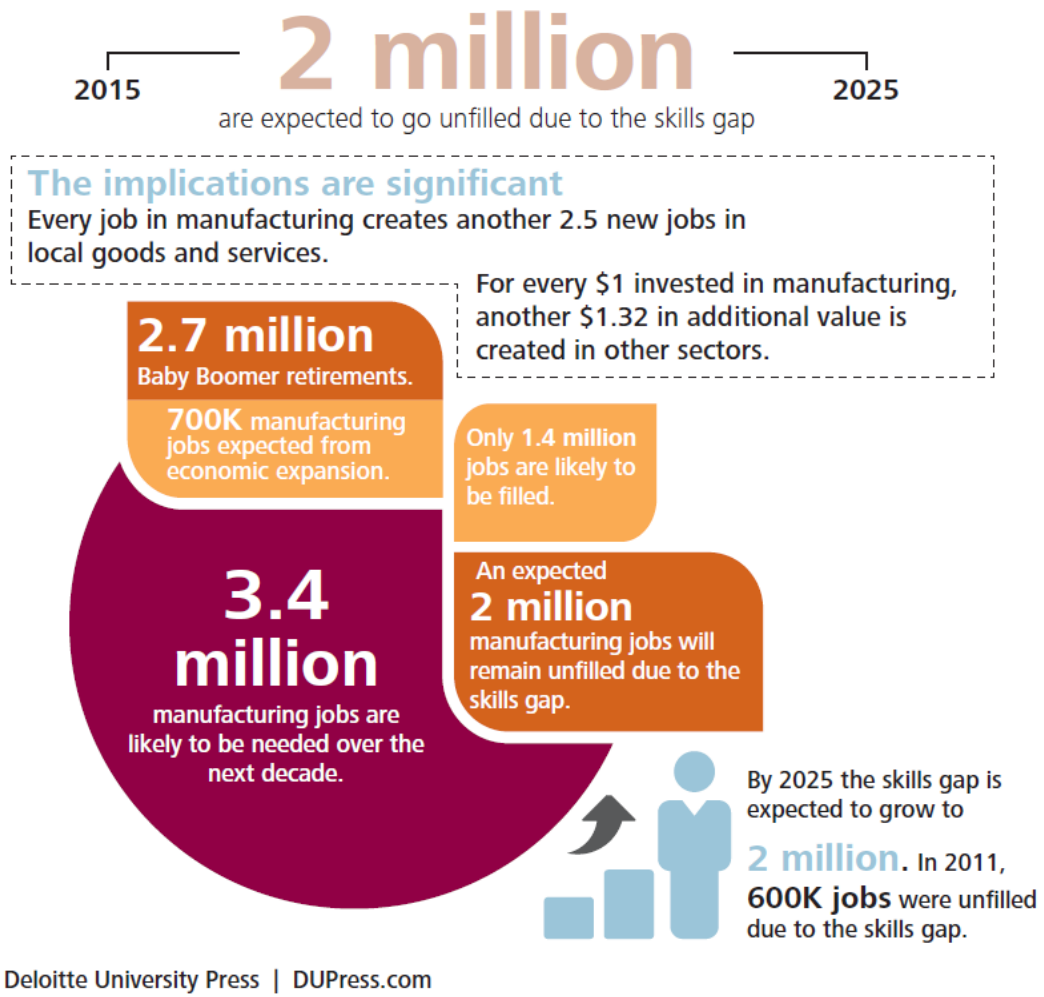
Nathan Hartman, Jennifer Herron, Rosemary Astheimer, Duane Hess, Travis Fuerst

A NEED FOR DIGITAL ENTERPRISE WORKFORCE DEVELOPMENT

A new world…



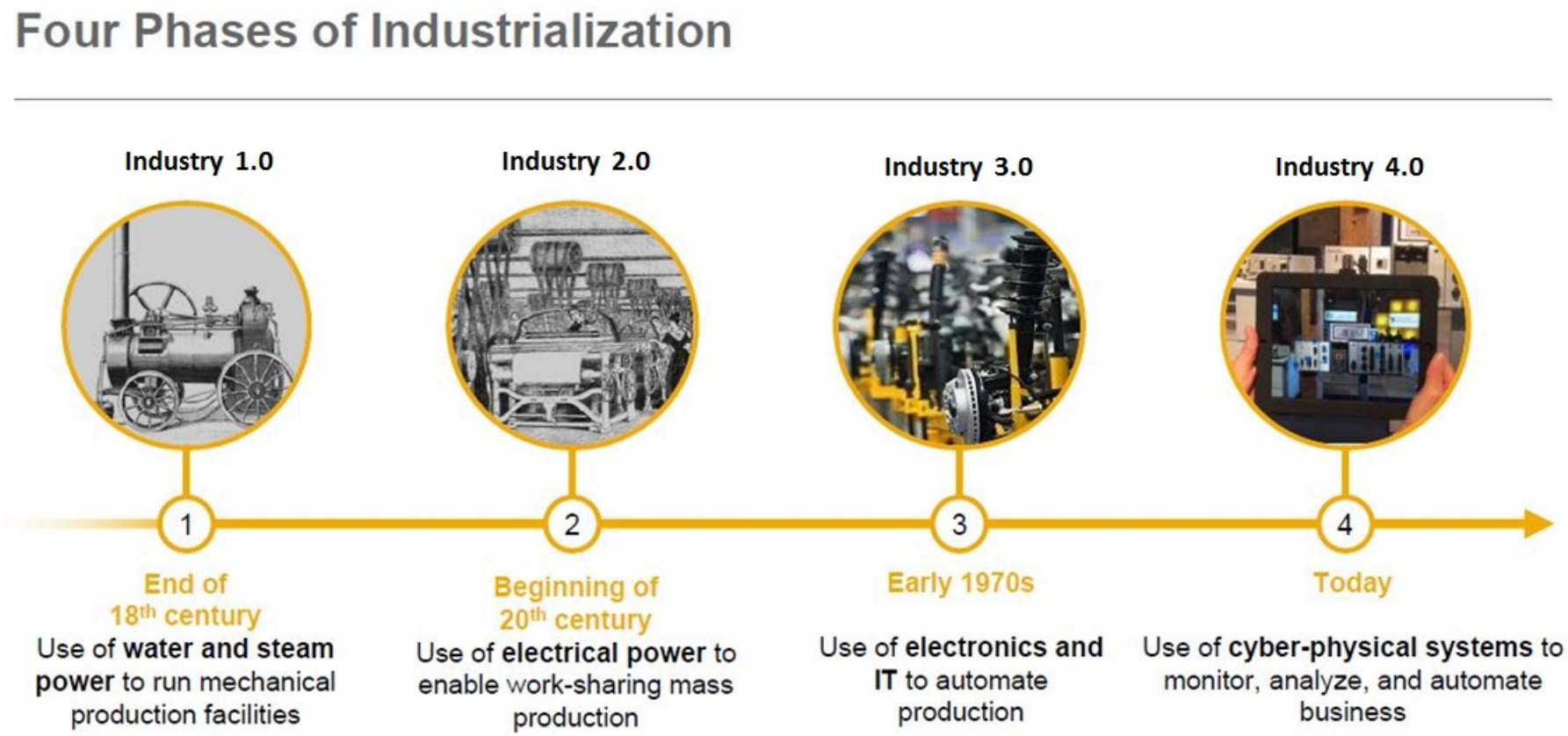
Graphic: Deloitte University Press | DUPress.com

- By 2018, 20% of all business content will be authored by machines
- By 2018, more than 3 million workers globally will be supervised by a "roboboss"
- The growing range of 3D-printable materials will drive a compound annual growth rate of 64.1% by 2019
- By 2020, more than 35 billion things will be connected to the Internet

Source : Gartner Analysis

The next industrial revolution

Mechanization, mass production, automation, virtualization



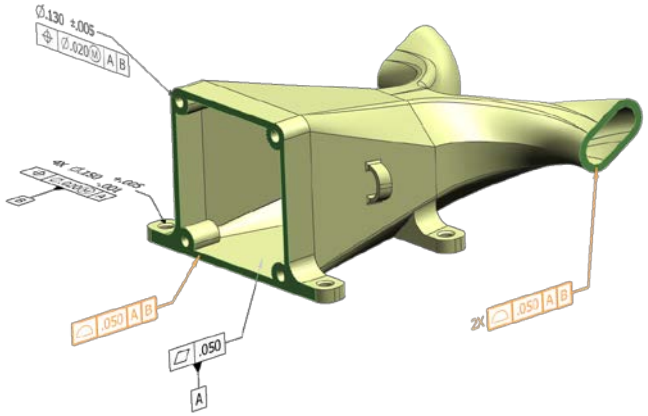
Digitalization and connectivity

http://saphanatutorial.com/industry-4-0/

The communications spectrum…

A complete MBD supports lifecycle communication

SHAPE

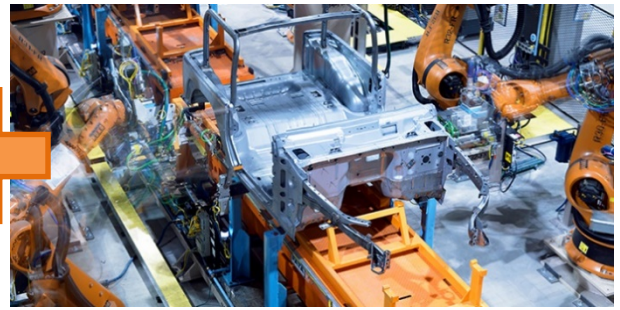


BEHAVIOR

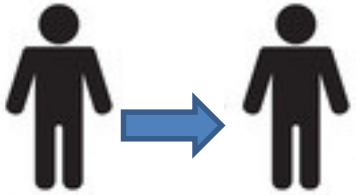
3.

