- **Lack of data harmonization:** Industry 4.0 at scale requires the ability to extract, interpret, and harmonize data from disparate systems.



# Digital Transformation of Metrology for Decision Intelligence in Manufacturing



Digital Factories  
in 2022



Reframing digital  
transformation



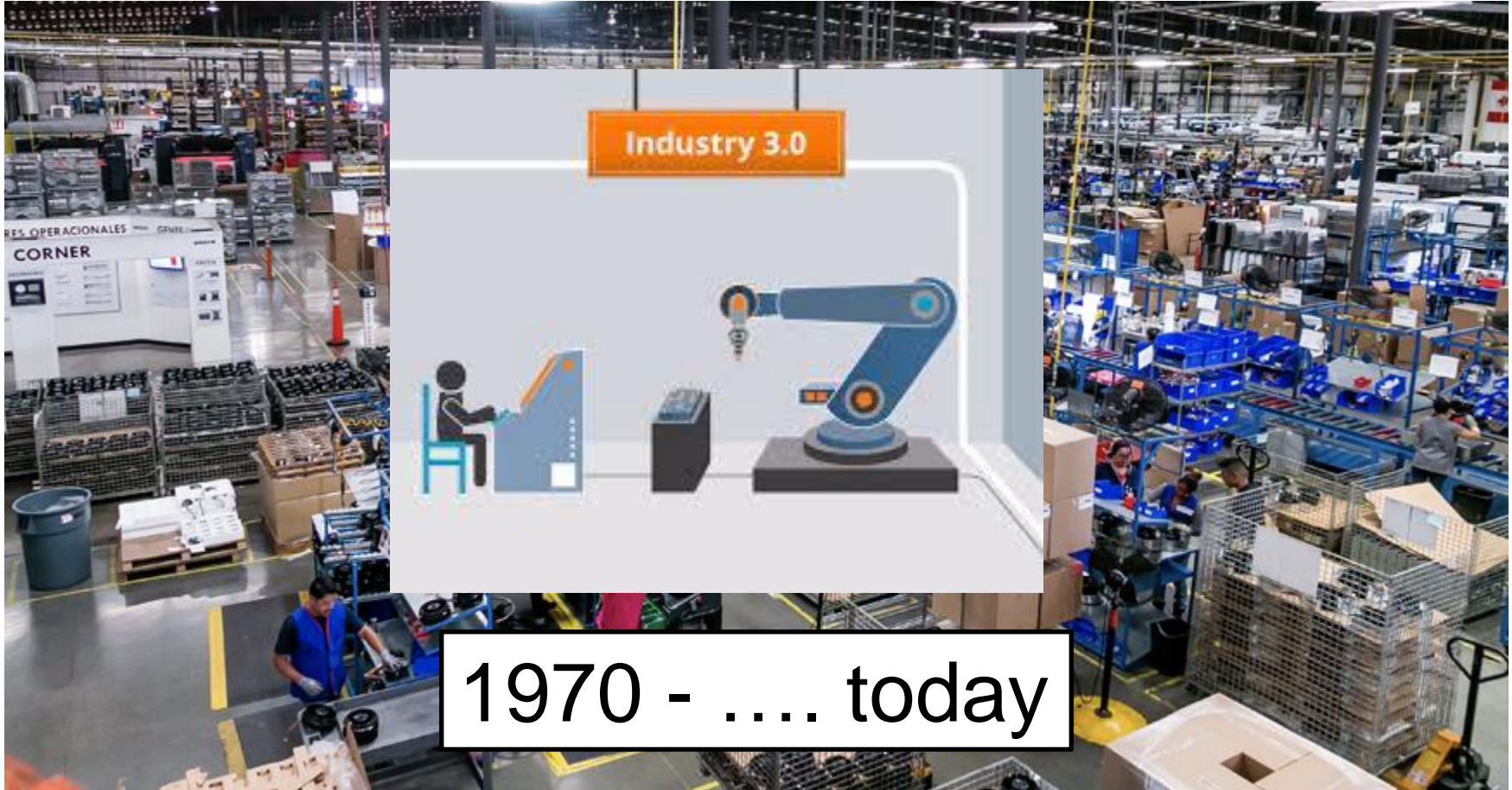
Metrology for  
digital factory



**BEHIND  
THE SCENES**

# Of Digital Transformation







T Total  
Q Quality  
M Management

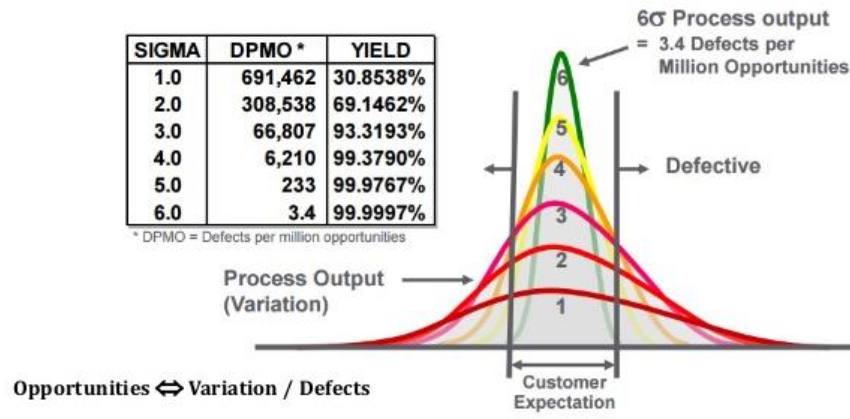
Edward Deming  
(1900-1993)



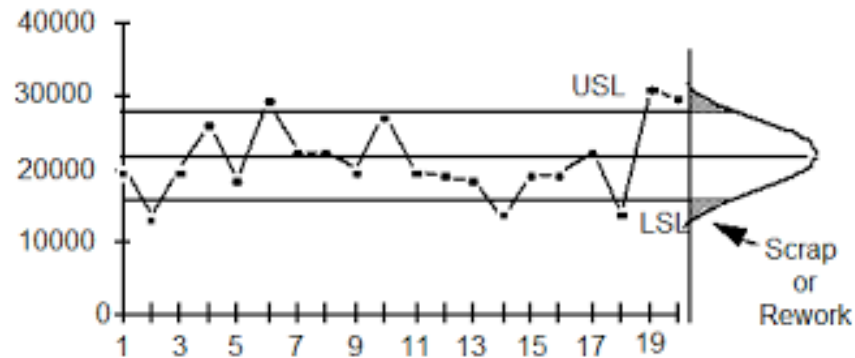
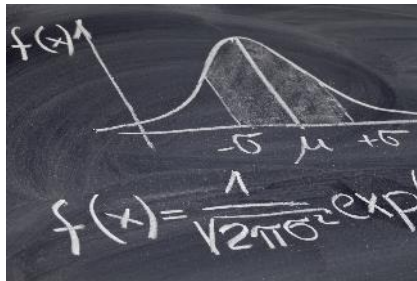
Bill Smith  
(1929-1993)

SIGMA	DPMO*	YIELD
1.0	691,462	30.8538%
2.0	308,538	69.1462%
3.0	66,807	93.3193%
4.0	6,210	99.3790%
5.0	233	99.9767%
6.0	3.4	99.9997%

\* DPMO = Defects per million opportunities



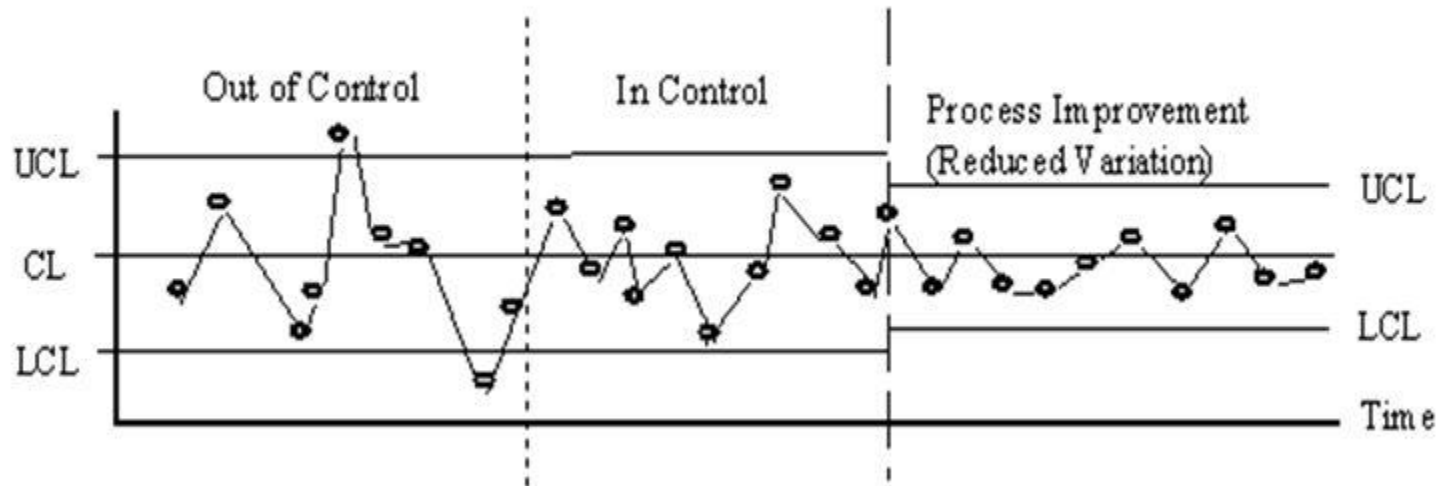
# Mission: taming the variability



## Measurements & Statistics

Forecasting. Decisions.

# SPC Process Improvement



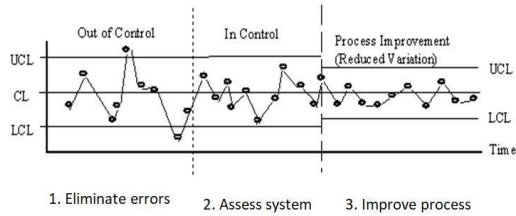
1. Eliminate errors

2. Assess system

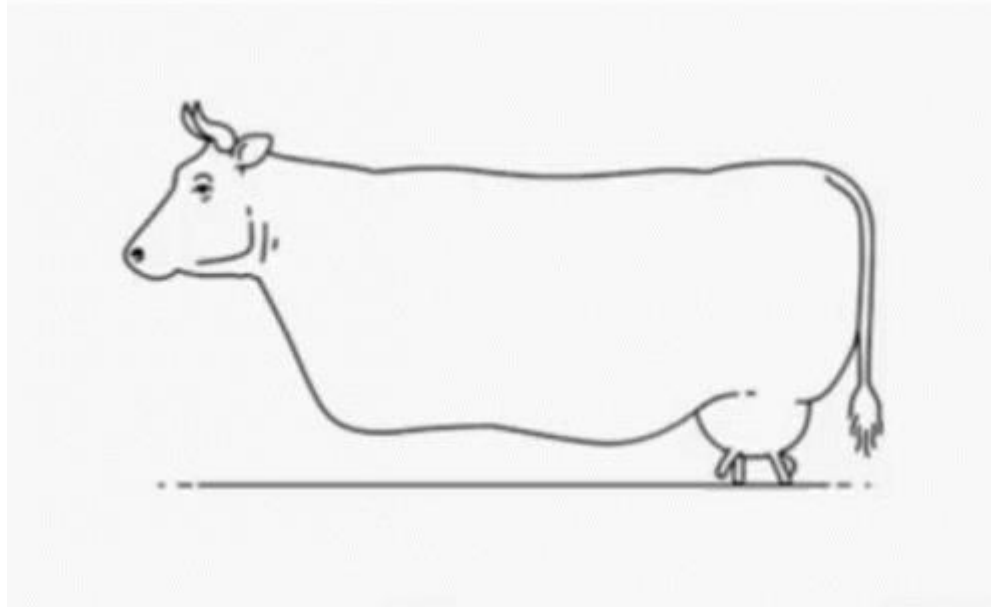
3. Improve process

Forecasting. Decisions.

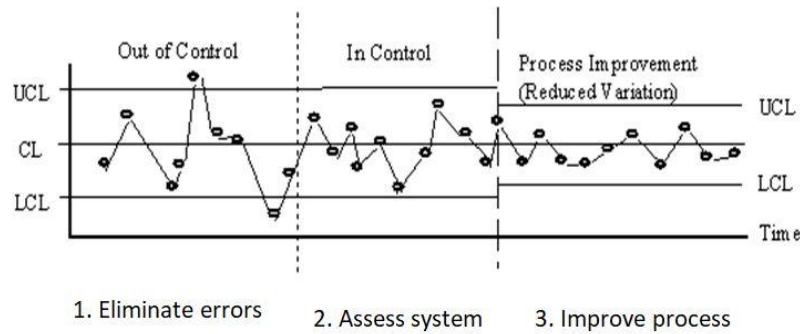
## SPC Process Improvement



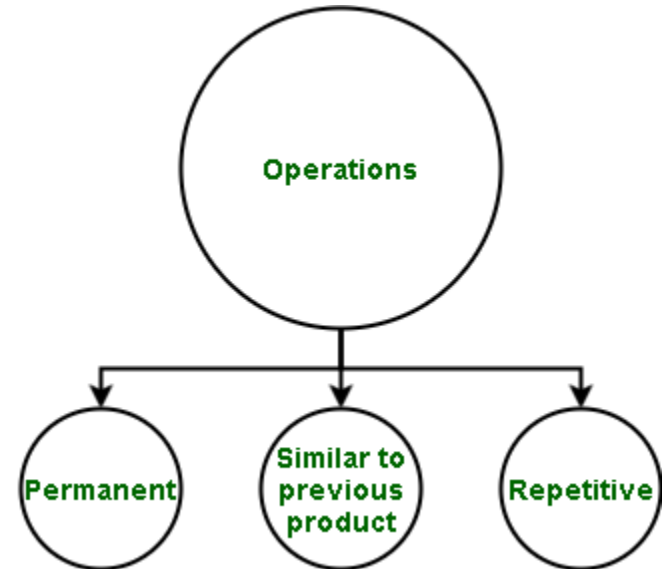
If it works, don't touch it



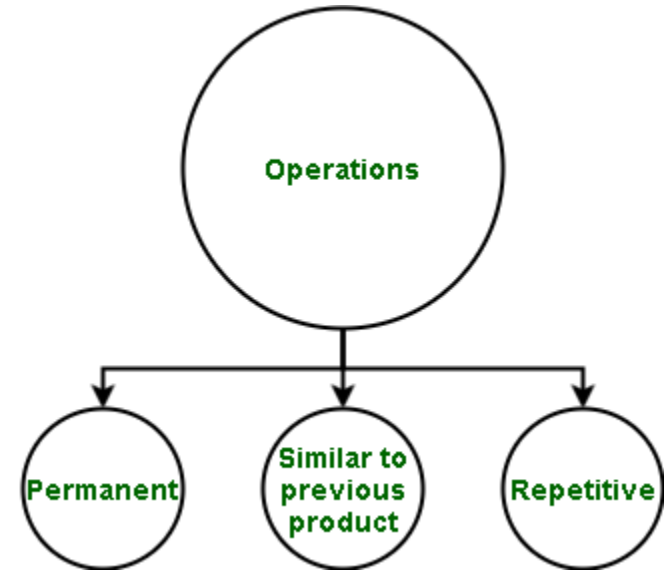
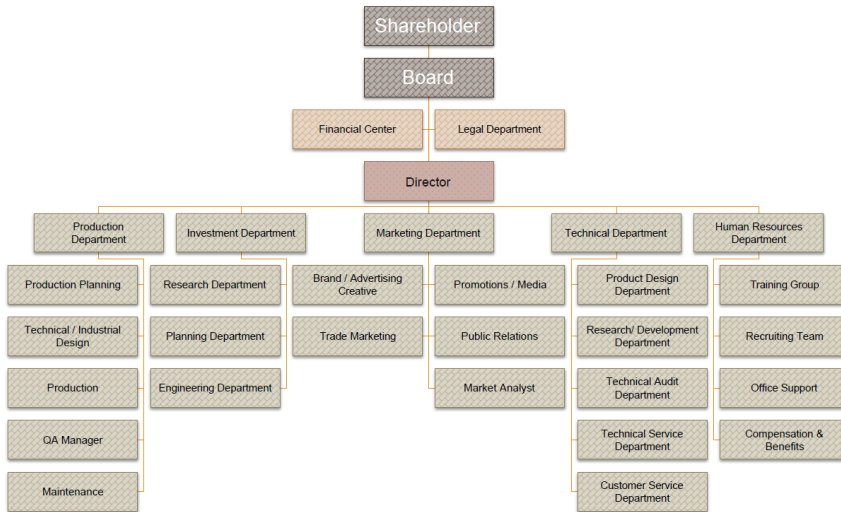
# SPC Process Improvement



