

# Assembly Process Animations

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Specialist Engineering Support  
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## GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2016



# Speaker Information

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## Myon D. Caruthers

- Hired as a Specialist Engineering Support for Product Realization/Development
- Work Instruction Preparation
- Currently Specialist Engineering Support in Design Services/DPRE/MBE
- Support Model-Based Enterprise efforts
- Support PDM efforts
- KCNSC SME for Assembly Process Animations

# Kansas City National Security Campus

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***Government sponsored, multi-mission engineering and manufacturing enterprise delivering trusted national security products and government services***



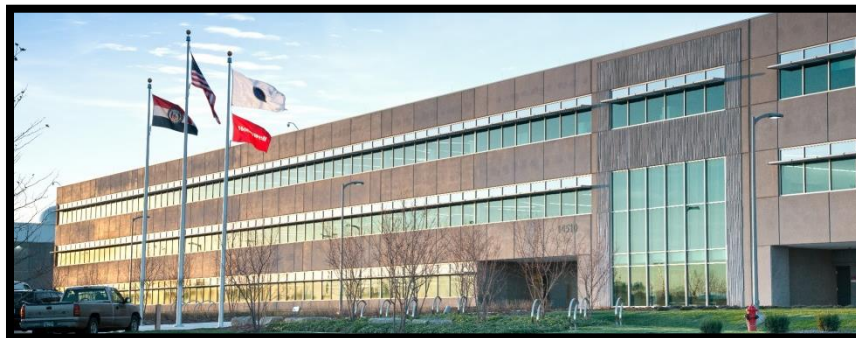
## **Core Mission – National Nuclear Security Administration**

- A large portion of the Campus is dedicated to NNSA's mission of keeping our nation's nuclear stockpile safe, secure and reliable by delivering mission-critical mechanical, electrical and engineered material components.



## **Global Security – Other Government Agencies**

- Our unique expertise extends beyond the nuclear security enterprise to benefit national security and promote nonproliferation with field-ready solutions for other government agencies.



**Honeywell**

# Assembly Process Animations

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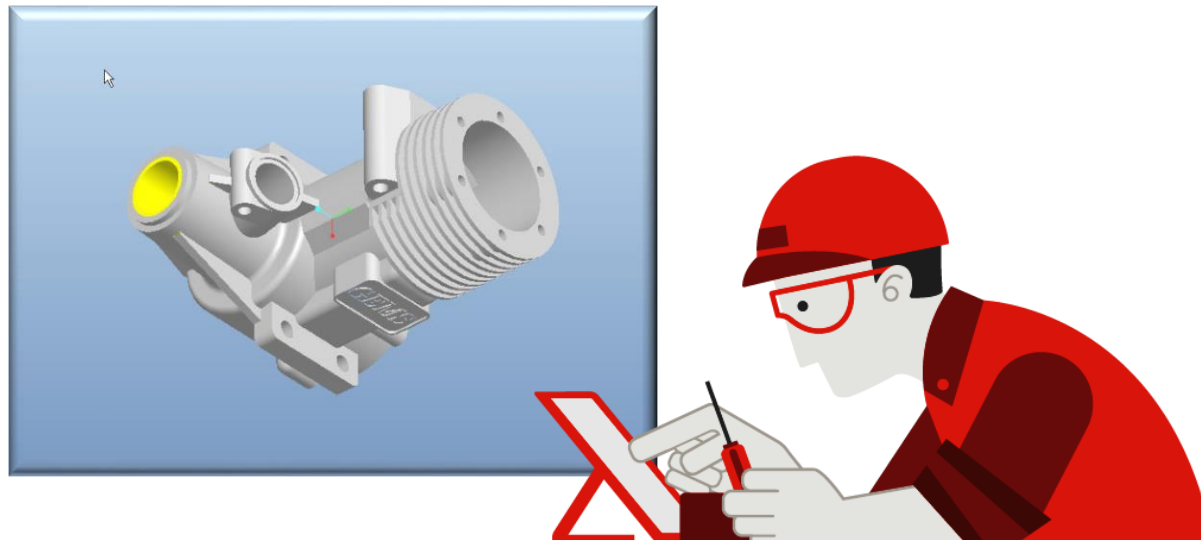
## Enhance assembly work instructions with process animations



# Why Good Work Instructions Are Critical

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**Manufacturing work instructions are the key tool to help workers comprehend the sequence of steps required to assemble, disassemble, or repair a product.**



# Why Good Work Instructions Are Critical

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- **The Challenge...**

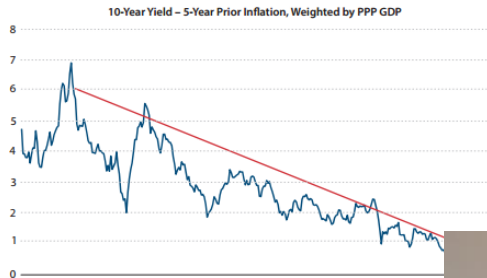
- Products are becoming more complex, making it more difficult to produce work instructions with clear, concise, and up-to-date communication.