Property	Test Standard DIN/ON EN ISO	corr.to ASTM	Unit	Value				Testing Frequency
Nominal Thickness			mil mm	78 2.0	100 2.5	98 3.0	196 5.0	
	DIN EN ISO 14632	D 5994	%	+10/-5	+10/-5	+10/-5	+10/-5	every hour
Density (Black) Density (base/coloured)	ISO 1183	D792	g/cm3 g/cm3	≥ 0.94 ≥ 0.931/935				per production run 1)
Melt Flow Rate (190°/5kg) (190/2 ,16kg)	ISO 1183 Cond T	D 1238 Cond P D 1238 Cond E	g/10 min	≤ 3 ≤ 1	≤ 3 ≤ 1	≤ 3 ≤ 1	≤ 3 ≤ 1	per production run 1)
Heat Reversion (110°C/1, 5h)	DIN EN ISO 14632	D 1204 modified	%	≤ 3	≤ 3	≤ 3	≤ 2	per productio
Tensile Stress at Yield	DIN EN ISO 527	D 6693	MPa (PSI)	≥ 15 2,200	≥ 15 2,200	≥ 15 2,200	≥ 15 2,200	per production run 1)
Elongated at Yield	DIN EN ISO 527	D 6693	%	≥ 9	≥ 9	≥ 9	≥ 9	per production run 1)
Elongated at Break	DIN EN ISO 527	D 6693	%	≥ 300	≥ 300	≥ 300	≥ 300	per production run 1)
Instrumented Puncture Test (Penetration Test)	ON EN ISO 6603-2	D 4833	N N (lbs)	≥ 1500 ≥ 537	≥ 1800 ≥ 625	≥ 2000 ≥ 750	≥ 2500 ≥ 1250	Approval Testing

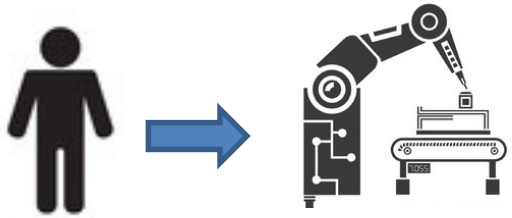
CONTEXT



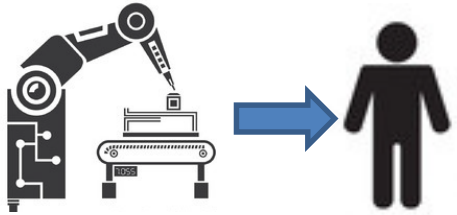
HUMAN TO HUMAN



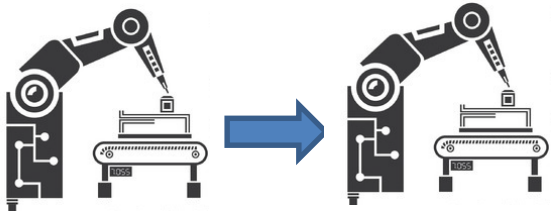
HUMAN TO MACHINE



MACHINE TO HUMAN

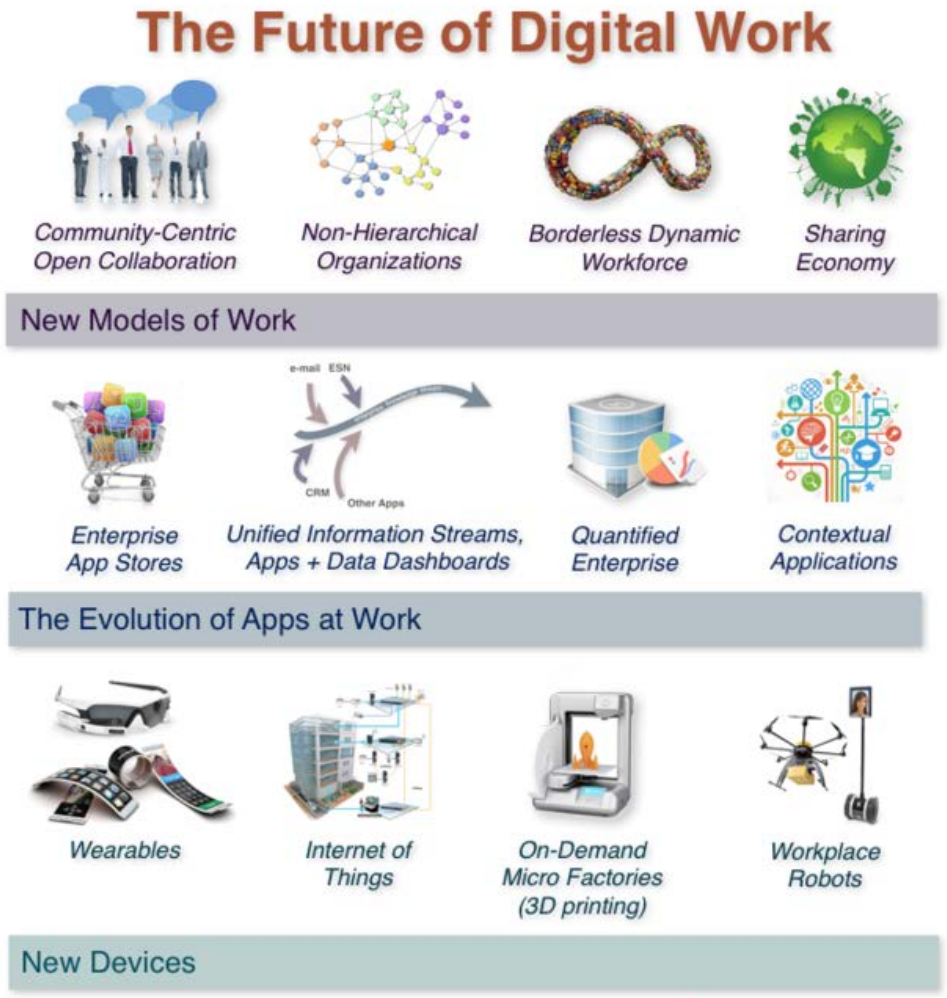


MACHINE TO MACHINE



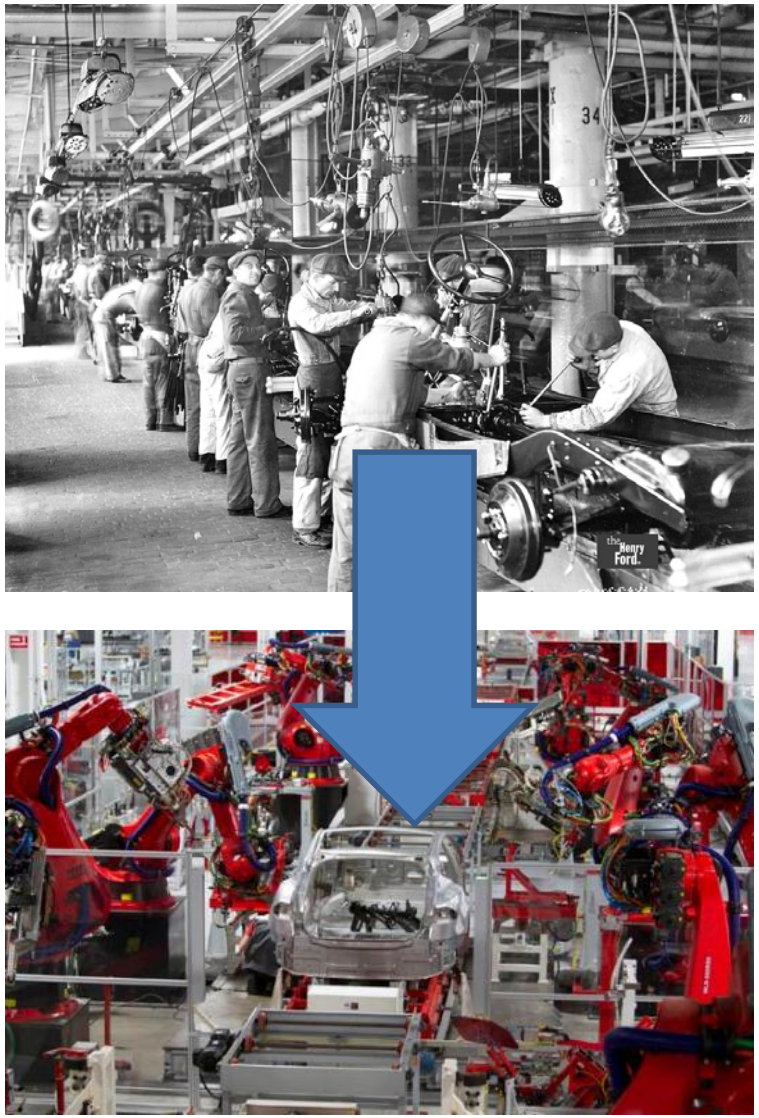
But we have a national dilemma…

- A lack of a skilled workforce is the number-one barrier to growth in Indiana and nationally
- There is no silver bullet solution, but employer-driven work-based-learning programs have proven to be hugely impactful by:
  - Employer/Educator Partnerships
    - Working Together
  - Breaking Barriers
    - What Employers and Educators Should Know
  - Culture Shift
    - How to Impact Effective Change



A shift in the focus on jobs

- A person born today can expect to live to be 100-years old.
  - Their careers will be 60 to 70 years long forcing them to not only change jobs but to change careers.
  - This aligns with our college's tag line: "*How to prepare graduates for jobs that do not exist.*"
- The second is a shift in skill requirements.
  - Demand for skills of the head (cognitive), have dominated those of the hands (technical) and to a lesser extent, those of the heart (social) over the past 300 years. In the future, those skills shifts are about to go into reverse.