## Decisions

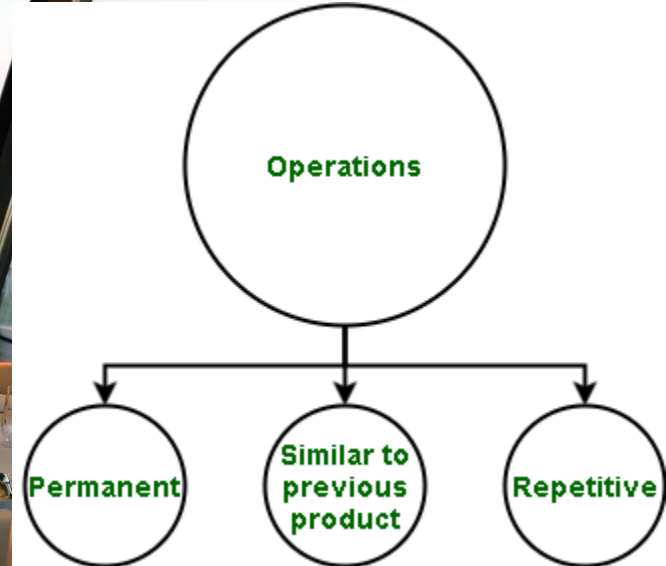
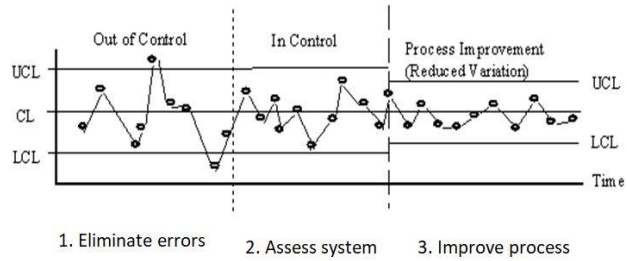


Manufacturing Organizational Chart

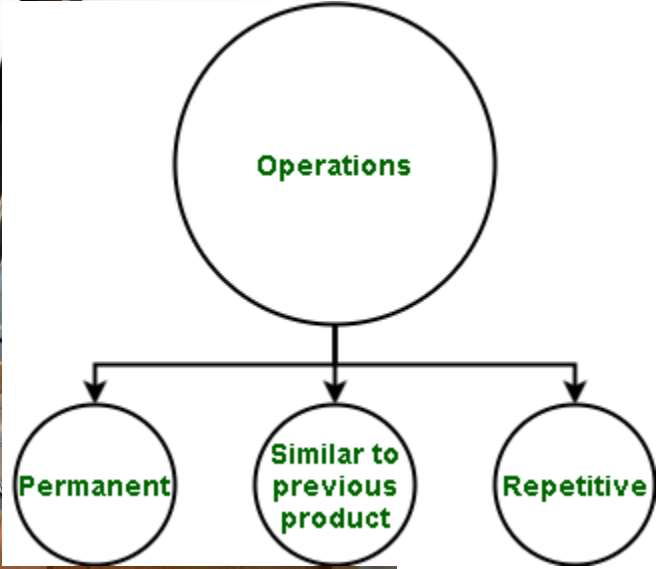
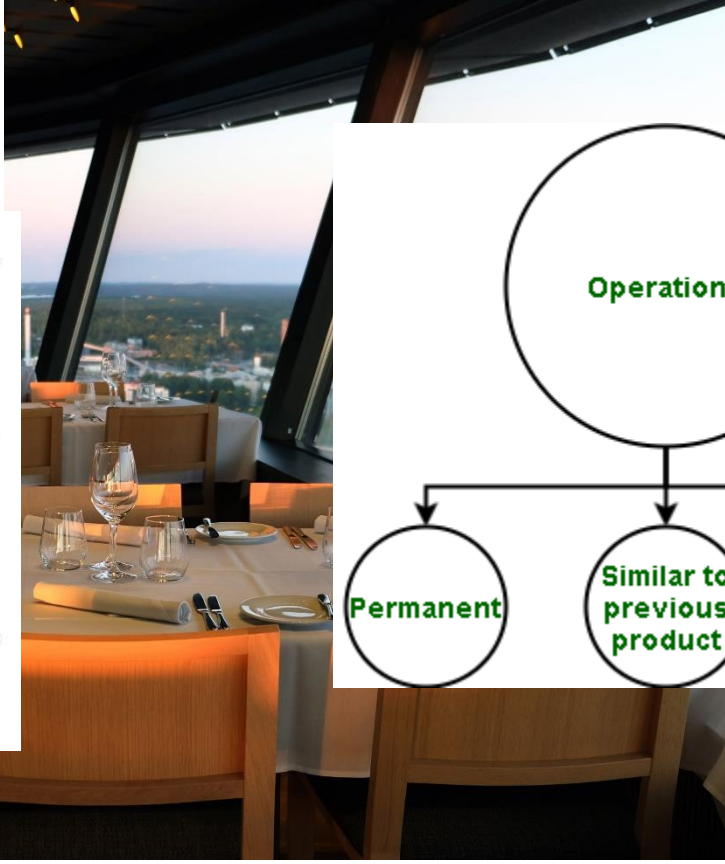
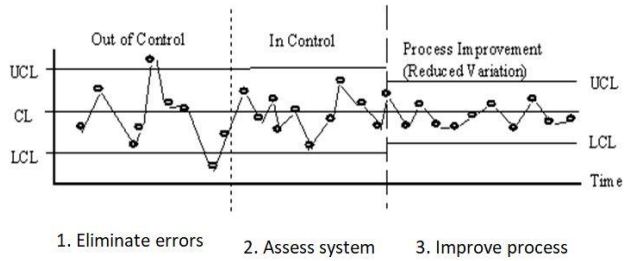




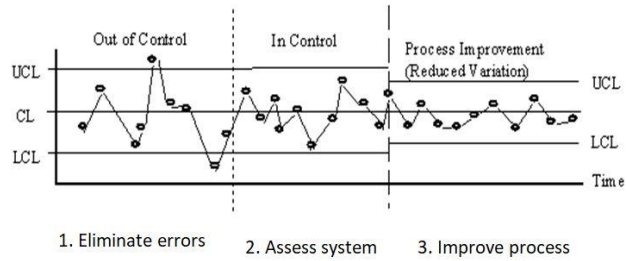
## SPC Process Improvement



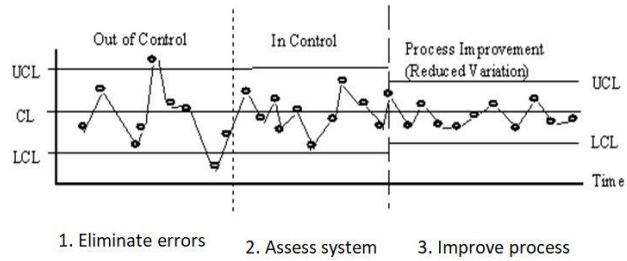
# SPC Process Improvement



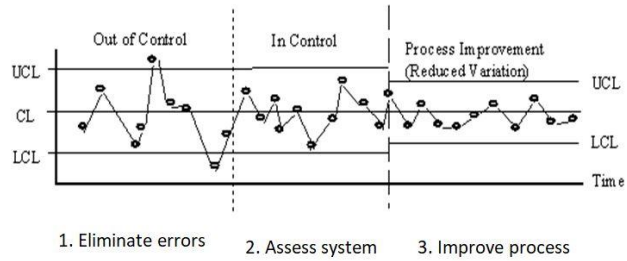
## SPC Process Improvement



# SPC Process Improvement



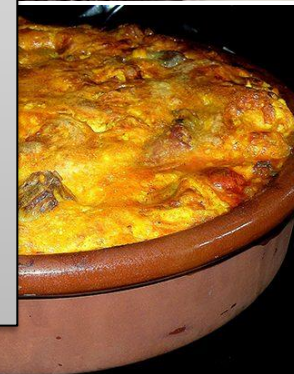
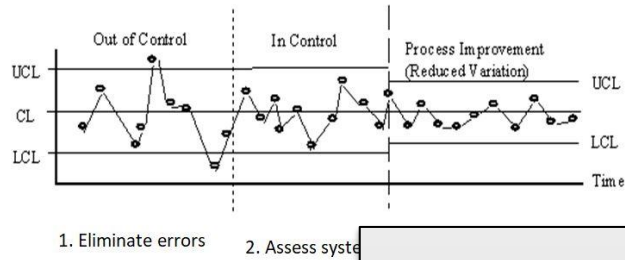
## SPC Process Improvement



SPC Process Improvement



## SPC Process Improvement

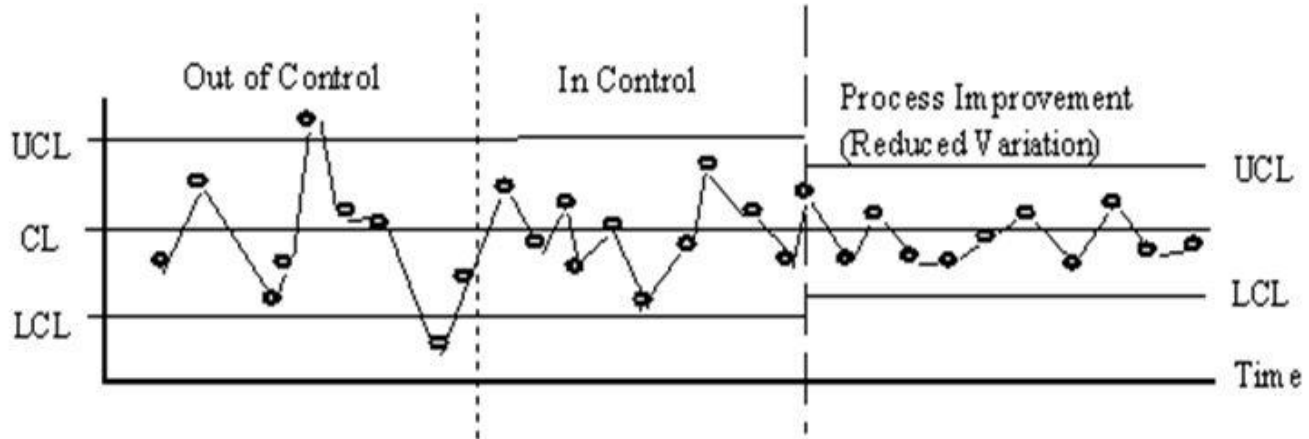


Less energy  
Less defects  
Less carbon print  
Less people

.....ZERO...X



# SPC Process Improvement



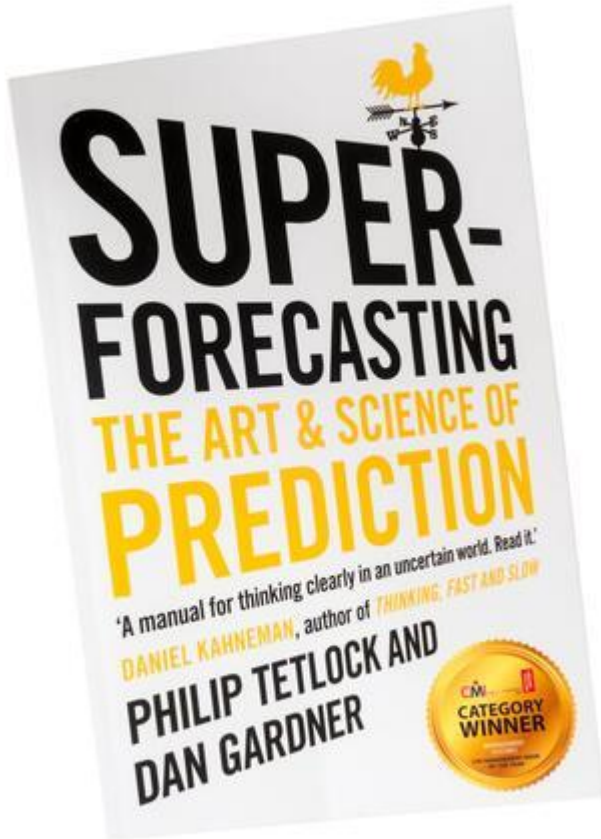
1. Eliminate errors

2. Assess system

3. Improve process

~~Forecasting.~~ Decisions. ?





2016



Philip Tetlock.

(1954-)

Annenberg University Professor at the University of Pennsylvania

*“People can forecast events in 1 year, but in 4 years accuracies decline to random.”*

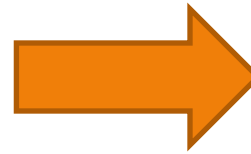
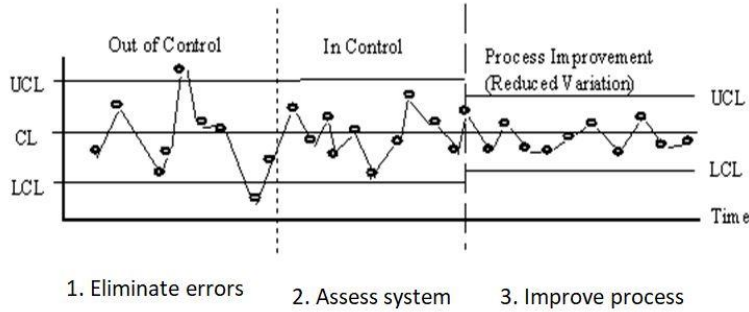
***“The rate of the development is not the rate at which you make observations alone but, much more important, the rate at which you create new things to test.”***



*— Philip Tetlock in Superforecasting: The Art and Science of Prediction*



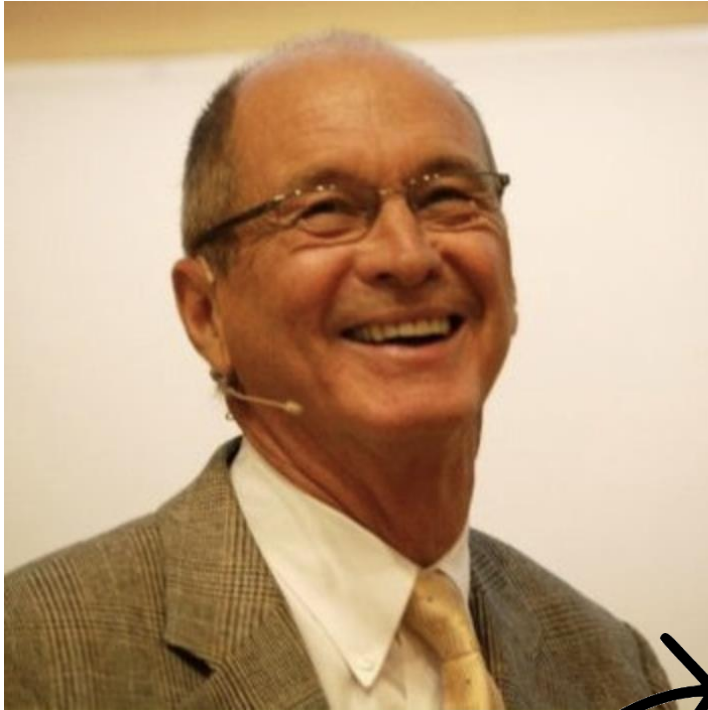
## SPC Process Improvement



**New Things**

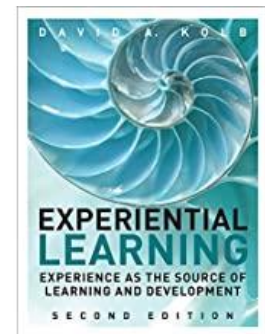
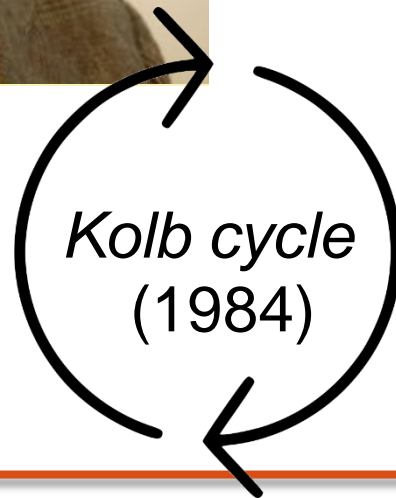
**T** Total  
**Q** Quality  
**M** Management