# Why Good Work Instructions Are Critical

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**When a product is manufactured improperly, the impact on the organization is tremendous.**



**Poor Quality is realized through low yield rates, cost overruns, and customer dissatisfaction.**



# Why Good Work Instructions Are Critical

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**Quality work instructions are critical to realizing improved manufacturing efficiency and quality on the factory floor.**

- **Key to reducing variation in build processes**
- **Enforce consistency when performing tasks**



**Good work instructions... “the cornerstone of lean manufacturing.”**



# Conventional 2D Work Instructions

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The standard method for creating manufacturing work instructions is to convert multiple sheets of 2D engineering drawings into comprehensive instructional text with static 2D visuals, using non-standard tools, to create process documentation.

## Limitations

- Only show parts, not process. “What?” not “How?”.
- Only show what’s visible. Hidden features difficult to communicate.
- For complex assemblies, numerous pictures necessary to clearly communicate assembly instructions.
- Often use a variety of non-standard tools to create process documentation.
- Lack of integration with ERP and PLM systems resulting in out-of-date information.
- Information often difficult to interpret, slowing process and resulting in unnecessary errors, defects, rework, scrap, and waste.

# What Goes Into a Work Instruction?

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## **Novick and Morse, Memory & Cognition 2000, 28 (7), 1242-1256; “The Role of Diagrams in Executing Assembly Procedures”**

- Studied the importance of media in the learning process
- Examined accuracy, time, and recollection required to execute a series of assembly procedures
- Compared delivery formats: text only, text with final picture, and picture with each step

## **Results:**

- Faster finish times with much more accuracy is achieved with step-by-step instructions with a picture at each step.

# What Goes Into a Work Instruction?

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## Marcus, Cooper, and Sweller; Journal of Educational Psychology 1996, Vol. 88, No. 1, 49-63; “Understanding Instructions”

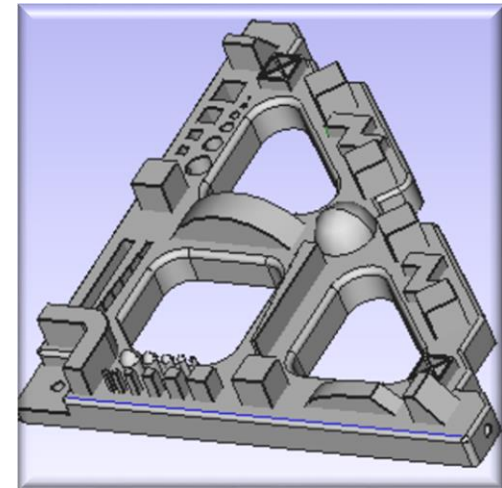
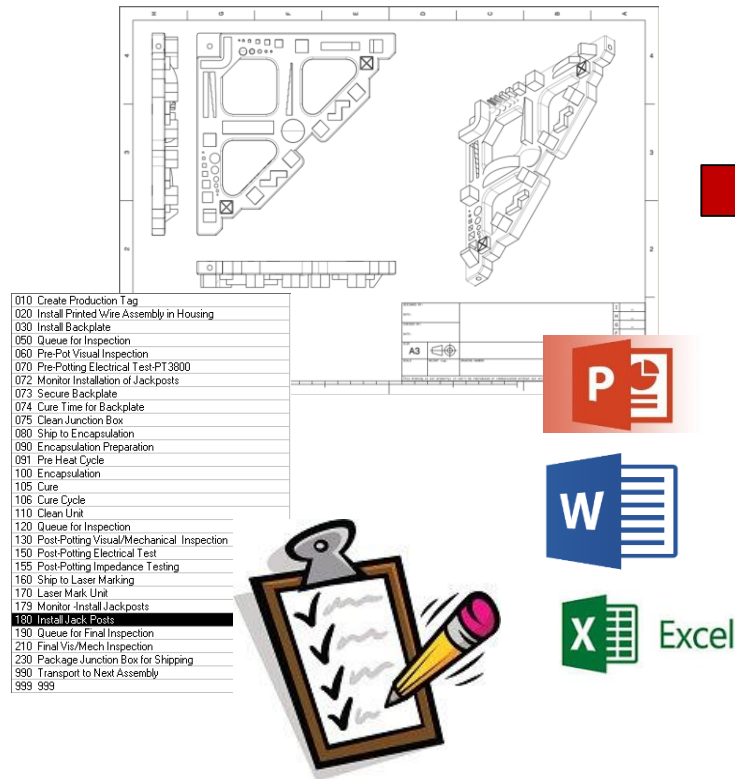
- Studied the understanding of instructions within the context of cognitive load theory
- Examined aspects of the cognitive system critical to understanding information