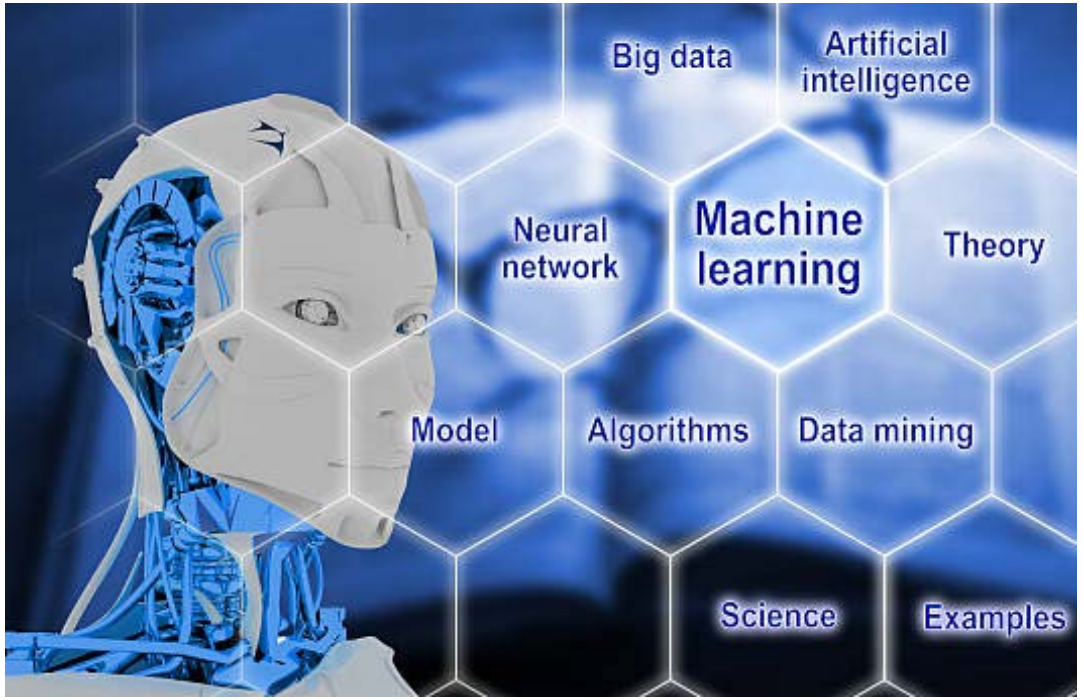


And this 4th Industrial Revolution is different.

- During the first three Industrial Revolutions, the skills workers needed to keep ahead of the machines were largely cognitive.
- Machines were doing manual tasks and cognitive tasks were the exclusive domain of humans.
- The 4th Industrial Revolution challenges this equilibrium.

Impacts to the next-generation workforce

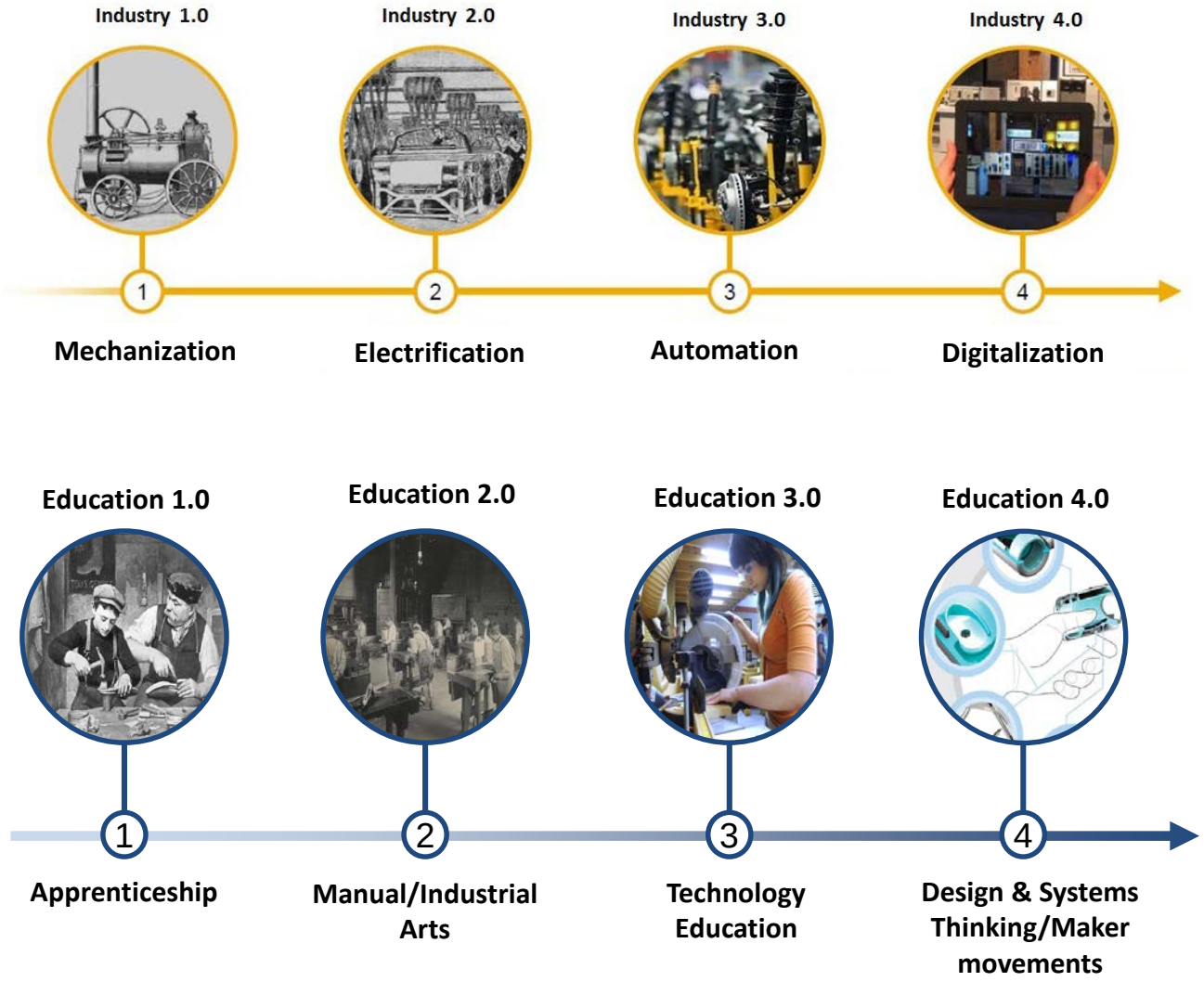
- The dawning of AI means that humans will no longer have the cognitive playing field to themselves.
- Machines will be able to process more quickly, more cheaply and with fewer errors than their human counterpart, at least in some activities.
- That could make the hollowing-out of human tasks, now cognitive as well as manual, far greater than ever before.



So what do humans have left?

- Cognitive tasks requiring **creativity and intuition** to solve tasks or problems whose solutions require great logical leaps of imagination.
- There will remain a demand for skills to **program, test and oversee machines**.
- **Personalized design and manufacturing**.
- **Social skills**; tasks that require emotional intelligence rather than cognitive alone.
- **Preparing graduates solely for cognitive skills will not be enough for the 4th Industrial Revolution**.