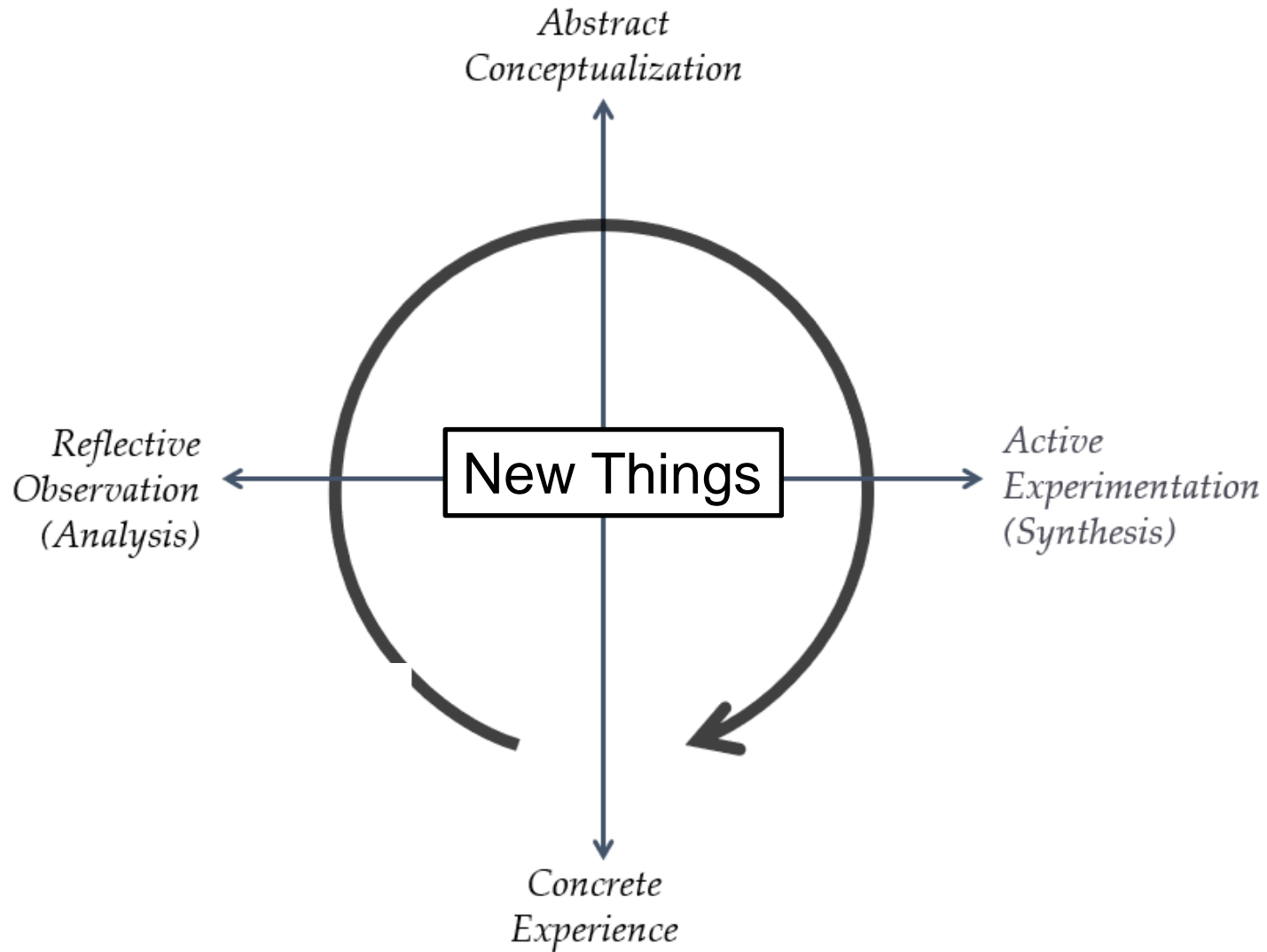
**6σ**  
SIX SIGMA

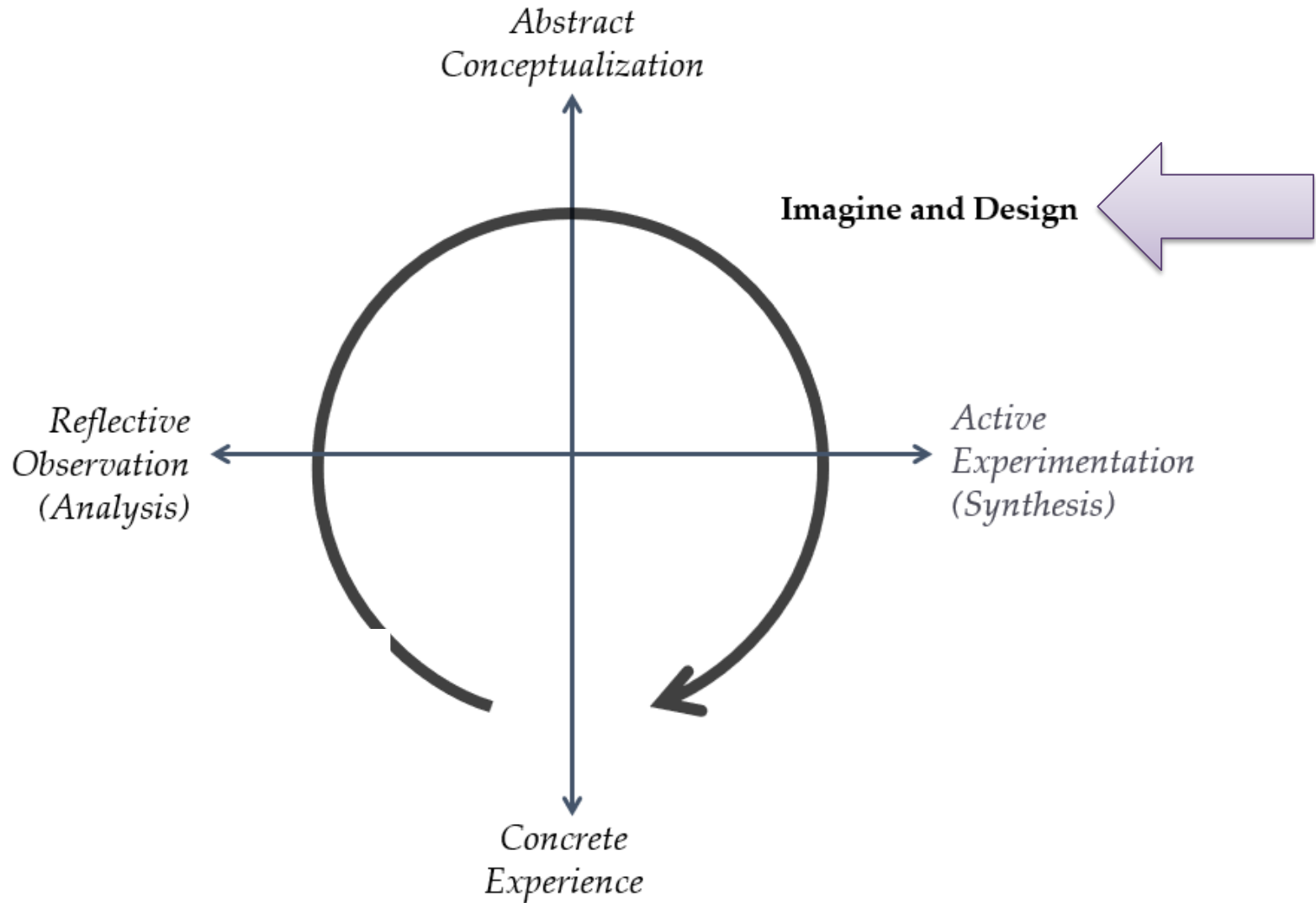


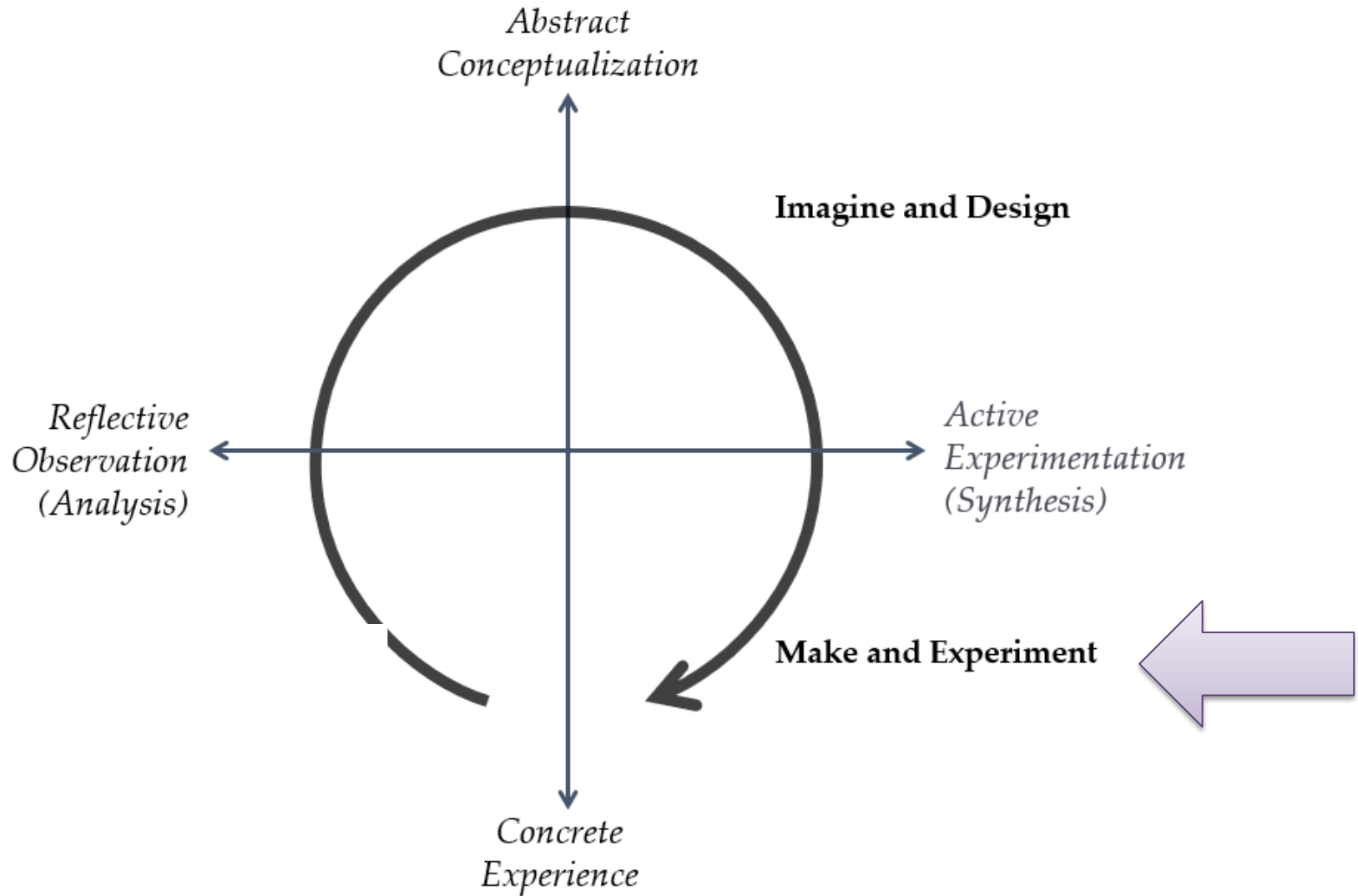
David A. Kolb  
(1939-)

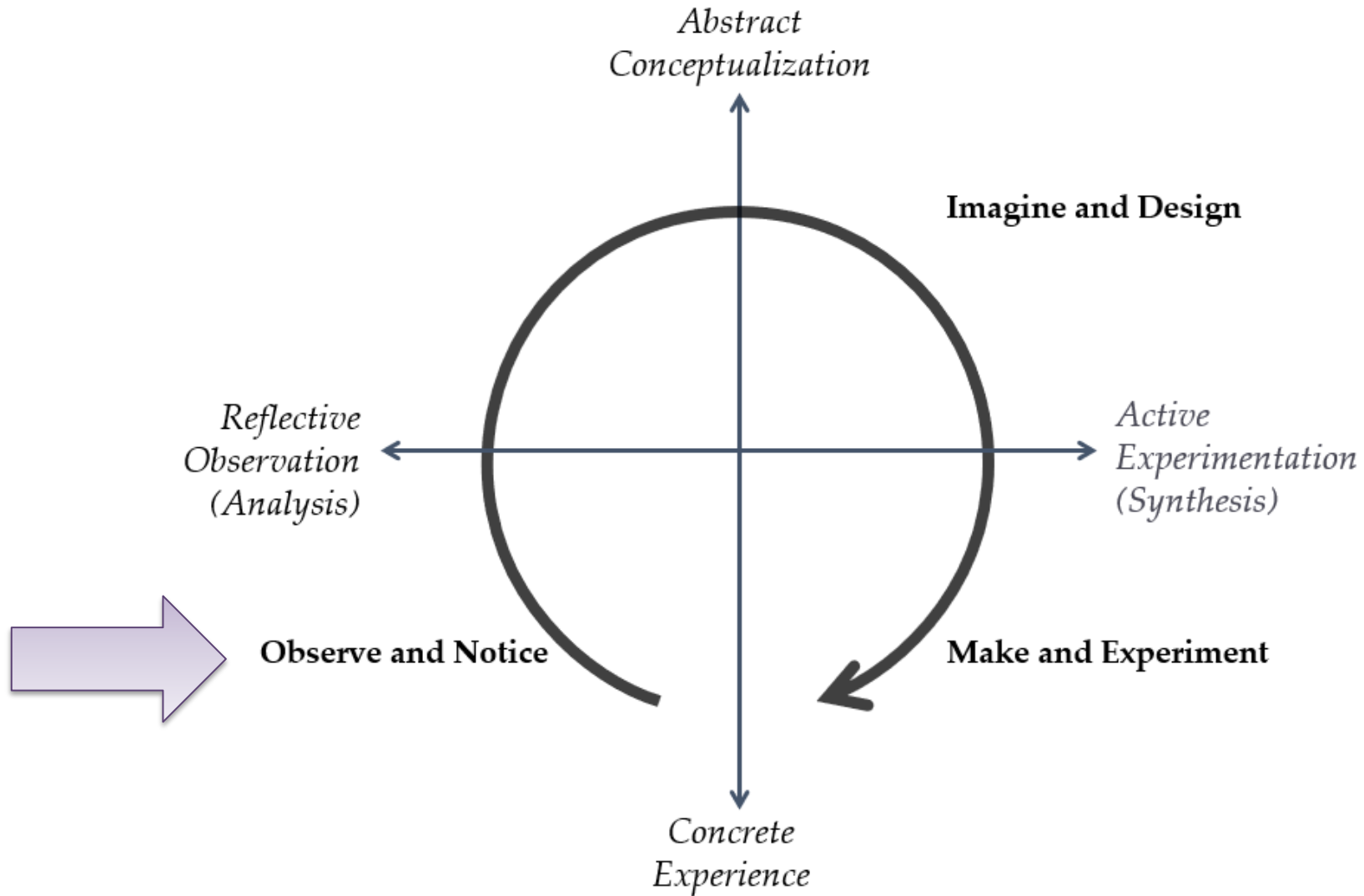
Emeritus Professor of Organizational Behavior in  
the Weatherhead School of Management

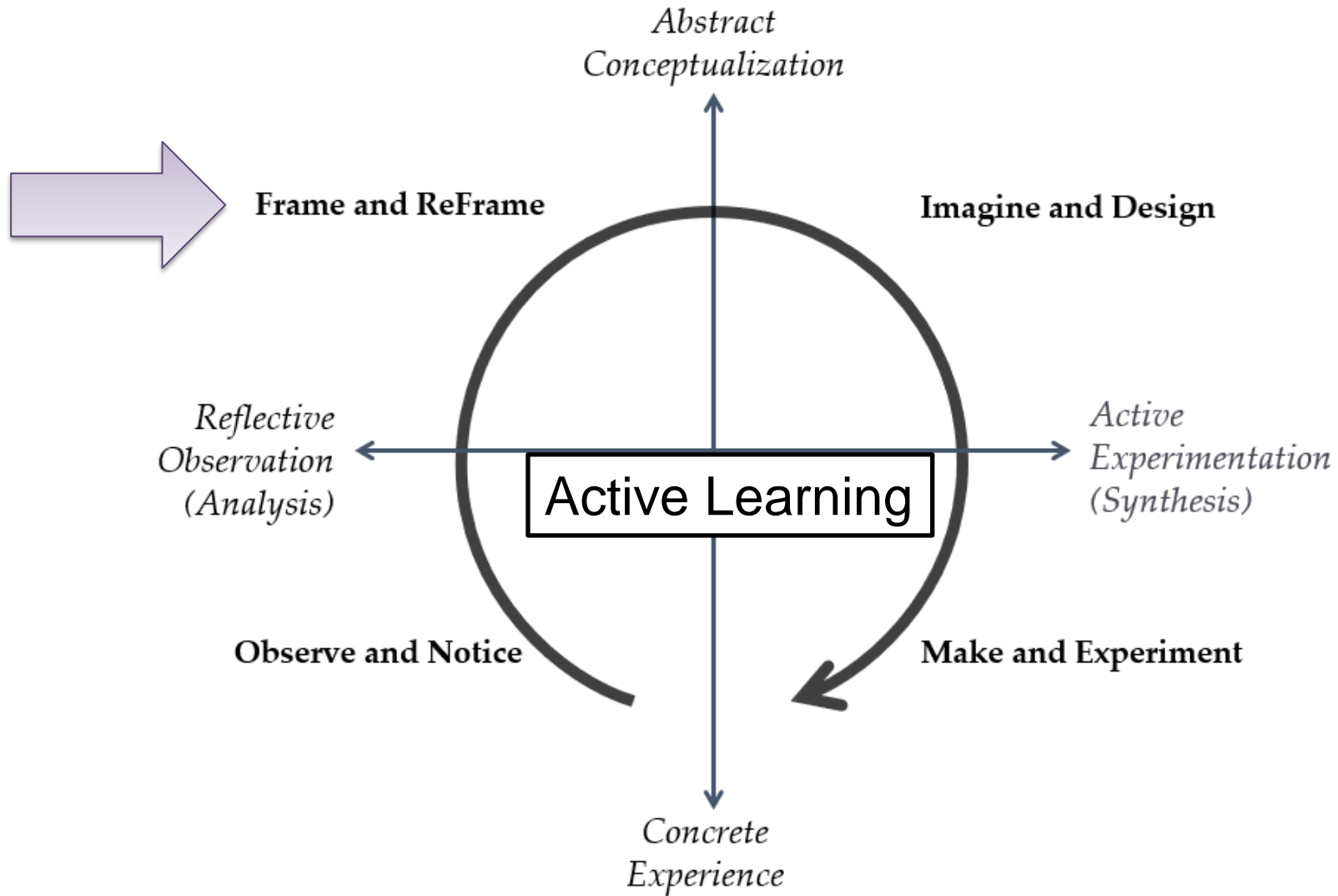


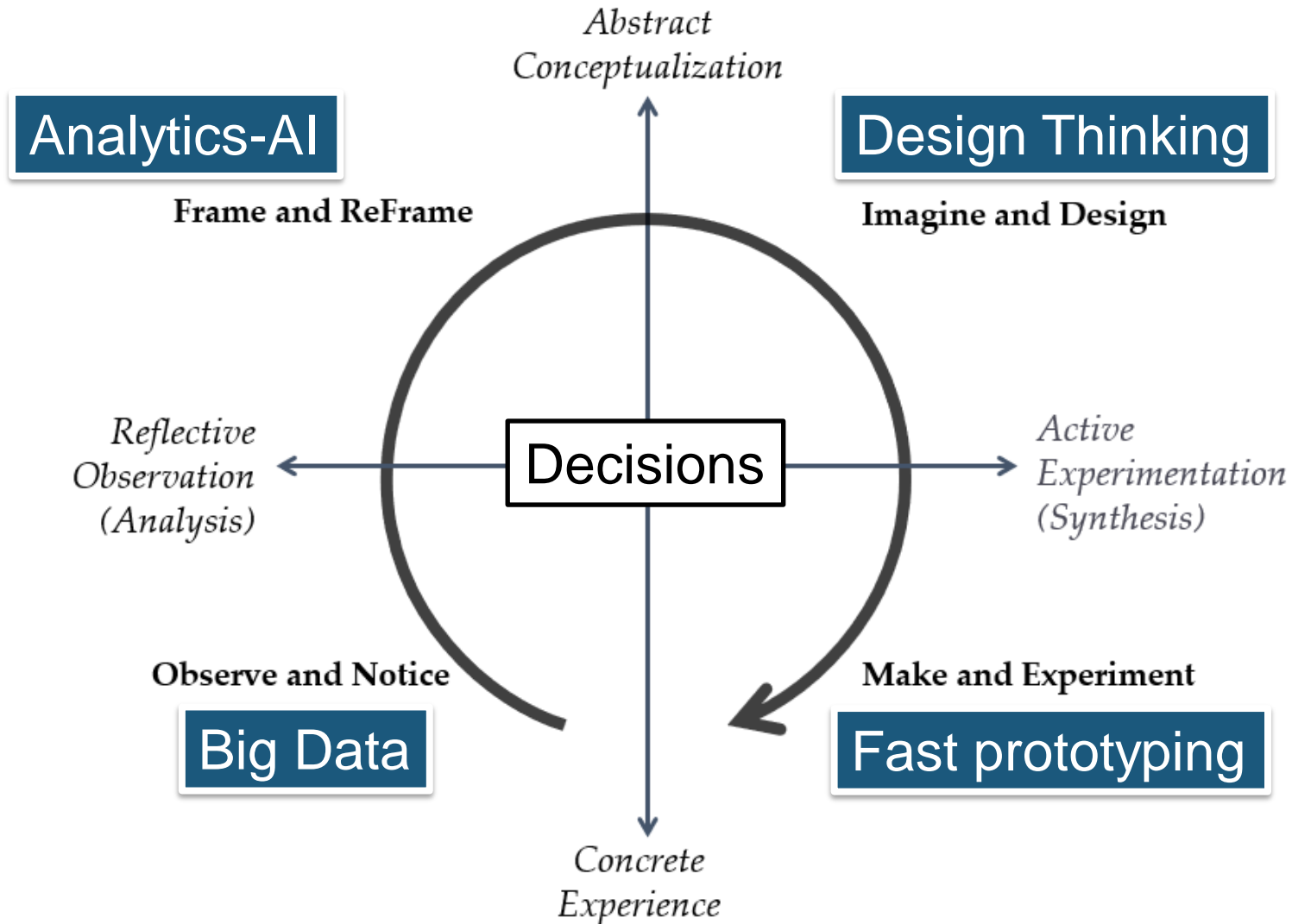


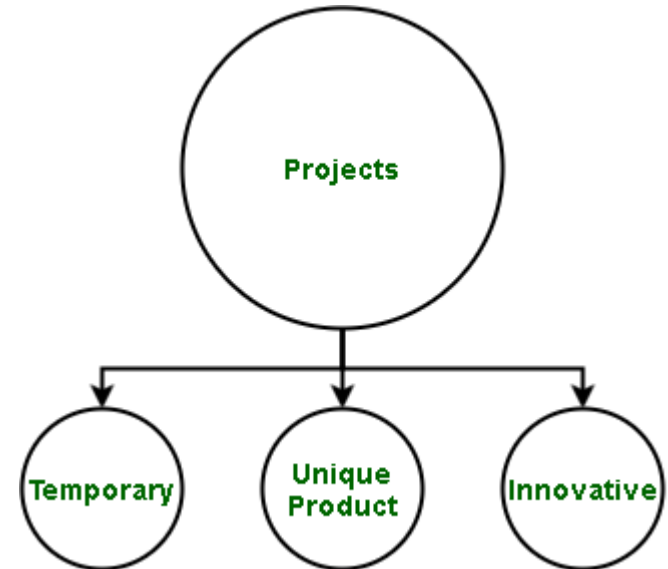
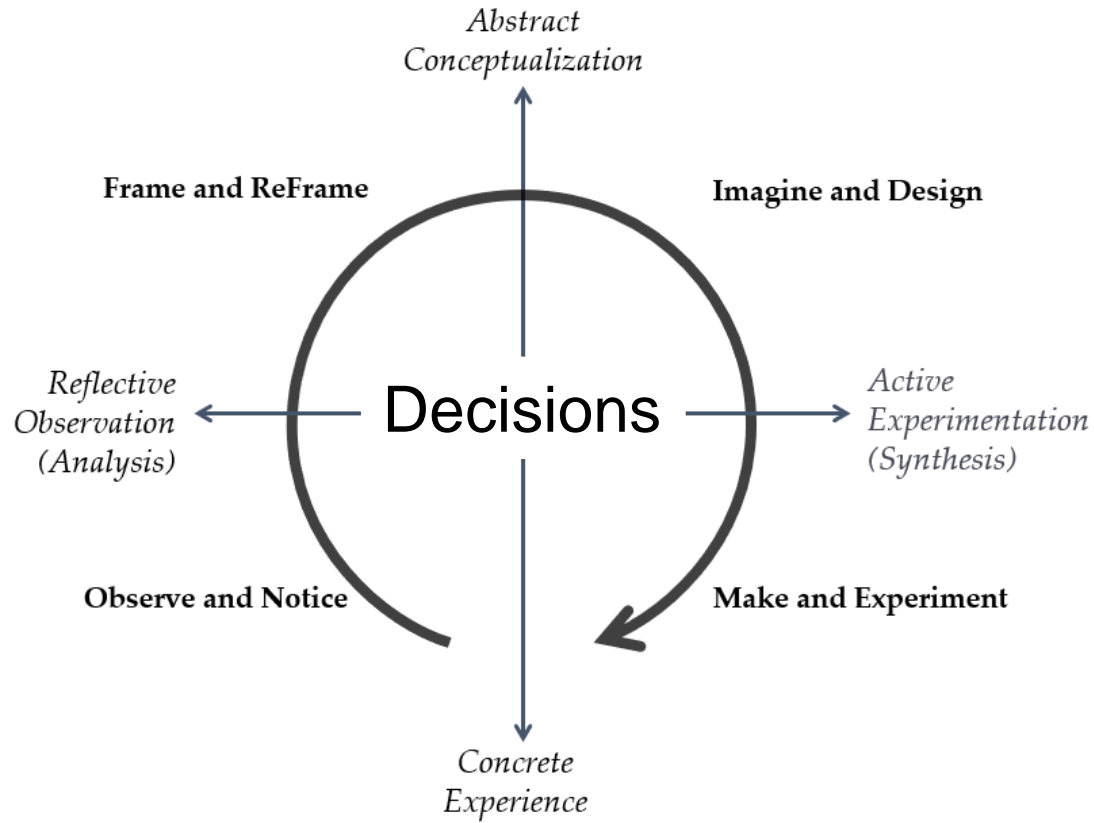


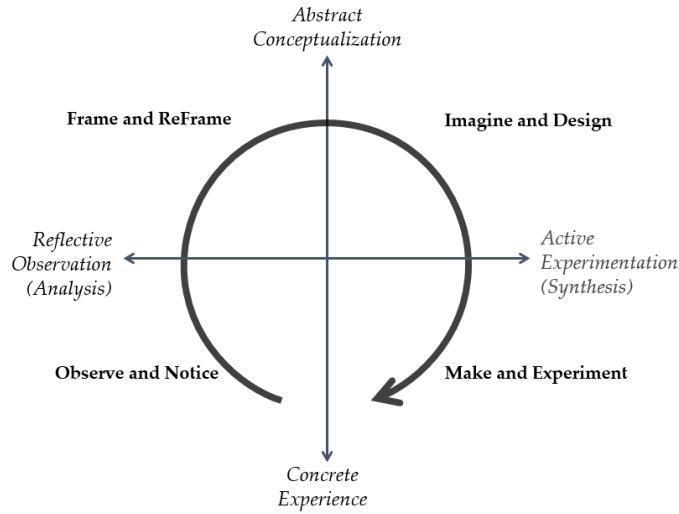




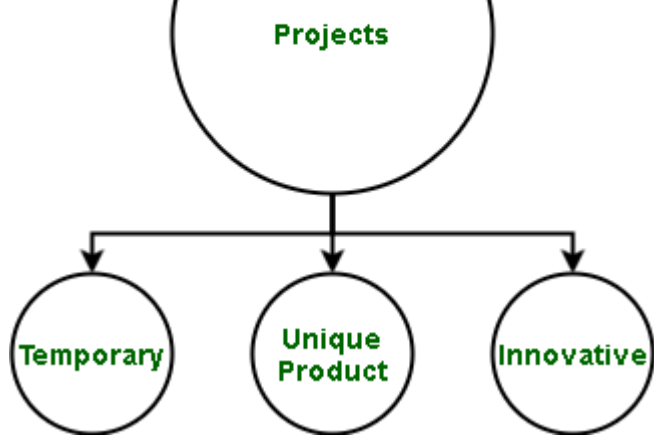




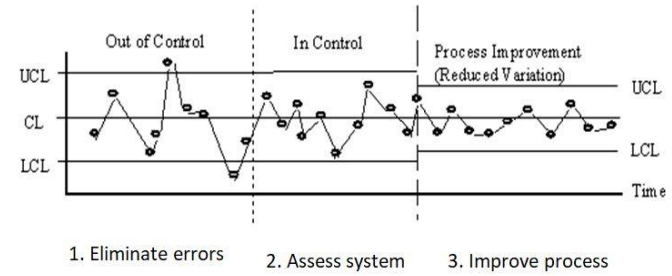




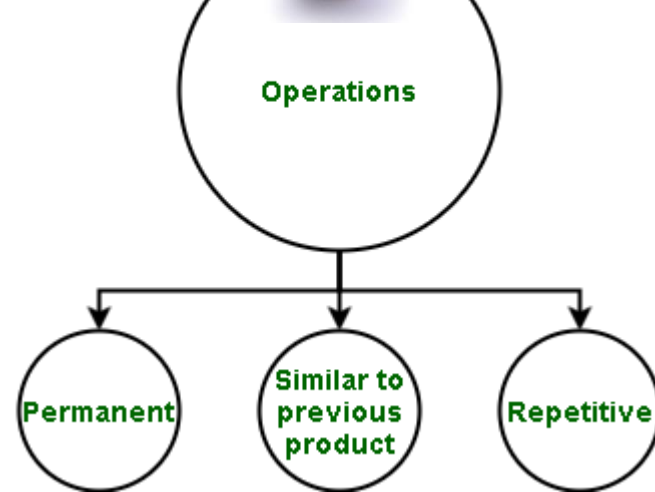
**Projects**

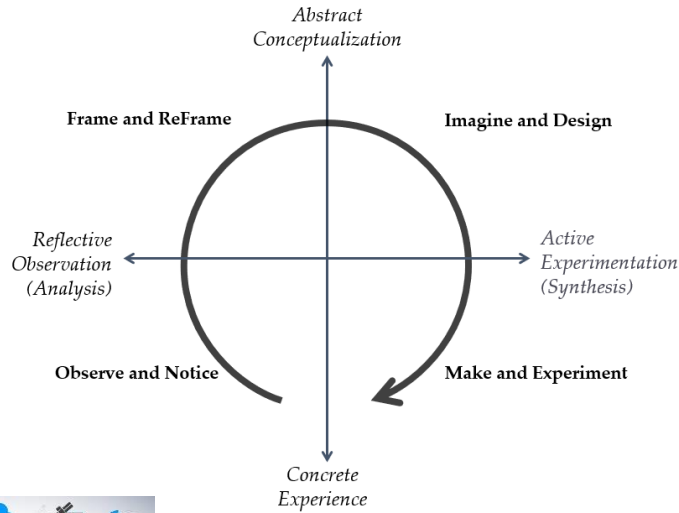


## SPC Process Improvement

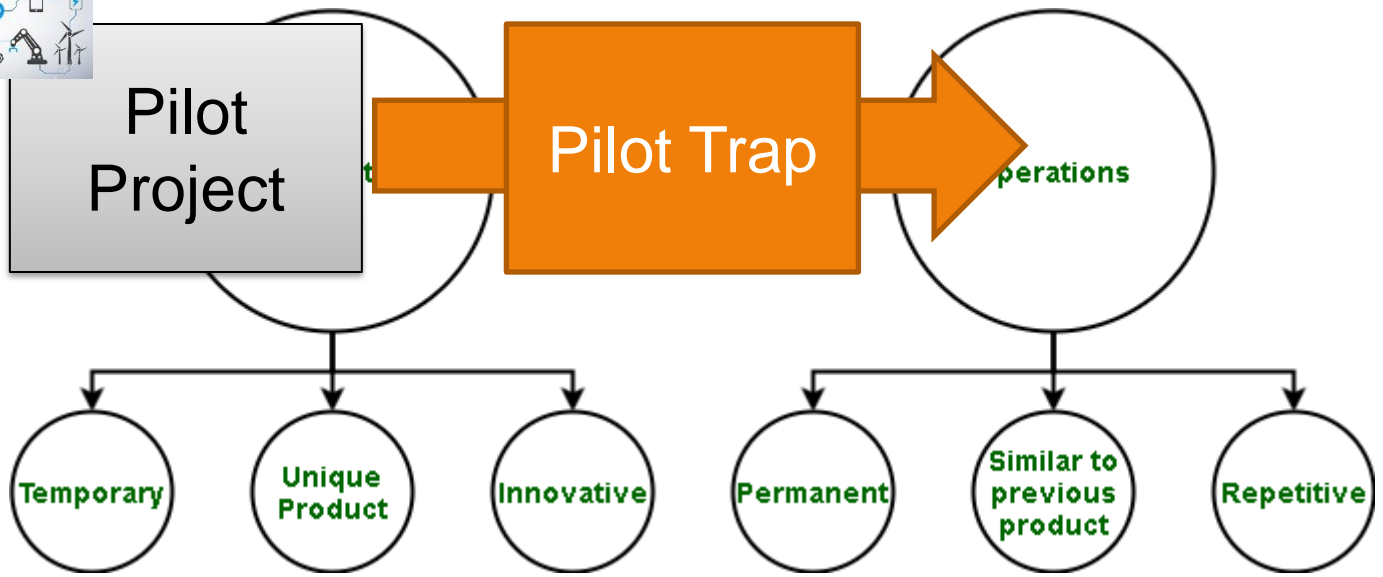
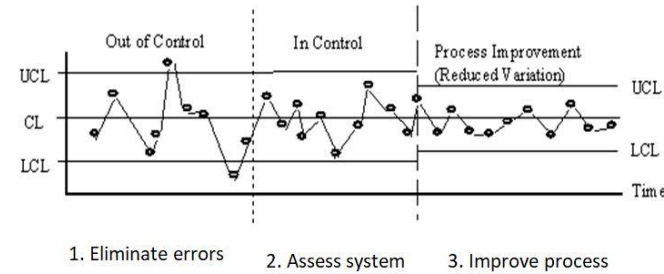