Parallel Revolutions

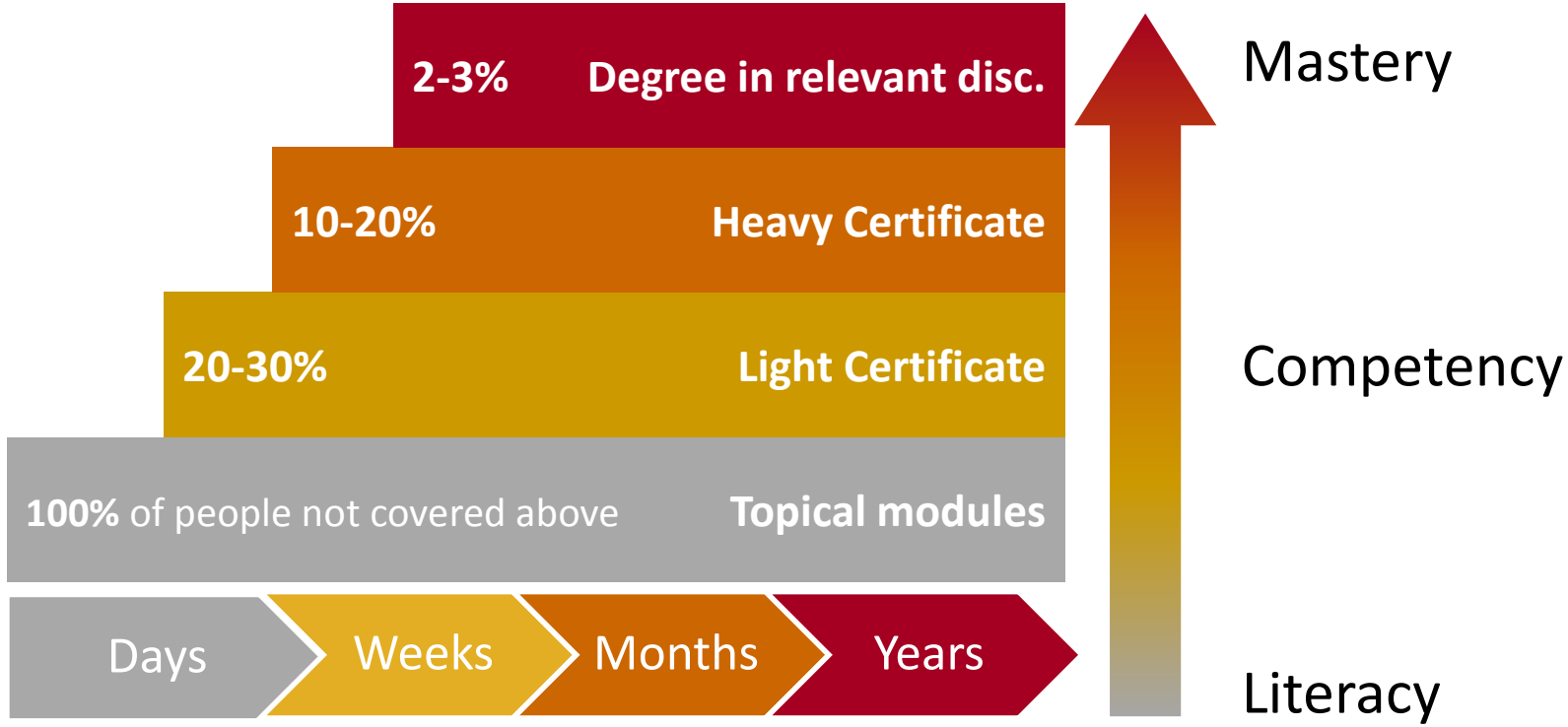


Regardless of the era, the educational revolution connected to manufacturing has always had a focus on the tools and techniques of the day, to enable the design and production of something.

Workforce Education for Industry 4.0

- Built upon the old literacies of reading, writing and mathematics.
- New literacies include:
  - **Data literacy:** read, analyze and apply information
  - **Technological literacy:** coding and engineering principles
  - **Human literacy:** humanities, communication and design
- Higher order mental skills – mindsets and ways of thinking about the world.
  - **Systems Thinking:** the ability to view an enterprise, machine or subject holistically, making connections between different functions in an integrative way.
  - **Entrepreneurship:** applies the creative mind to the economic and social sphere.
  - **Cultural Agility:** how to operate deftly in a varied global environment.
  - **Critical Thinking:** the habit of disciplined, rational analysis and judgement.

Preparing a workforce for the digital enterprise



- Adaptable skills
- Problem solving skills
- Data interpretation skills
- Promote work experience in school

- Enhanced marketing
- Manage talent like a supply chain
- Re-do HR
- Foster professional development

- Experiential development
- Skill standards and competencies
- MBD, MBE, and PLM

Types of Credentials

- **Licensure**

Granted at the state level in the US by a governmental agency or its designated agent. Goal of licensure is to ensure that licensees have the minimal degree of competency necessary to ensure public health, safety and welfare.

  - Licensed Real Estate Agent
  - Licensed Practical Nurse
  - Professional Engineer
  - Registered Nurse

- **Certification**

Voluntary process through which an organization grants recognition to an individual after verifying minimum criteria was met. Certification holders are granted use of a designation.

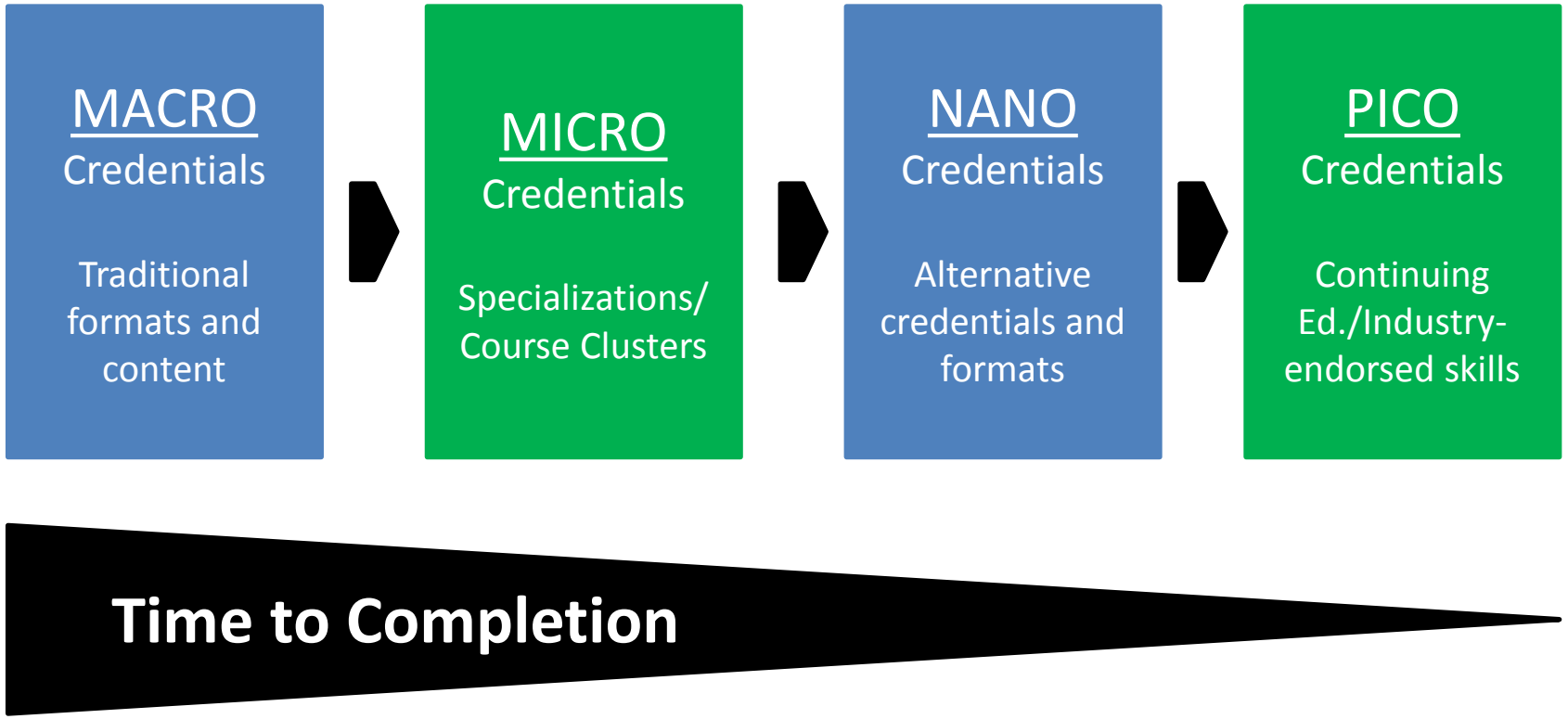
  - Often requires recertification every 3-5 years.
  - Can be revoked

- **Certificate Program**

Voluntary program in which an organization grants recognition to an individual after verifying that they met minimum criteria including participating in a training or education program and demonstrating comprehension.

- Certificates are a one time shot – no renewal required.
- Cannot be revoked

Credential Options



Stacked credentials

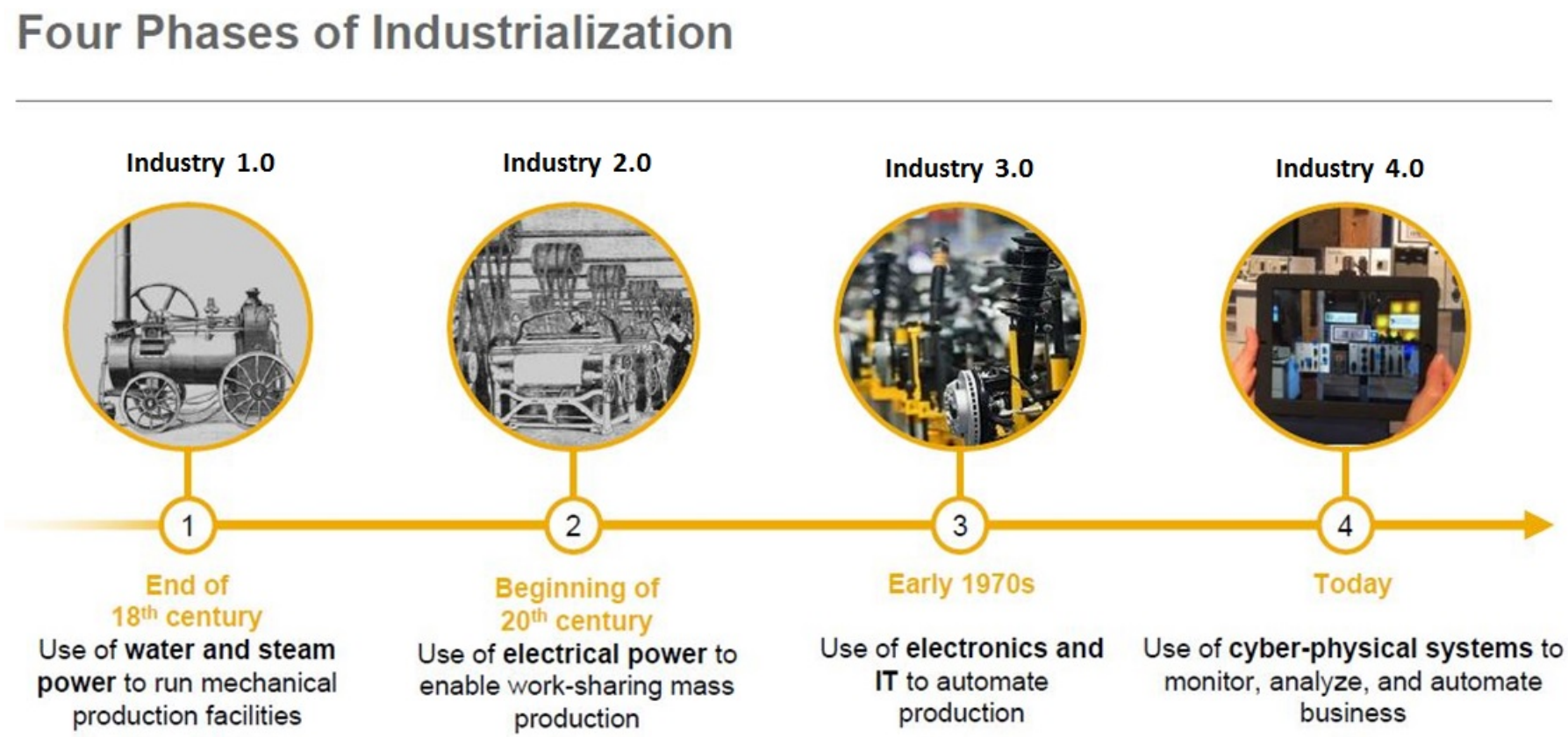
- Vertical: multiple credentials leading to a professional designation
- Horizontal: a focus on functional areas that may or may not be stackable
- Value-add: certification with optional certificates to expand