**Operations**

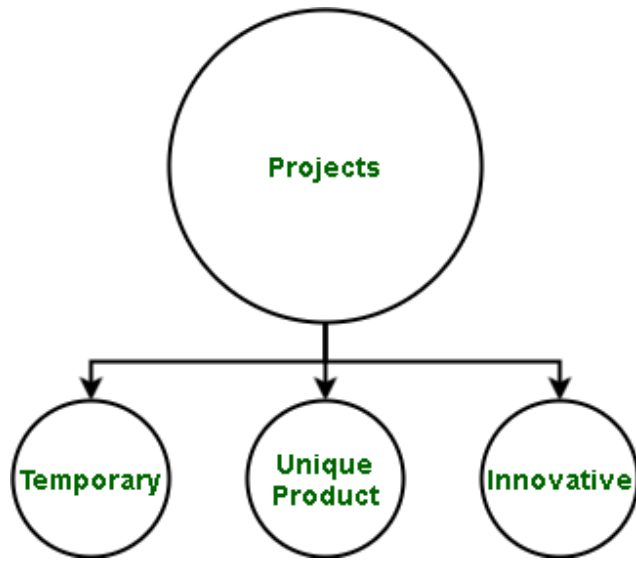




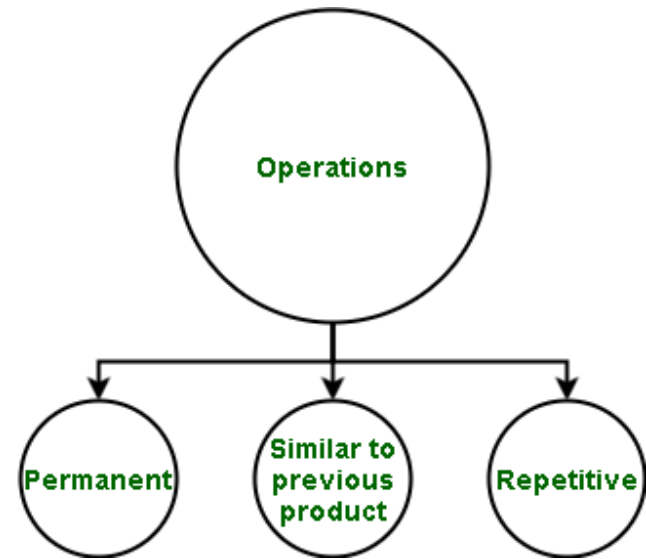
### SPC Process Improvement



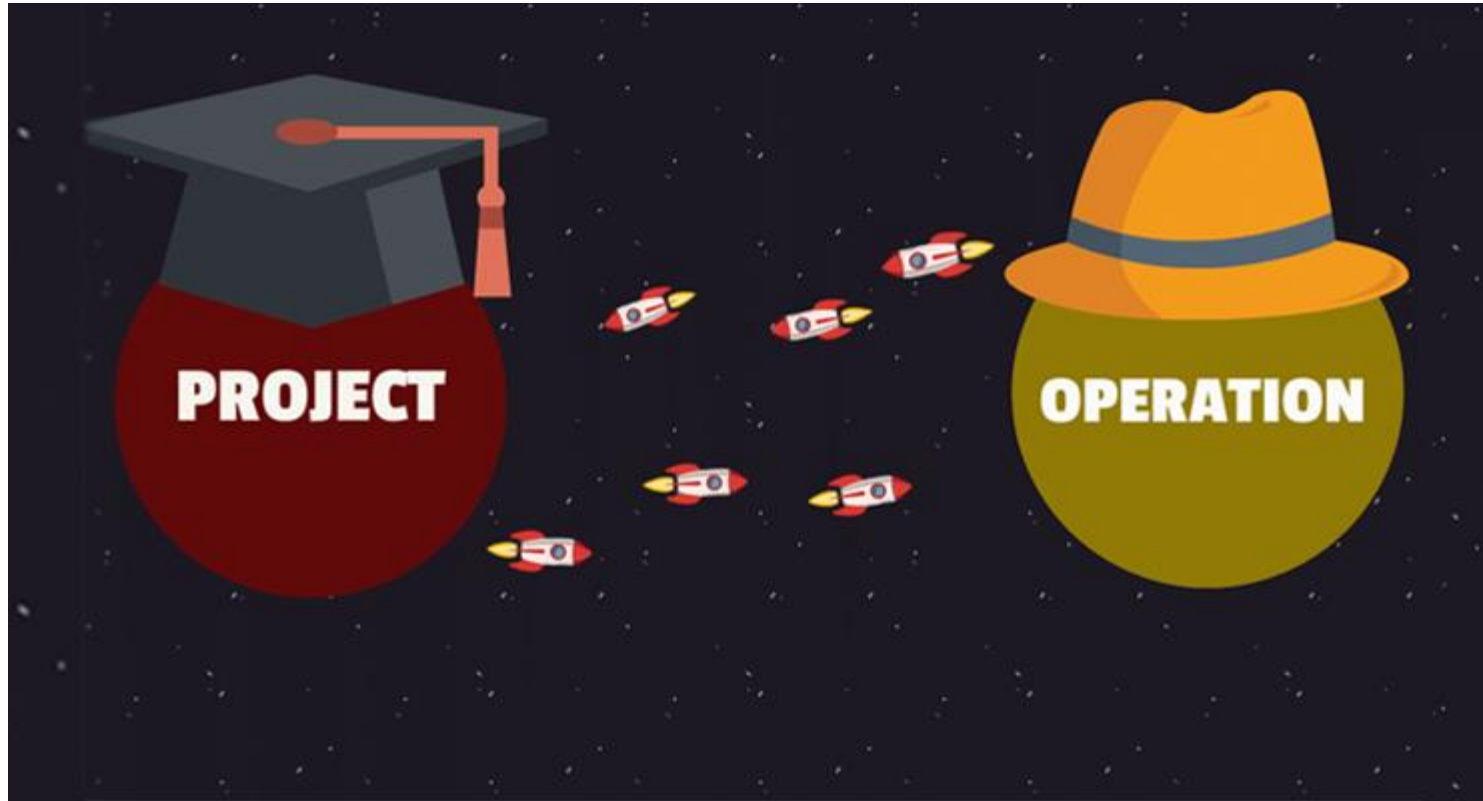
# Thinking styles Decisions



Learning

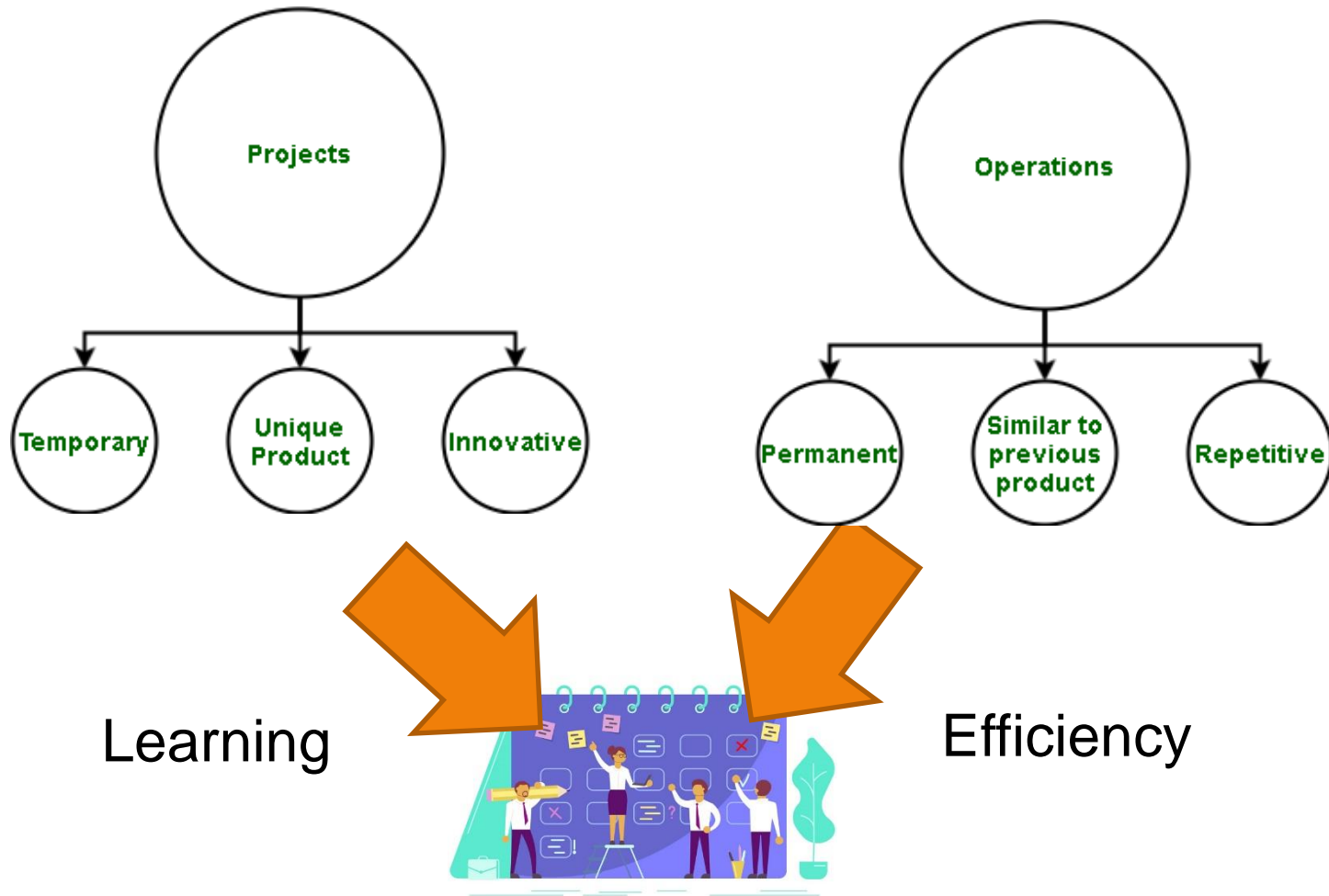


Efficiency



Learning

Efficiency



# Agile Digital Transformation



Learning

Efficiency

Digital  
Transformation



AGILE

Digital  
Transformation



~~AGILE~~

PILOT PURGATORY

Digital  
Transformation



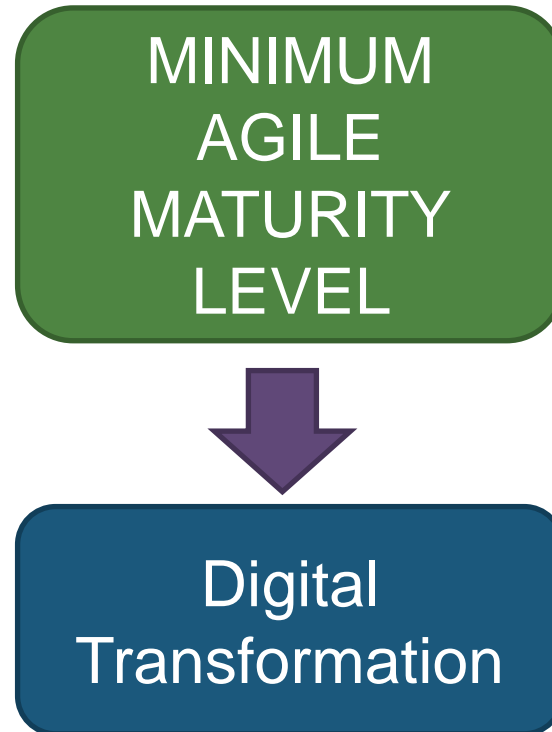
~~AGILE~~

PILOT PURGATORY

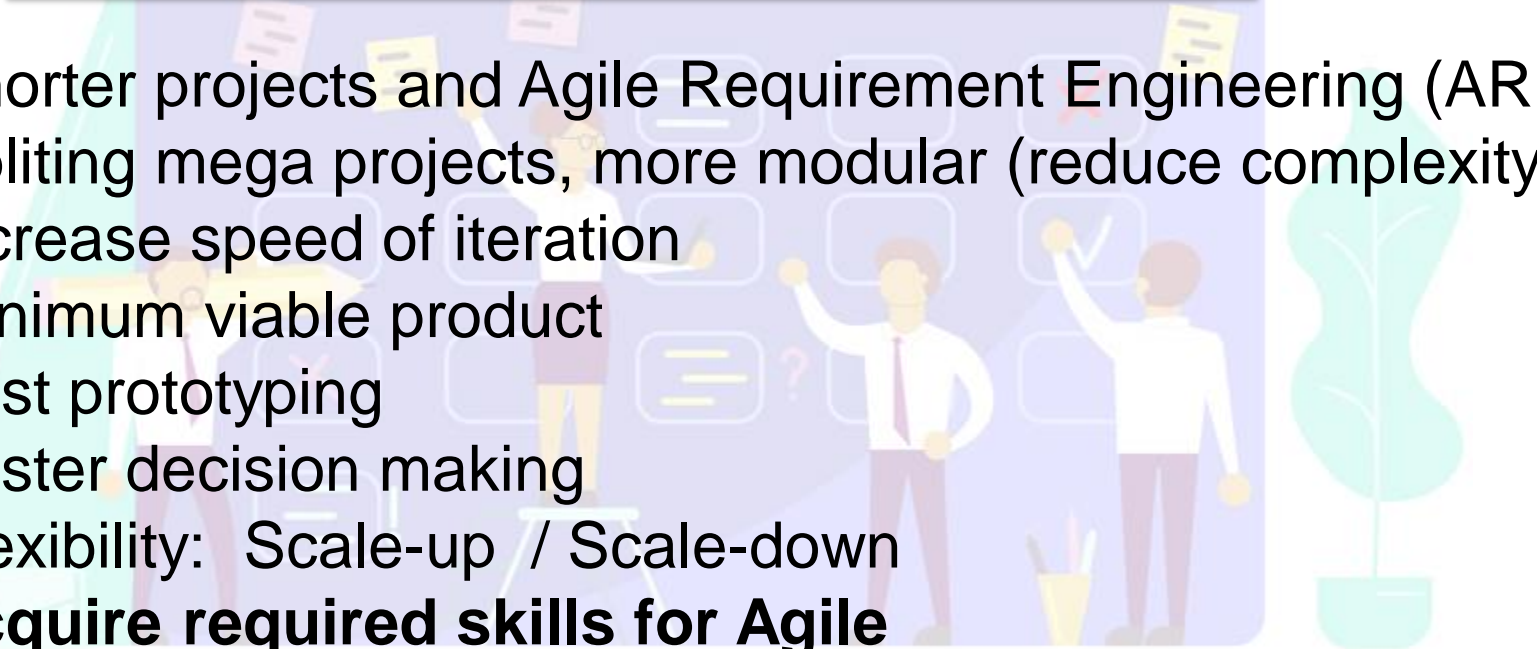
Digital  
Transformation



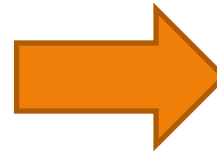
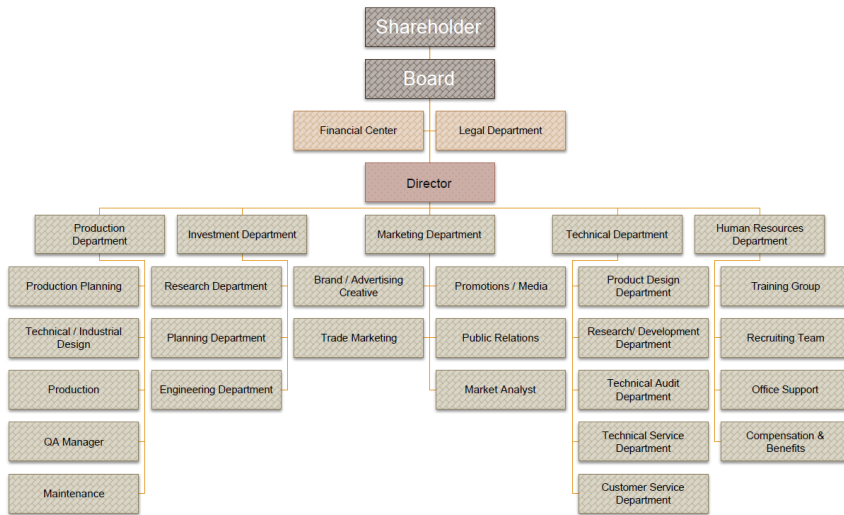
AGILE



## Minimum Agile Maturity Level Execution for both Learning and Efficiency

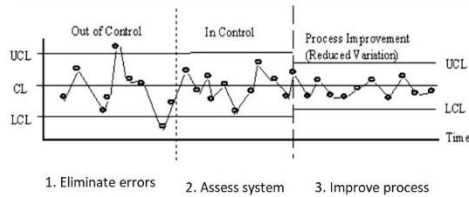
- Shorter projects and Agile Requirement Engineering (ARE)
  - Splitting mega projects, more modular (reduce complexity)
  - Increase speed of iteration
  - Minimum viable product
  - Fast prototyping
  - Faster decision making
  - Flexibility: Scale-up / Scale-down
  - **Acquire required skills for Agile**
- 

Manufacturing Organizational Chart



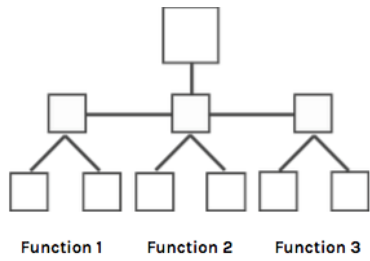
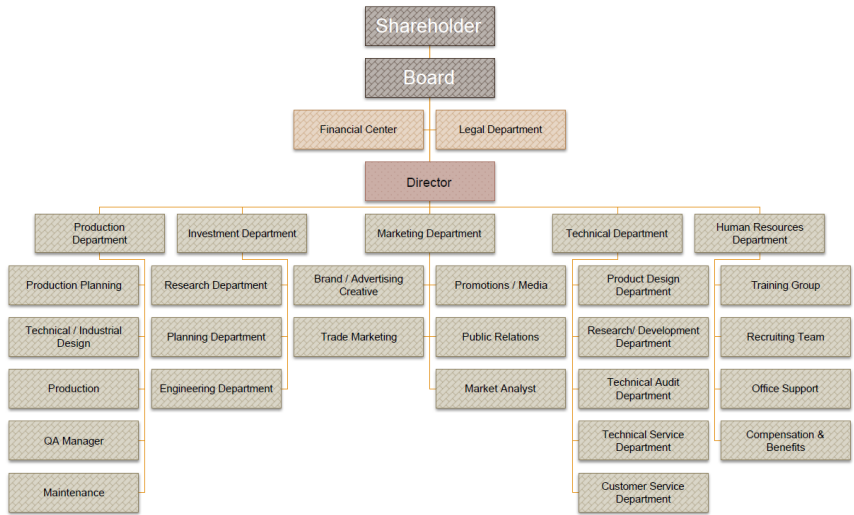
Minimum Agile Maturity Level?