ACTION ENGINEERING

How do you engage an existing workforce?

The next industrial revolution

- Mechanization, mass production, automation, virtualization



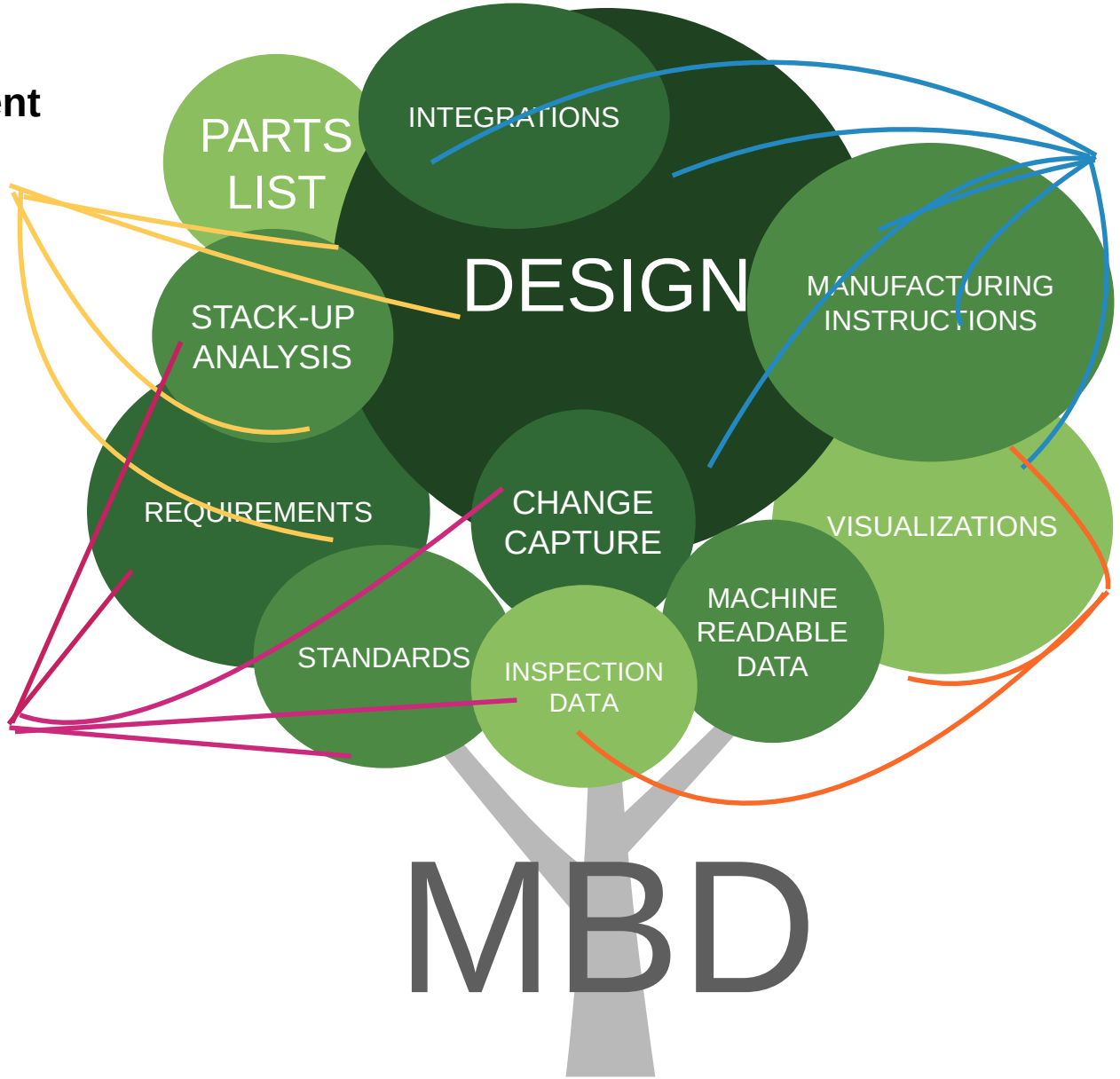
Digitalization and connectivity

http://saphanatutorial.com/industry-4-0/

Your existing enterprise is full of personas

Steve, Procurement

Terry, Manufacturing

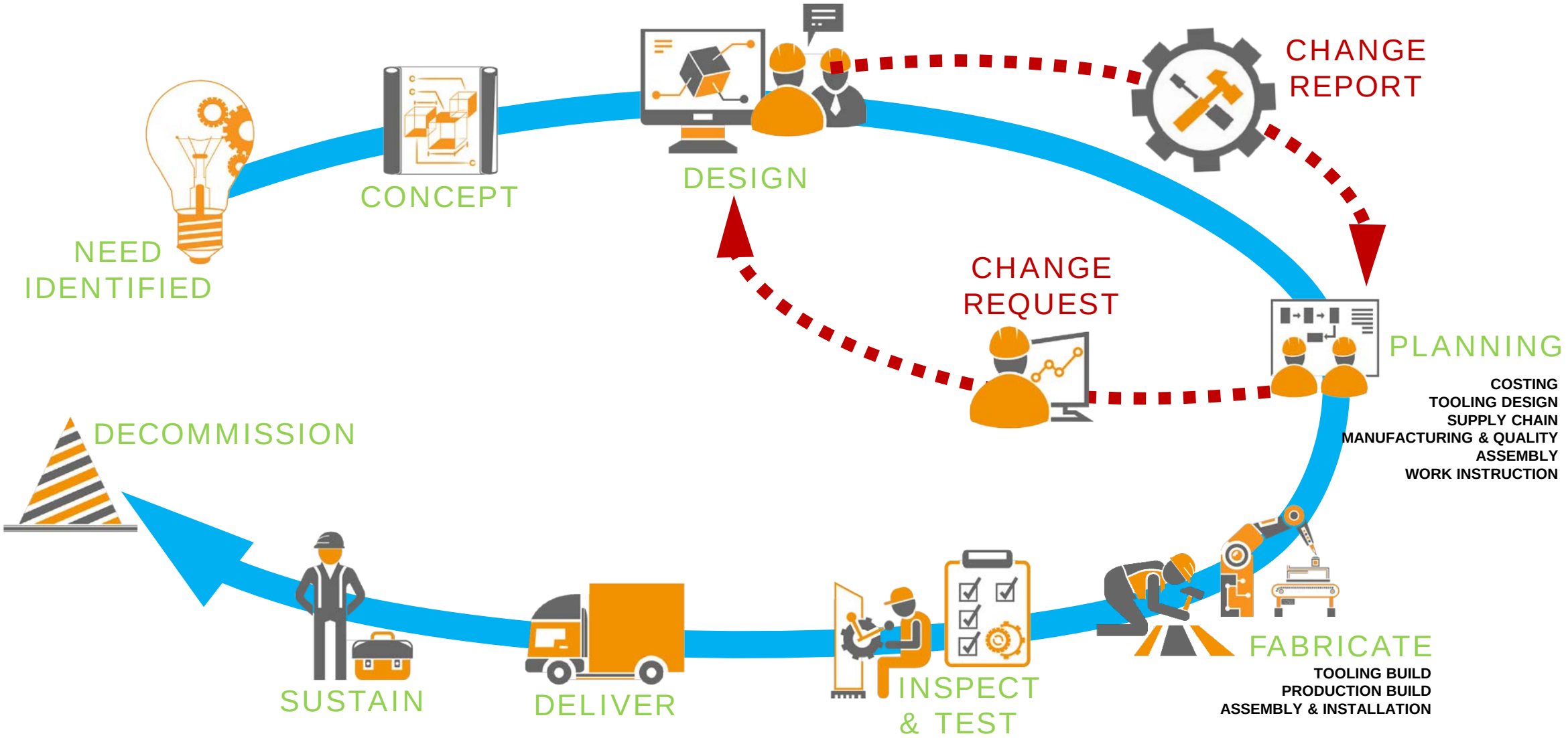


Ada

Mara, Quality

Are all these . . . well . . . Other People

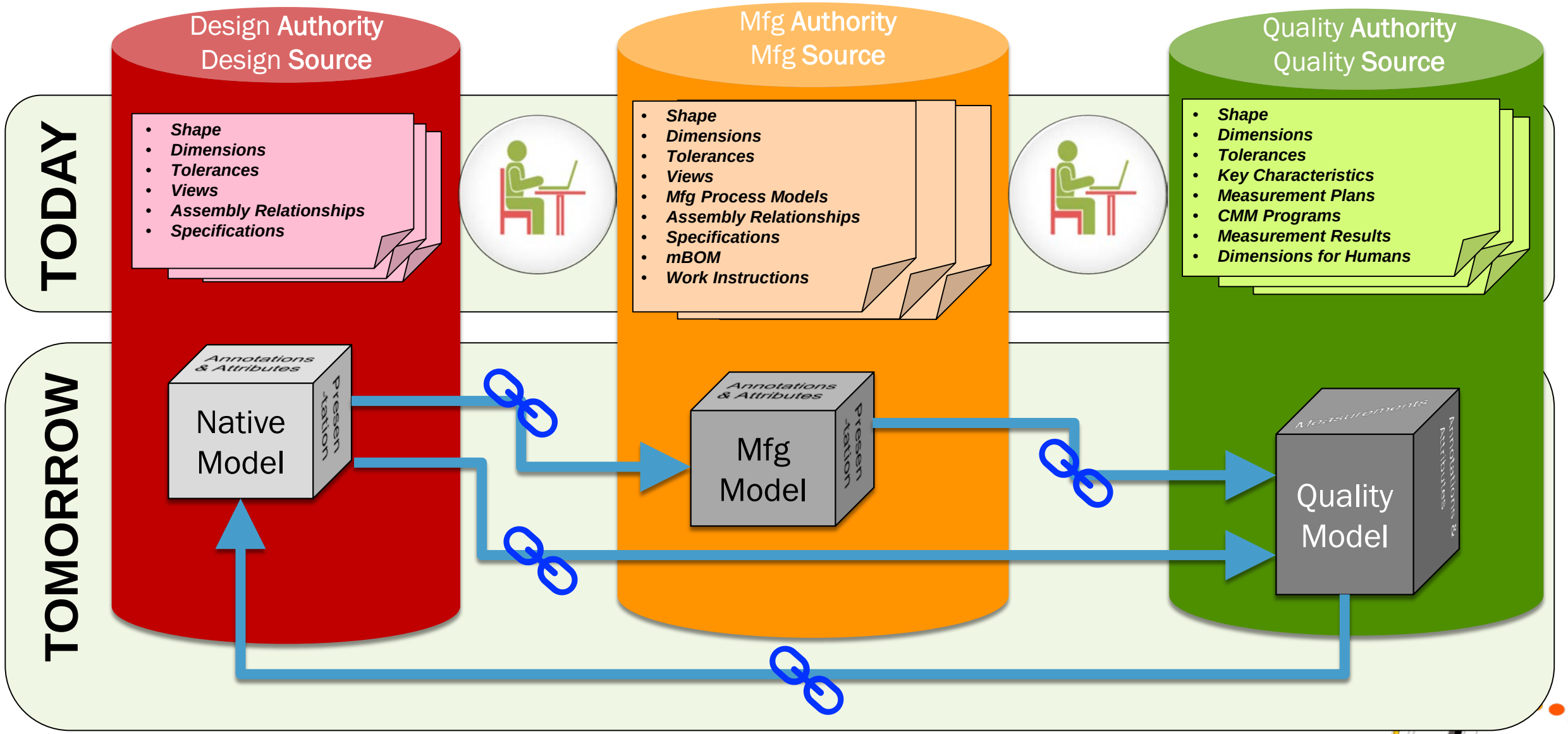
How things are made



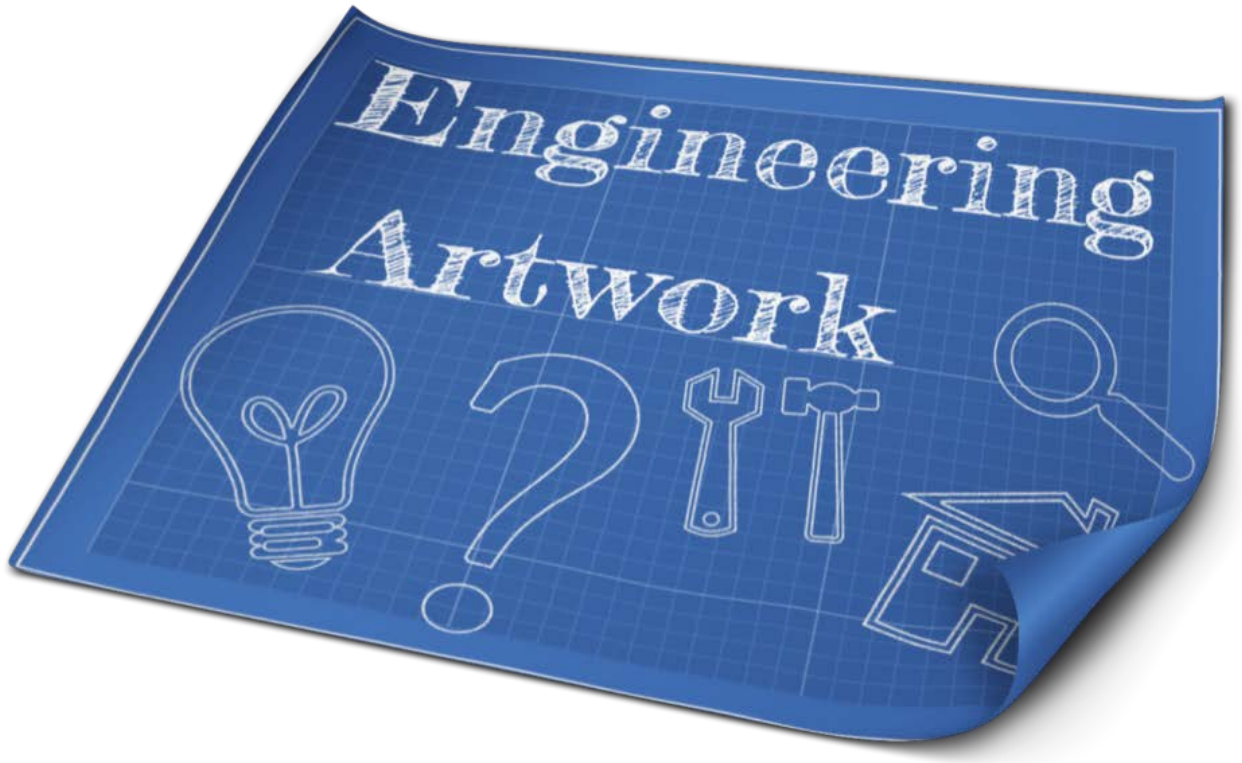
MBE is Value Engineering

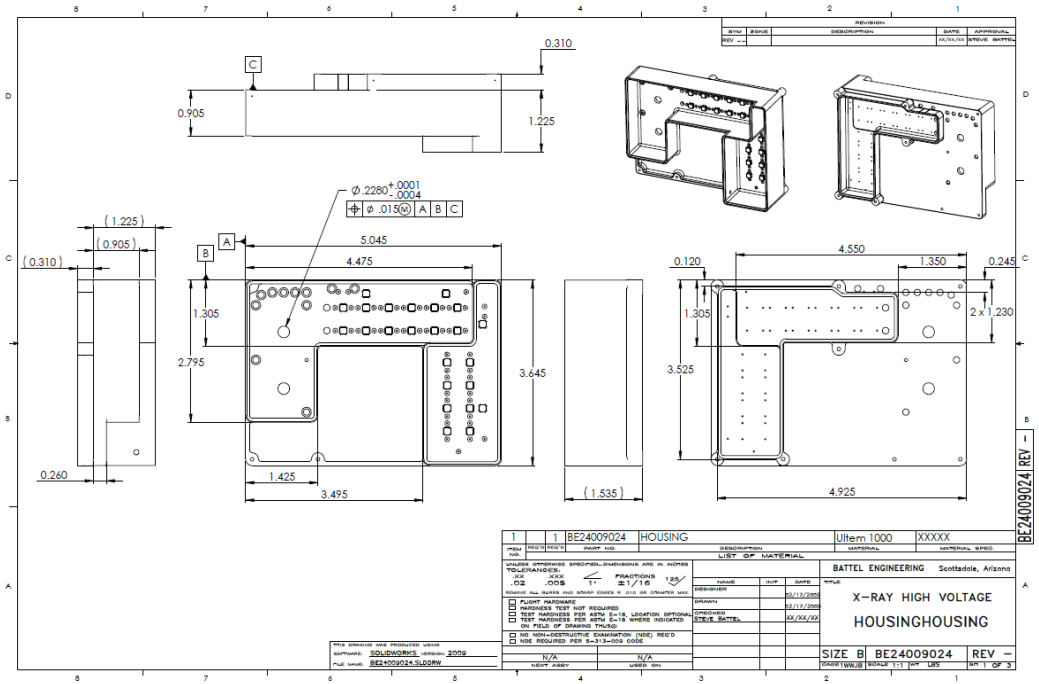
MBE is Value Engineering

Information Flows Throughout the Lifecycle

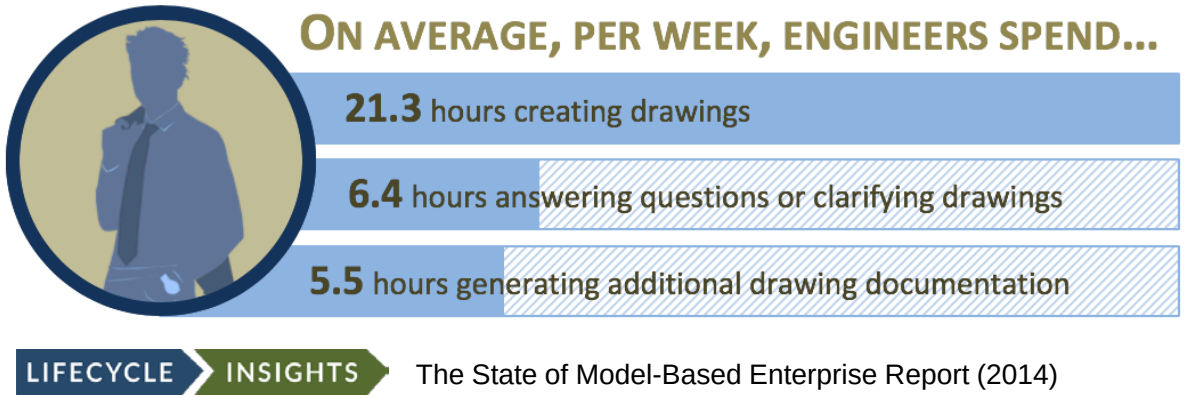