SPC Process Improvement



# Agile

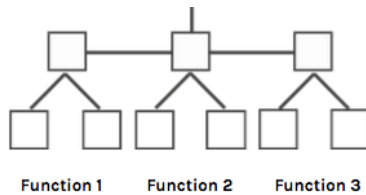
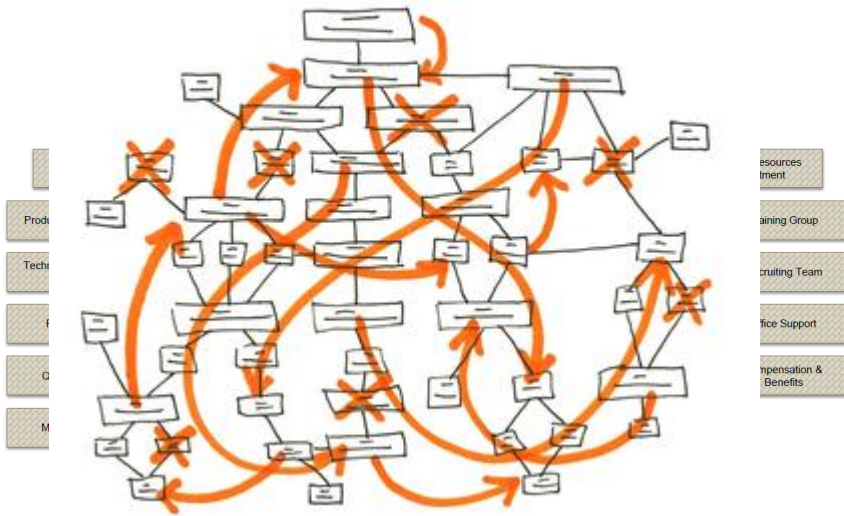
## Manufacturing Organizational Chart



**Teams dictated by Org Chart**

# Agile

Our Org Chart

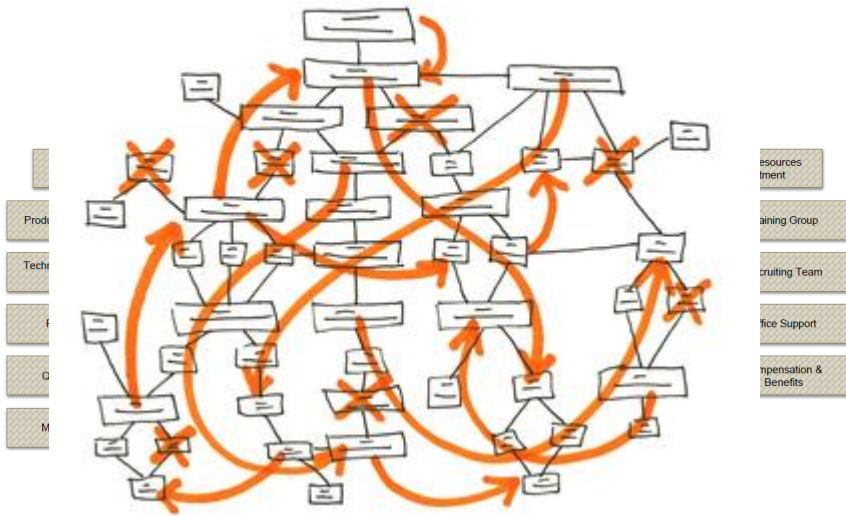


Teams dictated by Org Chart

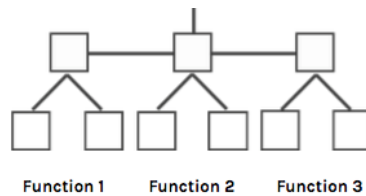
# Agile

# SLAM

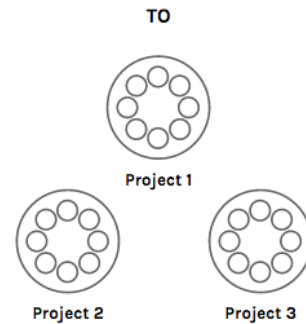
our Org Chart



Self-organizing  
Lean  
Autonomous  
Multidisciplinary



Teams dictated by Org Chart



Teams dictated by work to be done

**From To**

siload departments multidisciplinary teams

individual contribution multiplayer collaboration

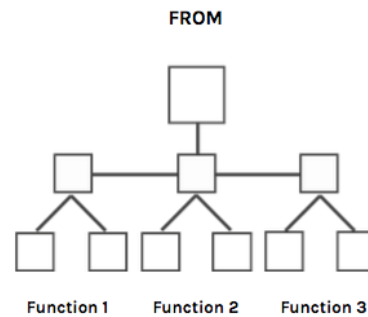
withholding information knowledge transparency

centralized power distributed authority

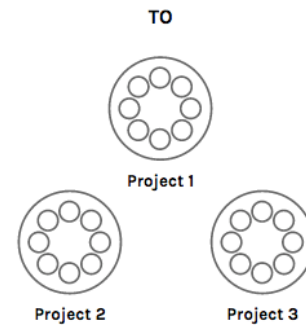
the plan dictating the work the work dictating the plan

grand reveals weekly delivery

long-term strategy Gantt charts weekly action meetings with emergent agendas

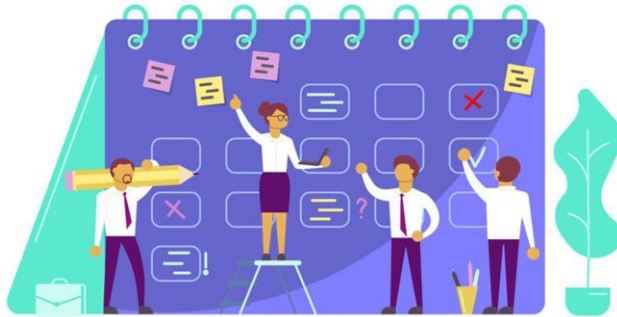


Teams dictated by Org Chart



Teams dictated by work to be done

Agile Digital Factory



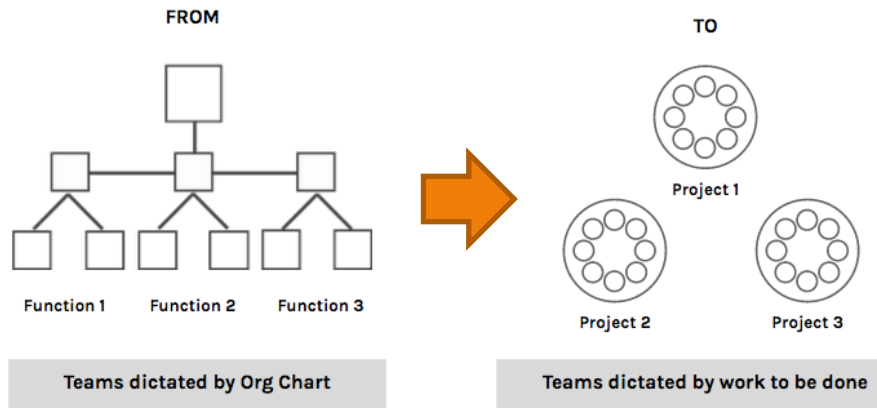
Learning

Efficiency

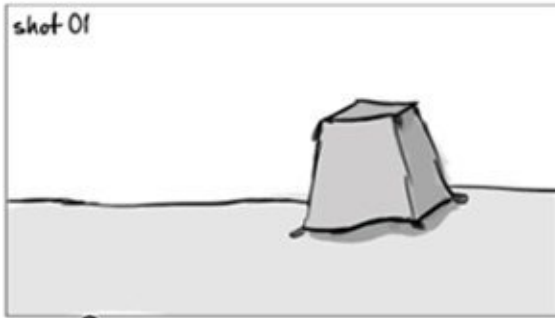
**MINIMUM  
AGILE  
MATURITY  
LEVEL**



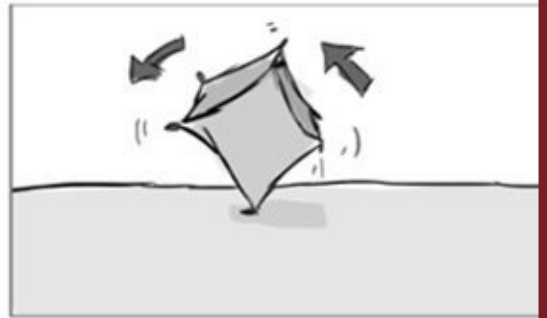
Reframing digital  
manufacturing



# Digital Transformation of Metrology for Decision Intelligence in Manufacturing



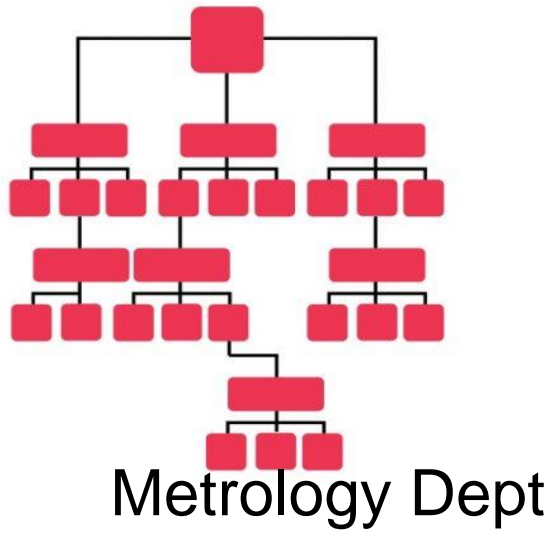
Digital Factories  
in 2022



Reframing digital  
manufacturing



Metrology for  
digital factory



## Agile metrology

Isolated	Connected
Rigid - Planned	Flexible-On-demand
Physical	Digital
Slow	Fast
Operation oriented	Efficient Learning oriented
Siloed	Multi-disciplinary
Individualist	Multi-player collaboration
Centralized	Distributed
Opaque	Transparent

DATA

INTELLIGENCE



AGILE



CONNECTION

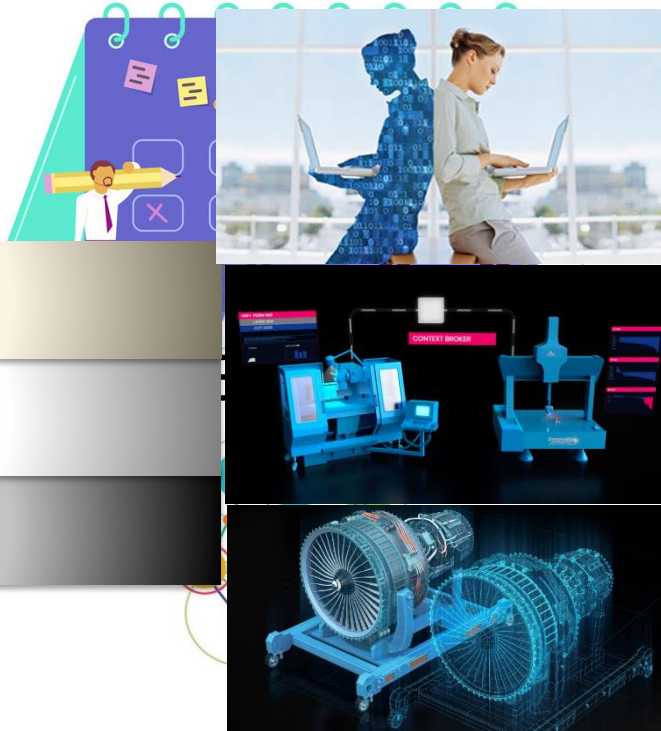
DATA

INTELLIGENCE

Human

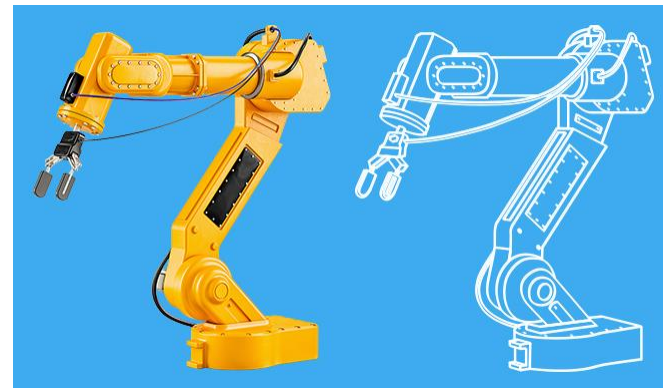
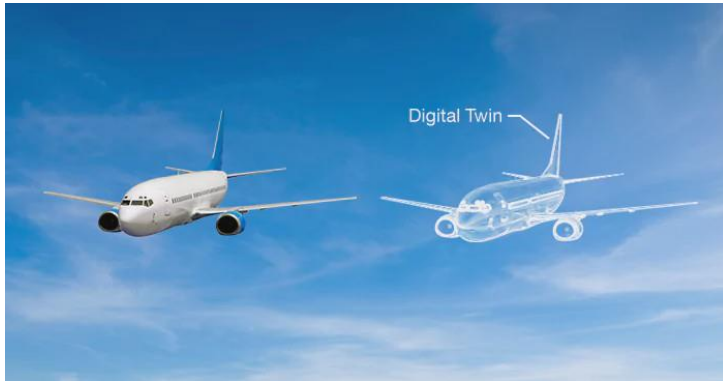
Machine

Product



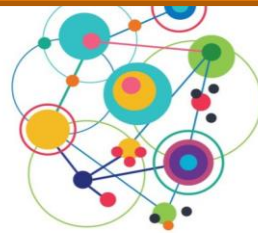
CONNECTION

# Digital TWIN





# CONNECTION

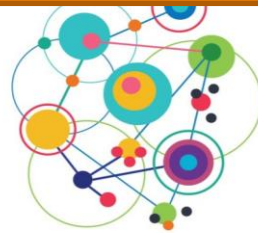


# Standards facilitating COMMUNICATION



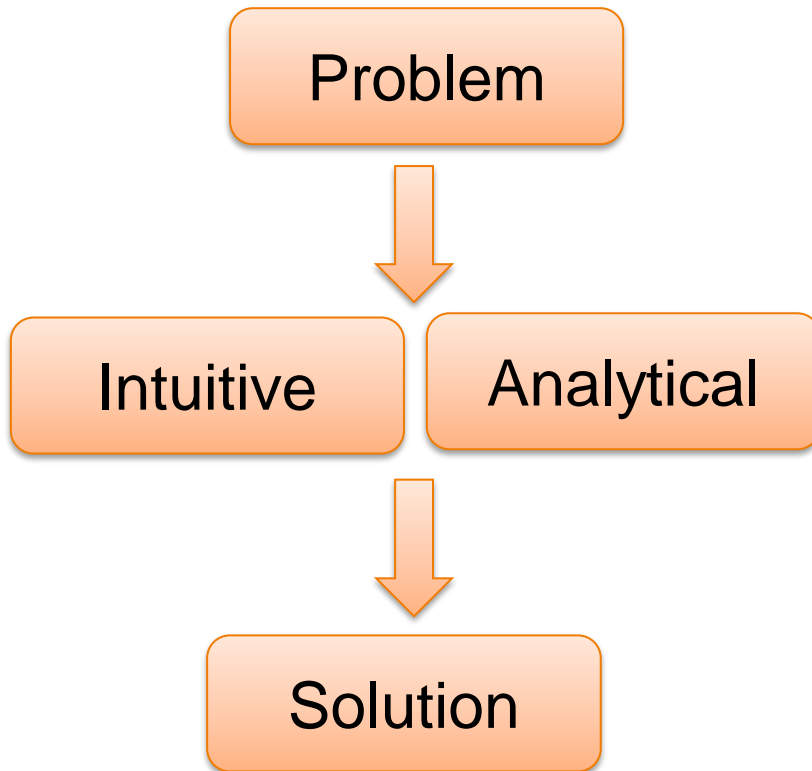


# INTELLIGENCE





## *“Productive” Intelligence*



# Intelligence

“the ability to **adapt** to the environment and to learn from experience  
(Sternberg & Detterman, 1986).”