Changing Perceptions of Product Definition





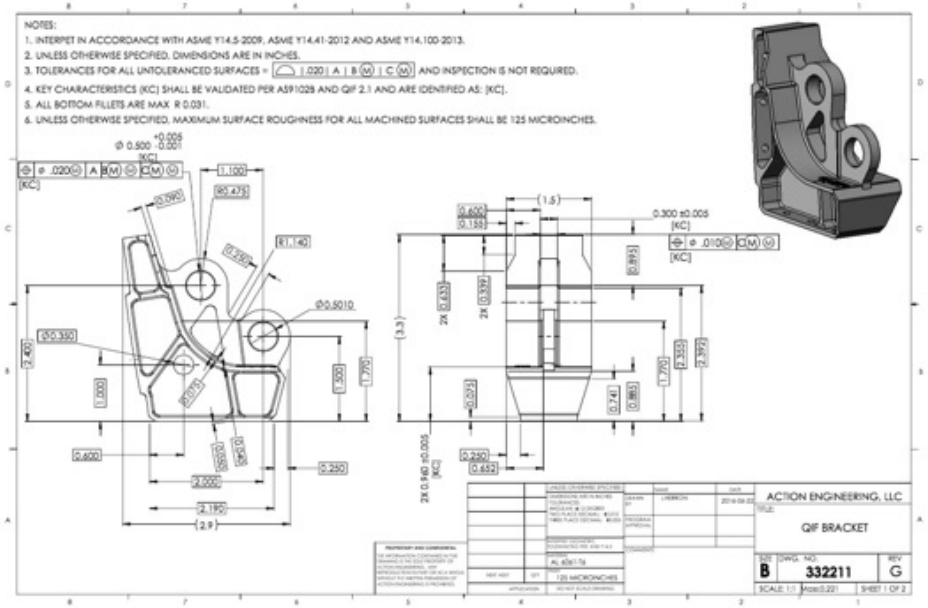
Flaws of a Drawing-Based Approach

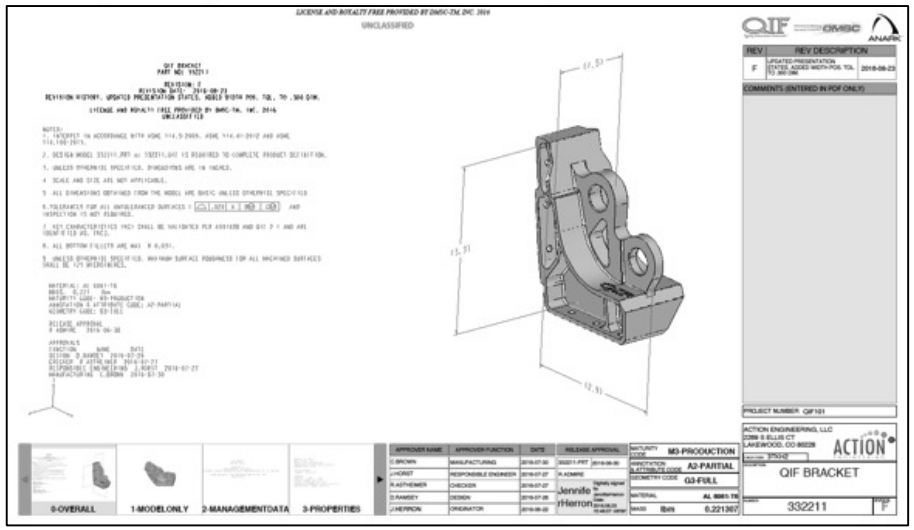


Drawings require skills to interpret. Downstream consumers often return to engineers for clarifications, consuming their time.

- Half the study's respondents (**51%**) state that suppliers or downstream consumers **request additional clarifications** of engineering documentation.
  The State of Model-Based Enterprise Report (2014, Lifecycle Insights)
- Average total **hours** spent creating, **clarifying**, or **amending** engineering documentation**: 27.3** for strongly 2D drawing reliant.
  Quantifying the Value of Model-Based Definitions (2015, Lifecycle Insights)
- Engineers spend an average of **6.4 hours answering questions** or **clarifying drawings** and **5.5 hours** generating **additional drawing** documentation per week.
  The State of Model-Based Enterprise Report (2014, Lifecycle Insights)

Models with Geometric Tolerancing Take Less Time

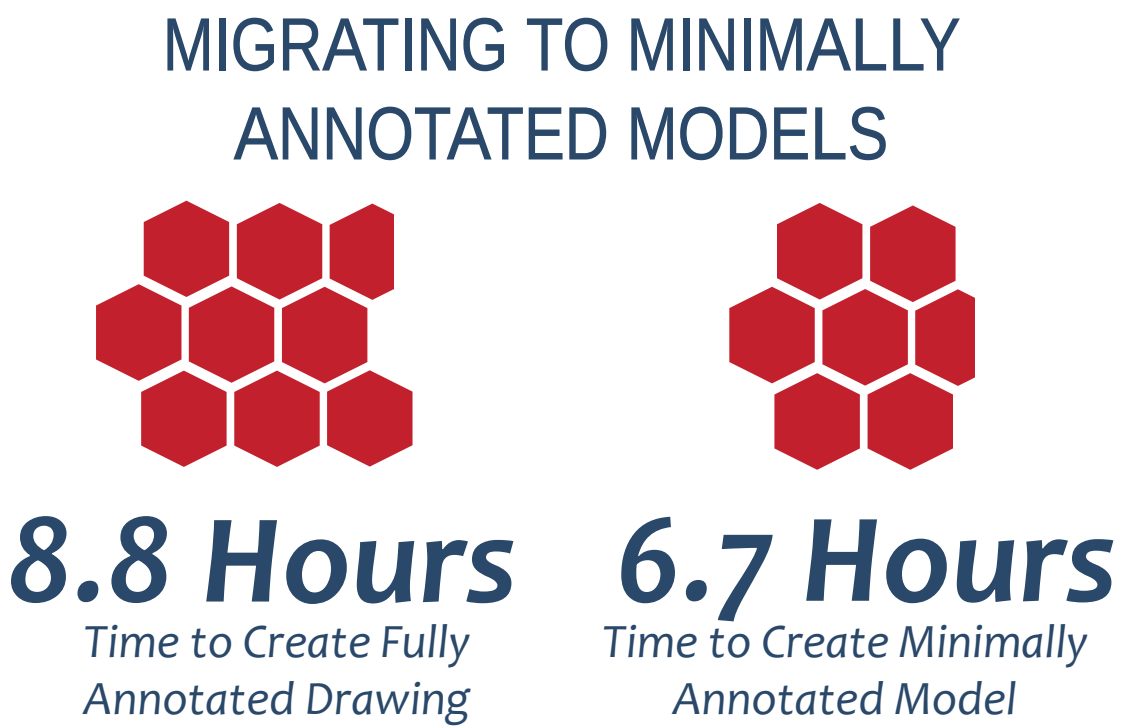




It takes less time to create minimally annotated MBDs than it takes to create fully annotated drawings.

- Time to create engineering documentation (benchmarked example): 8.8 hours for fully annotated drawing vs. 6.7 hours for minimally annotated model.
  ROI of MBD Report
  (2017, Lifecycle Insights)
- Time spent on engineering documentation per week: 23.9 hours for drawing-reliant organizations vs. 20.7 hours for model-based organizations.
  ROI of MBD Report
  (2017, Lifecycle Insights)