PROFESSOR - CORNELL UNIVERSITY

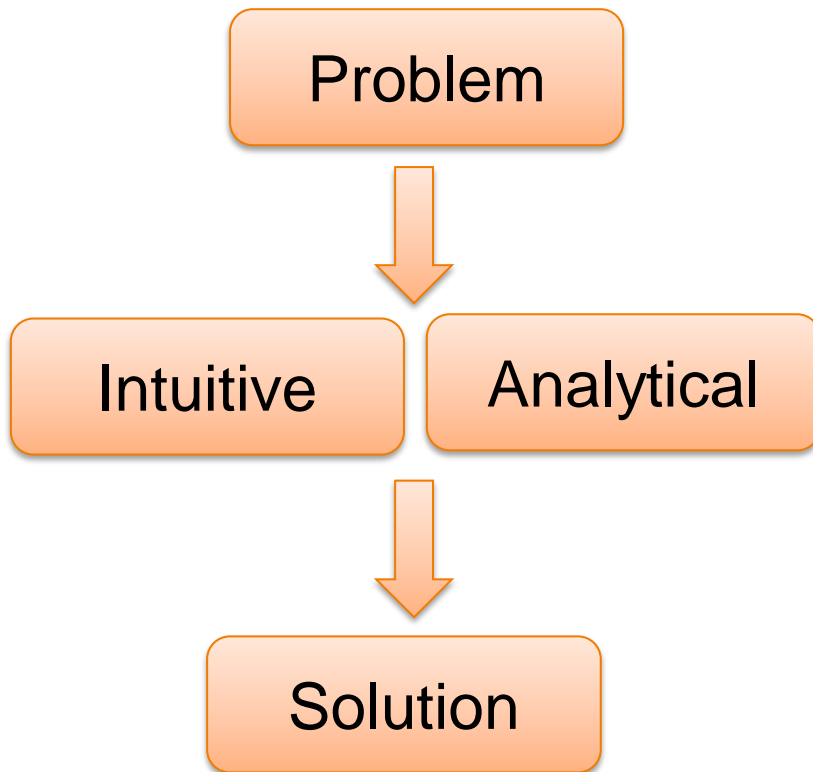
# *“Adaptative” Intelligence*

Capacity / ability to...

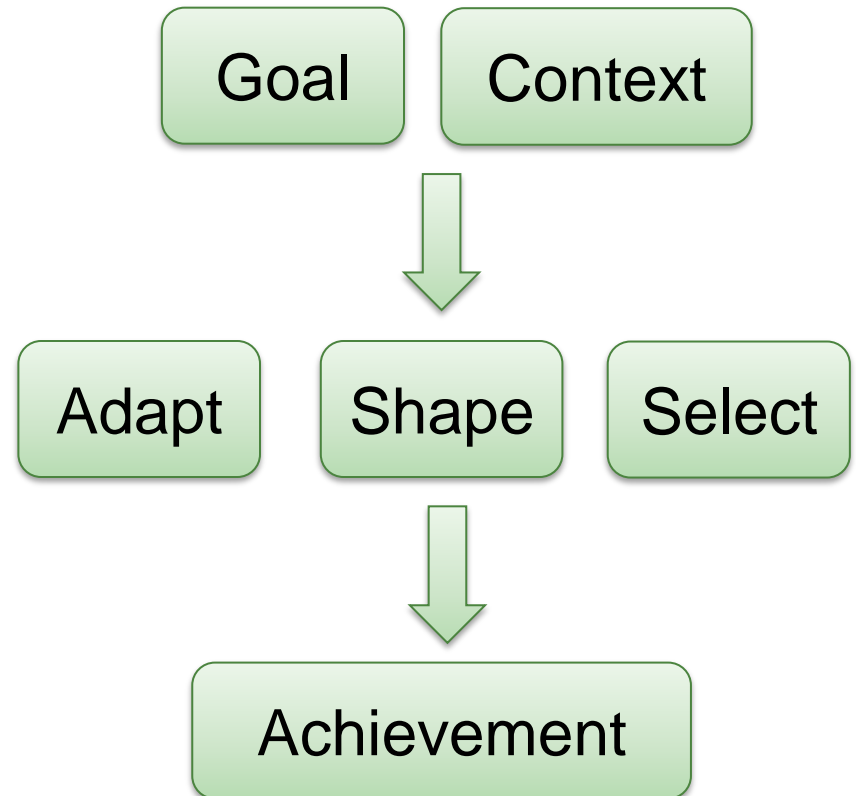
- **Adapt** to the changing context / environment
- **Shape** the context / environment to achieve the goal
- **Select** the context / environment to achieve the goal

# Smart

*“Productive” Intelligence*



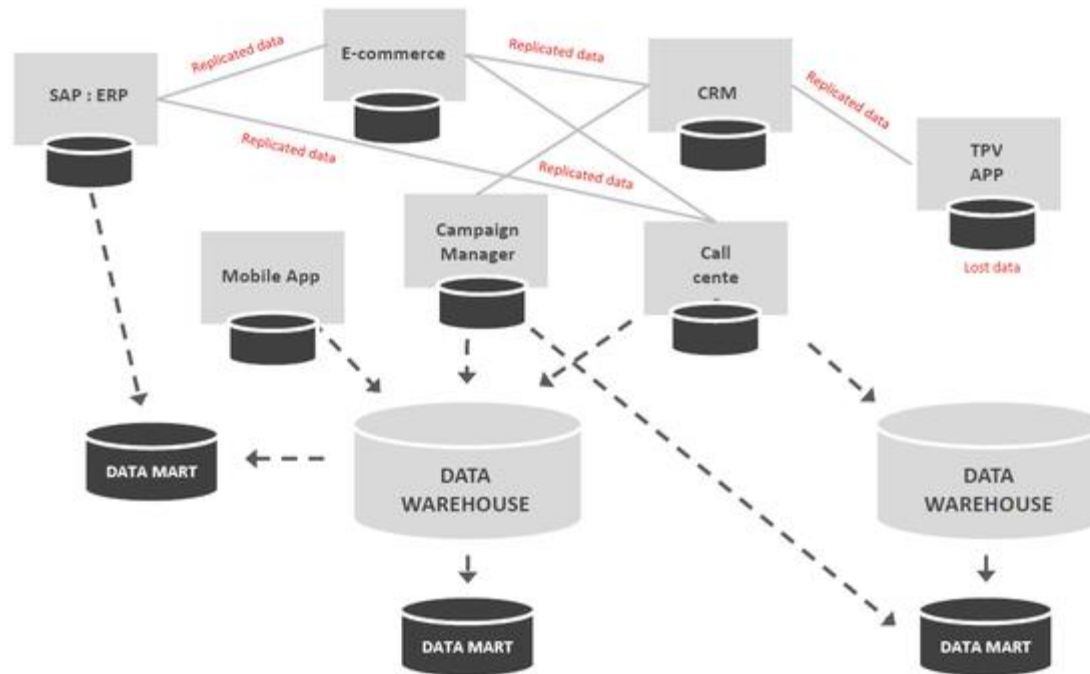
*“Adaptative” Intelligence*





# APPLICATION CENTRIC vs DATA CENTRIC

## THE ROOT OF THE PROBLEM FOR PHYSICAL COMPANIES: APPLICATION CENTRIC



### Problems

Data Replication x 10

Cost x 10

Not Real Time

Low TPO/TCO ratio

Analytic D-1

Unintegrated Vision

Departmental Silos

Partial intelligence

Data Intelligence

DaaS (Data as a Service)

Data

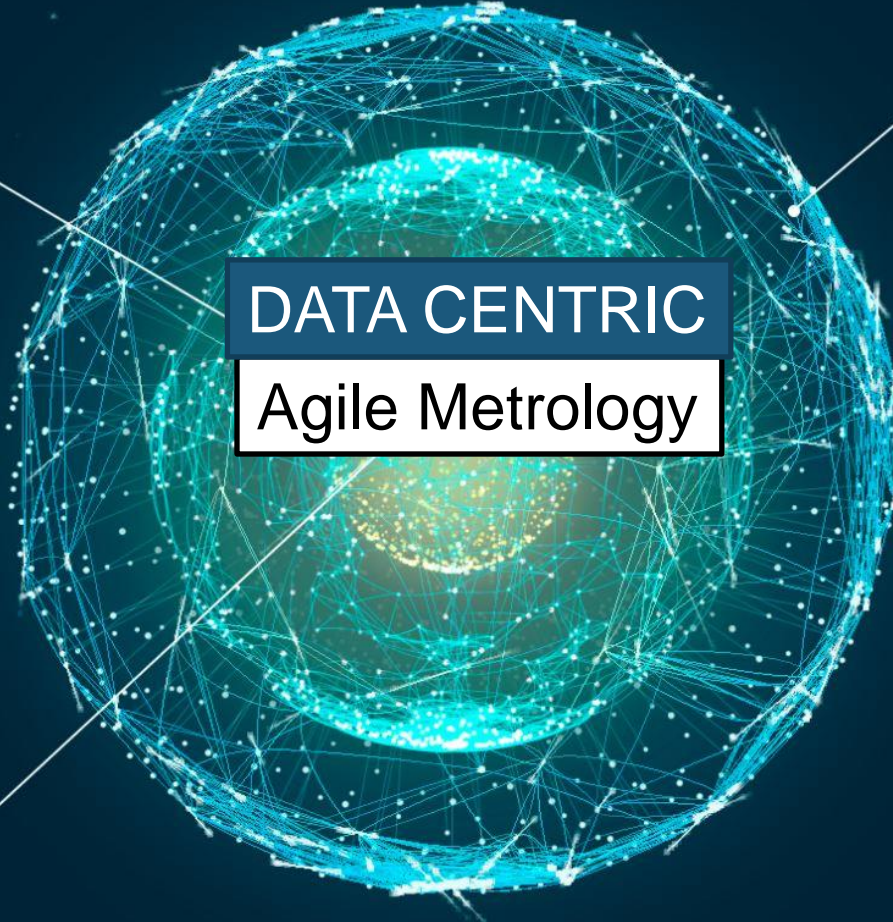


Data Intelligence

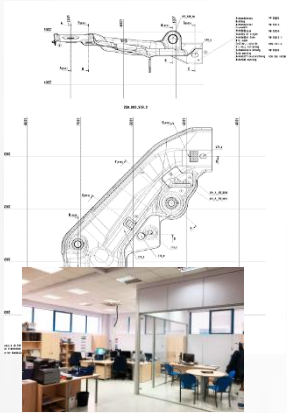
DaaS (Data as a Service)

**DATA CENTRIC**  
**Agile Metrology**

Data



# Traditional Metrology-Application Centric



Design



PLAN

Quality



MEASURE

Machine Program



Analyze

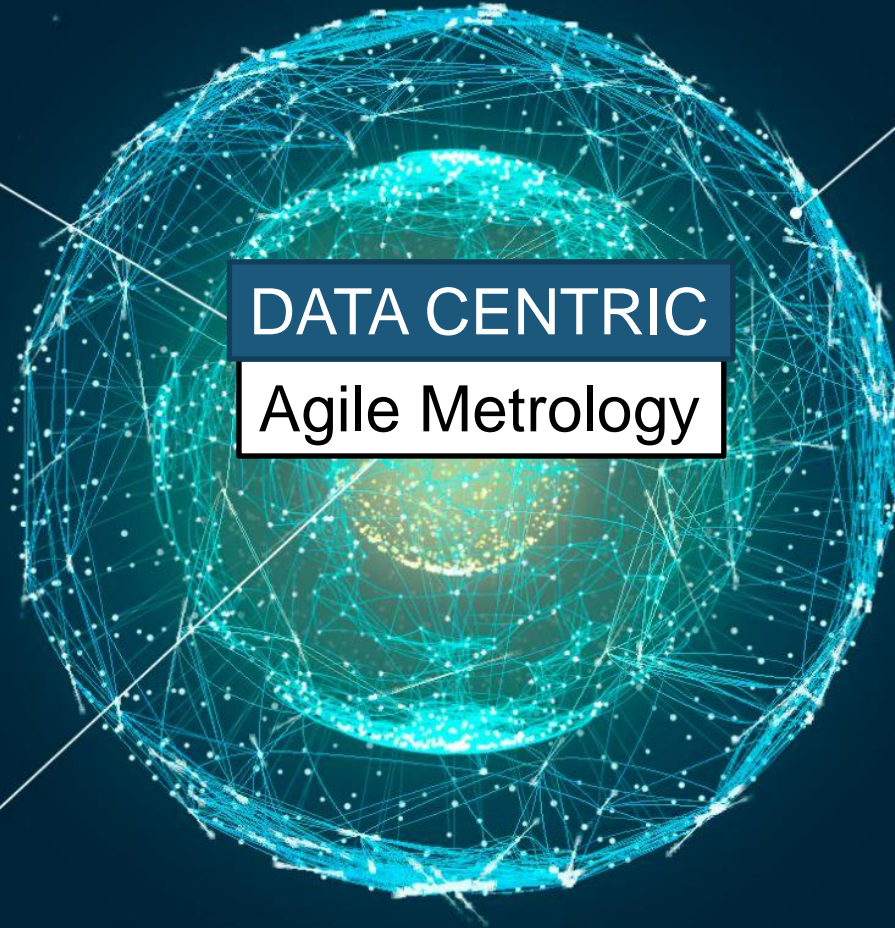


Data Intelligence

DaaS (Data as a Service)