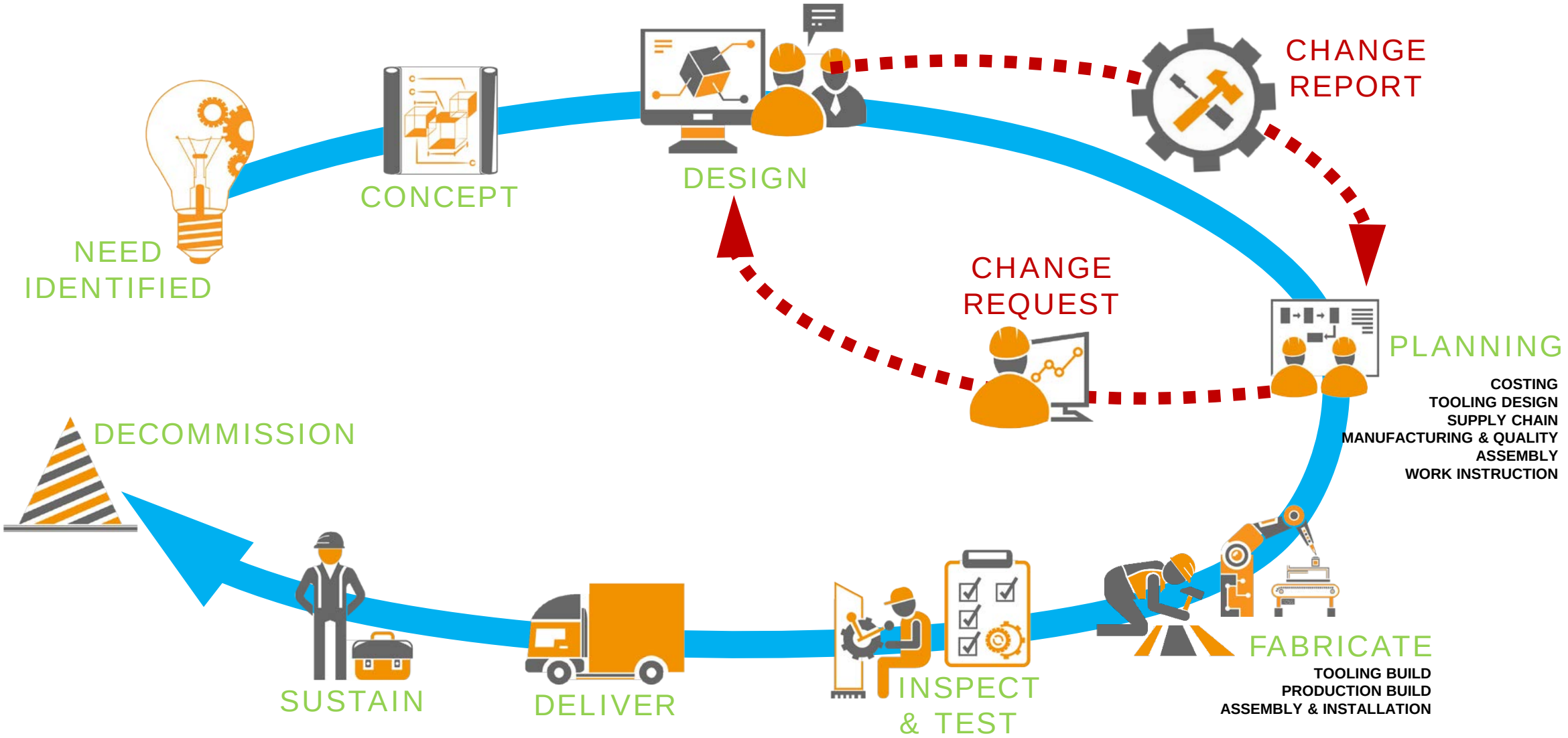
Models with Geometric Tolerancing Take Less Time



It takes less time to create minimally annotated MBDs than it takes to create fully annotated drawings.

- Time to create engineering documentation (benchmarked example): 8.8 hours for fully annotated drawing vs. 6.7 hours for minimally annotated model.
  ROI of MBD Report
  (2017, Lifecycle Insights)
- Time spent on engineering documentation per week: 23.9 hours for drawing-reliant organizations vs. 20.7 hours for model-based organizations.
  ROI of MBD Report
  (2017, Lifecycle Insights)

How things are made



Advantages of an MBD-Based Approach for Work Instructions

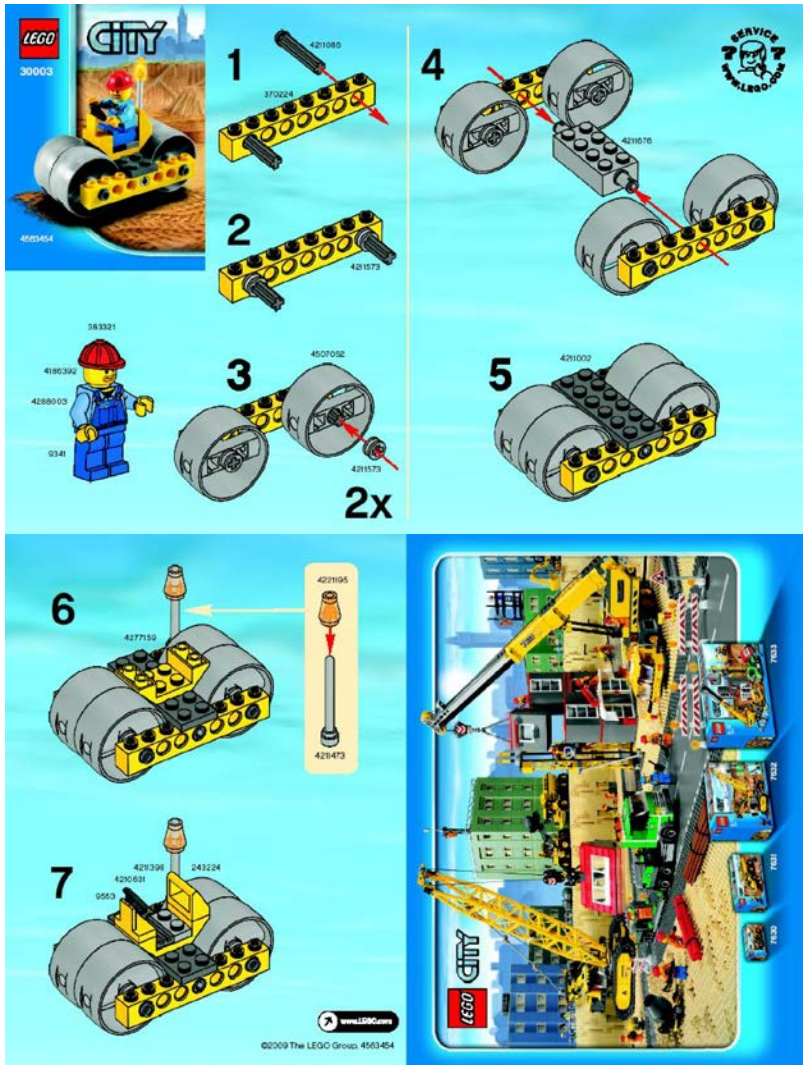
Comparison of metrics for instructions based on drawings or 3D models		
	Instructions based on drawings	*Instructions based on 3D models*
Average # of ECOs	***9.5***	***5.6***
Average # of non-conformances	***6.5***	***3.3***
Percent of respondents that reduced scrap	***10%***	***49%***

LIFECYCLE INSIGHTS The ROI of MBD Report (2017)

The inclusion of 3D models and animations in assembly and manufacturing instructions more clearly communicates intent, leading to a reduction in ECOs, non-conformances, and scrap.

- The average number of ECOs per development project for those using 3D models in instructions is 5.6 compared to 9.5 for those that are drawing-based.
  ROI of MBD Report (2017, Lifecycle Insights)
- The average number of non-conformances per development project is 3.3 for those using 3D models in instructions compared to 6.5 for those that rely on drawings.
  ROI of MBD Report (2017, Lifecycle Insights)
- The percent of respondents that reduce scrap is 49% for those that include 3D models in instructions compared to 10% of those that do not.
  ROI of MBD Report (2017, Lifecycle Insights)

Visual Work Instructions



V

S

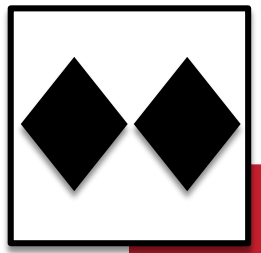
Role-Based Training for Professionals

Literacy

- Customers
- Management
- Systems
- IT
- Procurement

Competency

- Design
- Manufacturing
- Quality
- Configuration & Change Management



Mastery

- Engineering
- Product Definition
- Manufacturing Planners
- Inspectors

QUESTIONS

Dr. Nathan Hartman
Purdue University
nhartman@purdue.edu

Undergraduate:

Virtual Product Integration Major
Enhance the design, manufacture, and marketing of products through 3D modeling, managing product data, simulations and visualization.

Product Lifecycle Management Minor
Gain applied knowledge in current and emerging topics in PLM associated with the design, documentation, manufacture and support of products and related services.

Professional:

- **PLM Certificate**
  Make better business decisions and manage products from concept to disposal. - *Register here*
- **MBD Certificate**
  Streamline the production development process and reduce errors in manufacturing. - *Register here*
- **TDP Certificate**
  Make effective technical documentation and Create and interrogate 3Di TDPs. - *Register here*

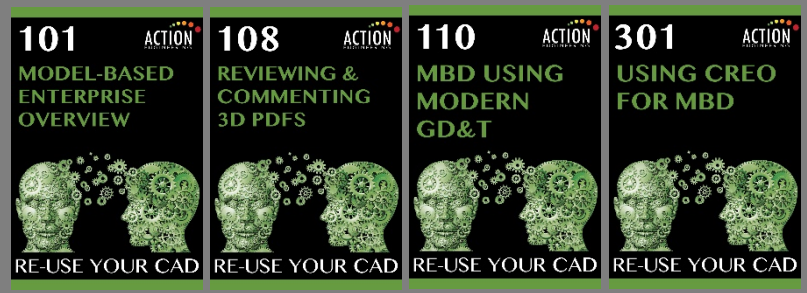
Graduate:

Product Lifecycle Management (CGT 514)
A survey of the graphical knowledge base with business and industry applications that support the product lifecycle management process

Duane Hess
Action Engineering
duane@action-engineering.com

Re-Use Your CAD University

https://www.action-engineering.com/courses



DIGITAL ENTERPRISE CENTER

ACTION ENGINEERING

www.action-engineering.com
www.purdue.edu/digital-enterprise-center