**DATA CENTRIC**  
**Agile Metrology**

Data



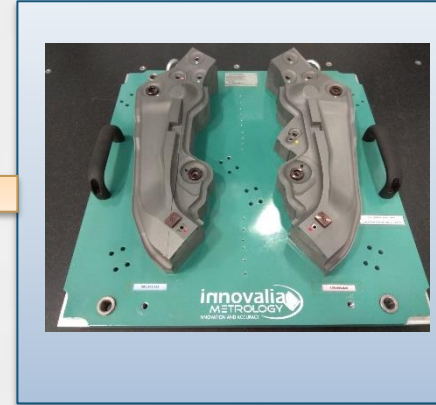


Multi-Sensor  
Scanning



Point Cloud

Digital Twin



Agility in generating data



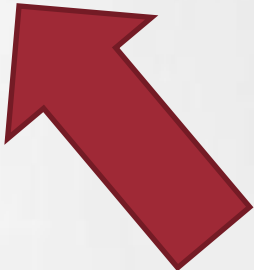
Digital Twin



Dynamic Plan

**Knowledge Data Base**

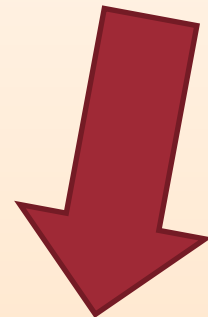
**Data Sharing Platform** 





Point Cloud

Digital Twin



STEP / QIF



PMI

Digital Thread

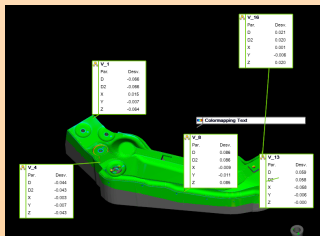
Digital Report

QIF

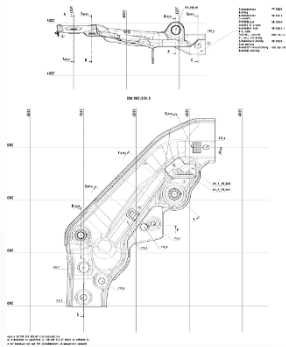
Virtual Metrology

QIF Knowledge Data Base Data Sharing Platform

VIRTUAL



# Traditional Metrology-Application Centric

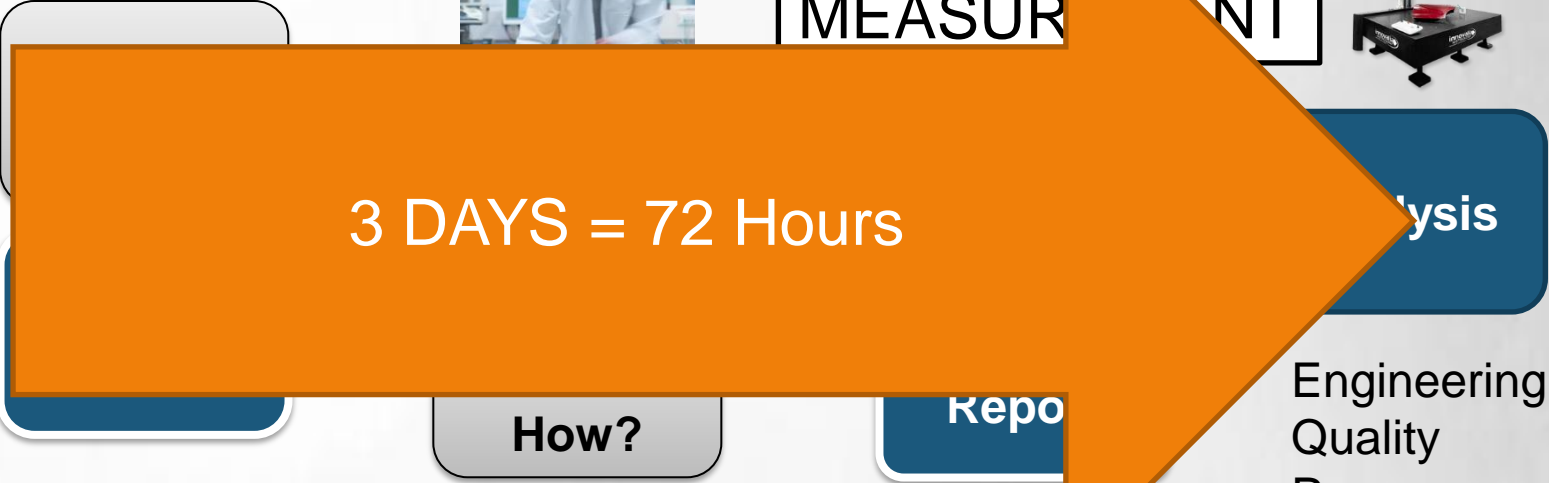


Machine Program

Quality



MEASUREMENT



Design



# STEP / QIF

Model Based Design

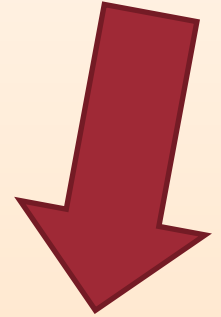
PMI



Point Cloud



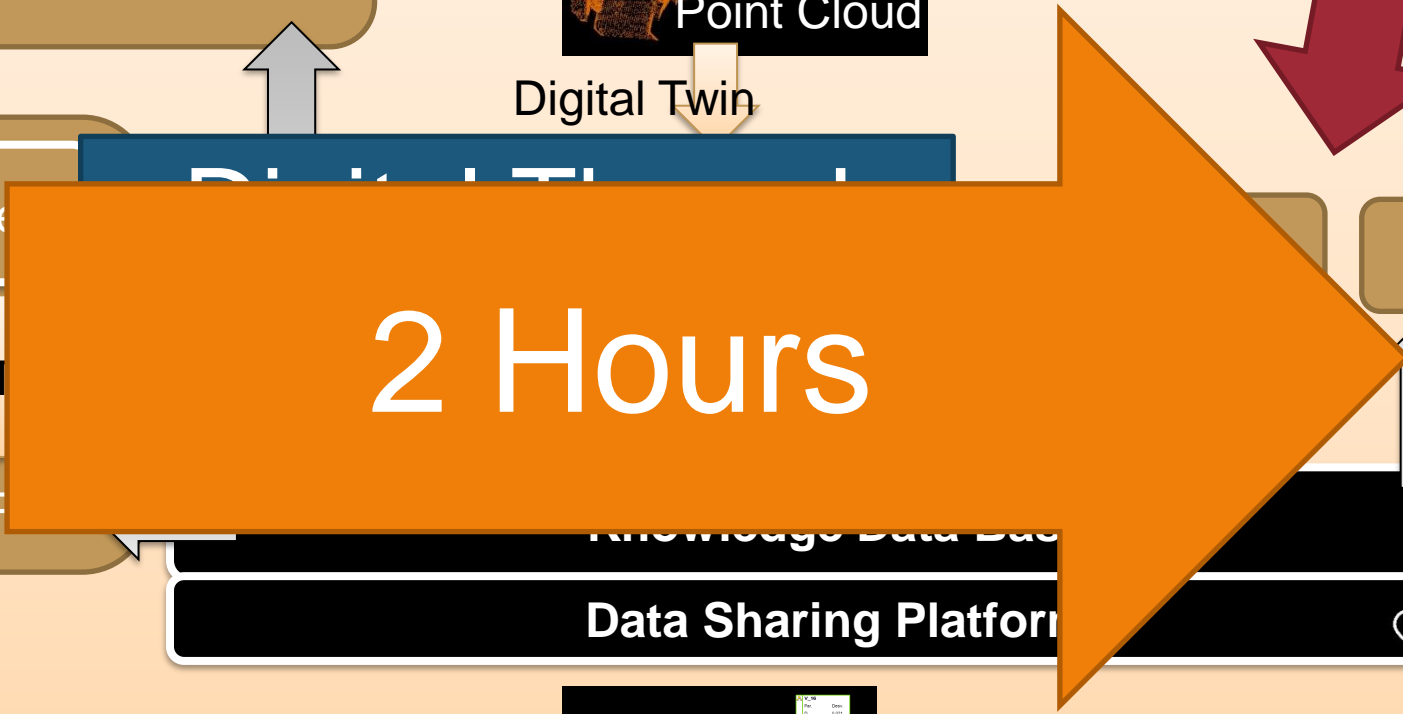
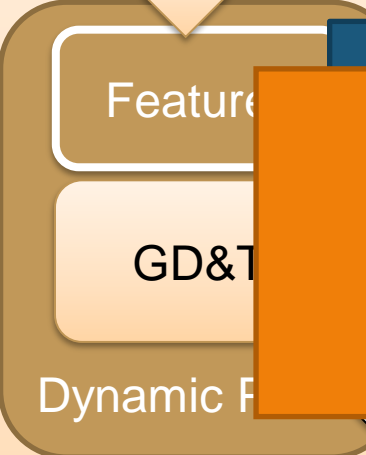
Digital Twin




Feature

GD&T

Dynamic F



AI

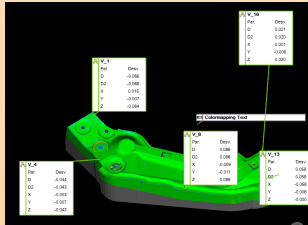


Knowledge Data Bus

Data Sharing Platform



# VIRTUAL



# STEP / QIF

Model Based Design

PMI



Point Cloud

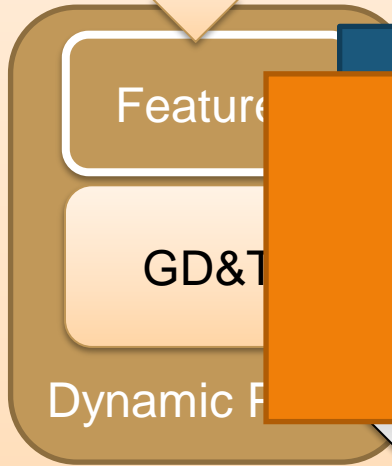


Digital Twin

Feature

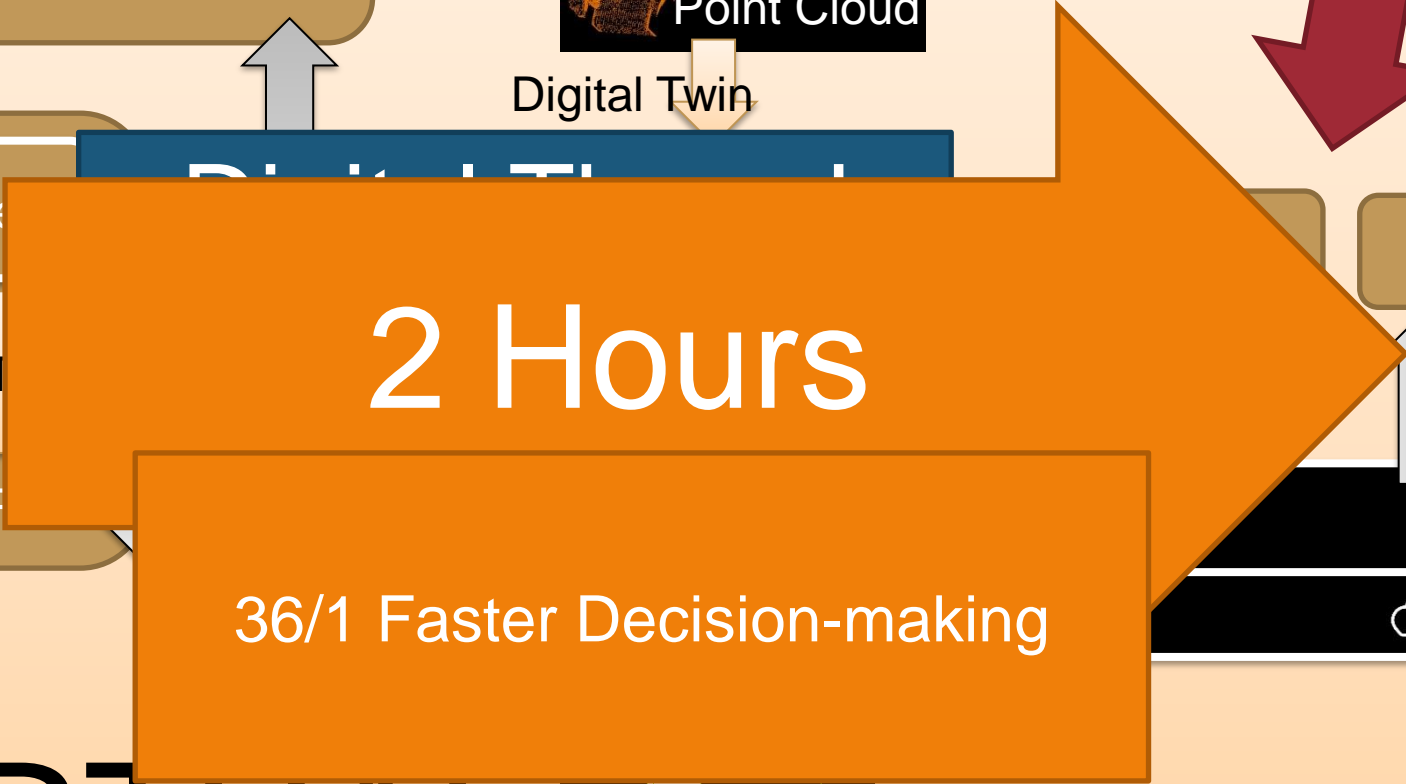
GD&T

Dynamic F



2 Hours

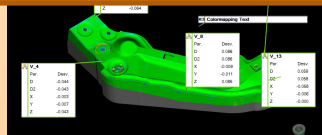
36/1 Faster Decision-making

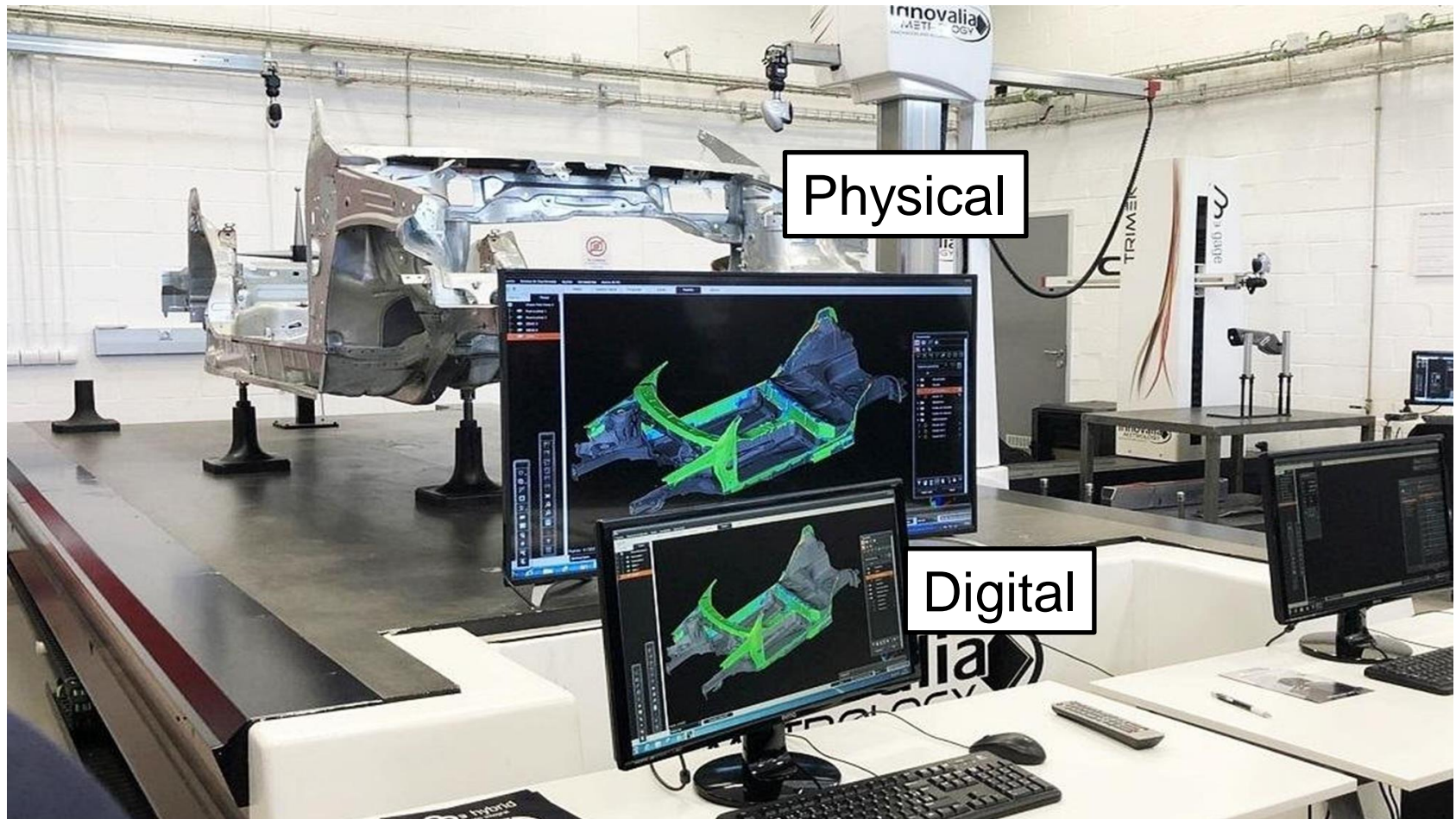


AI



# VIRTUAL

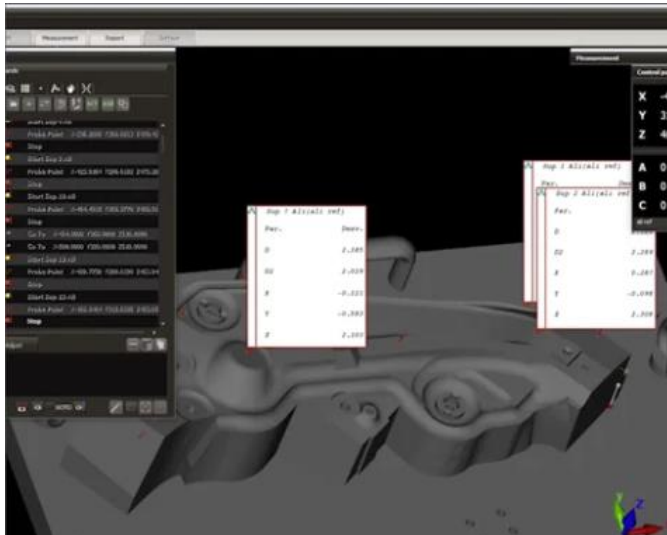
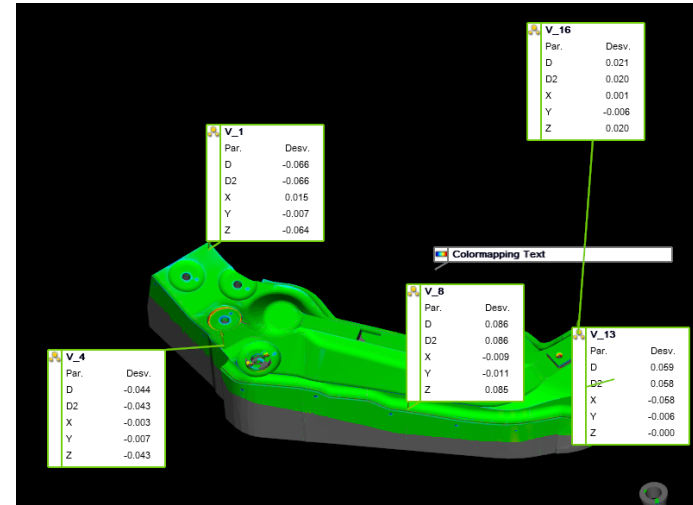
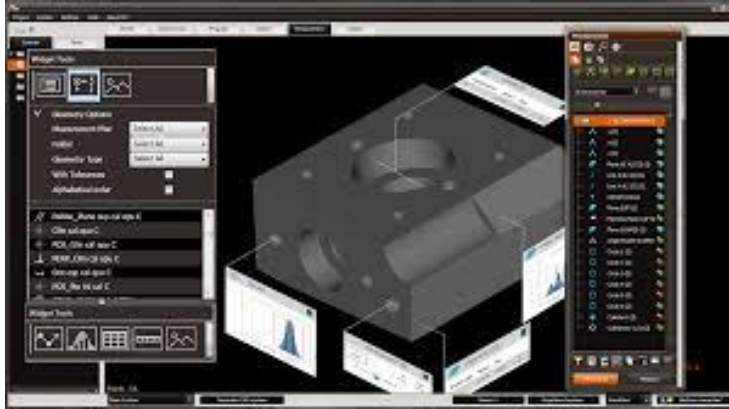




Physical

Digital

Source: Innovalia Metrology



# M3 analytics



# Summary

- Digital transformation is a must
- Context 2022-23 as an opportunity
- Decision-making styles: Learning vs Efficiency
- Learning + Efficiency = Agile Digital Transformation
- Minimum Agile Maturity Level
- SLAM and Agility
- Agile Metrology:
  - Data Centric – Intelligence – Connection



Agile Digital Metrology

*Thank You*