### Tested Hypothesis:

- The level of effort with which we understand instructions and procedures is influenced by 2 factors:
  1. The intrinsic complexity of information to be processed
  2. The manner in which the information is presented

# FM&T Work Instructions Research

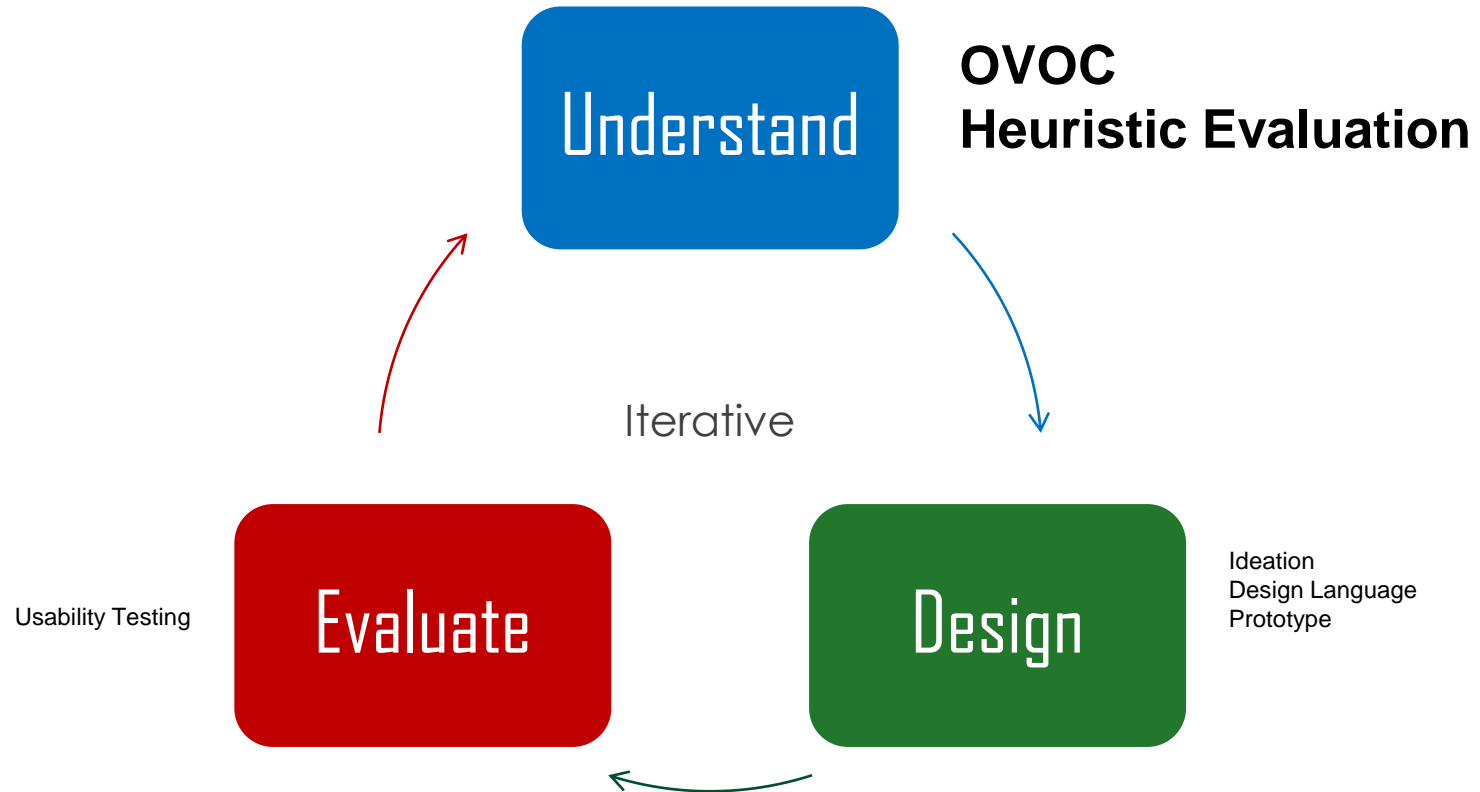
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**Leverage features, capabilities, and efficiencies associated with model based applications to enhanced process communication documentation.**

# FM&T Work Instructions Research

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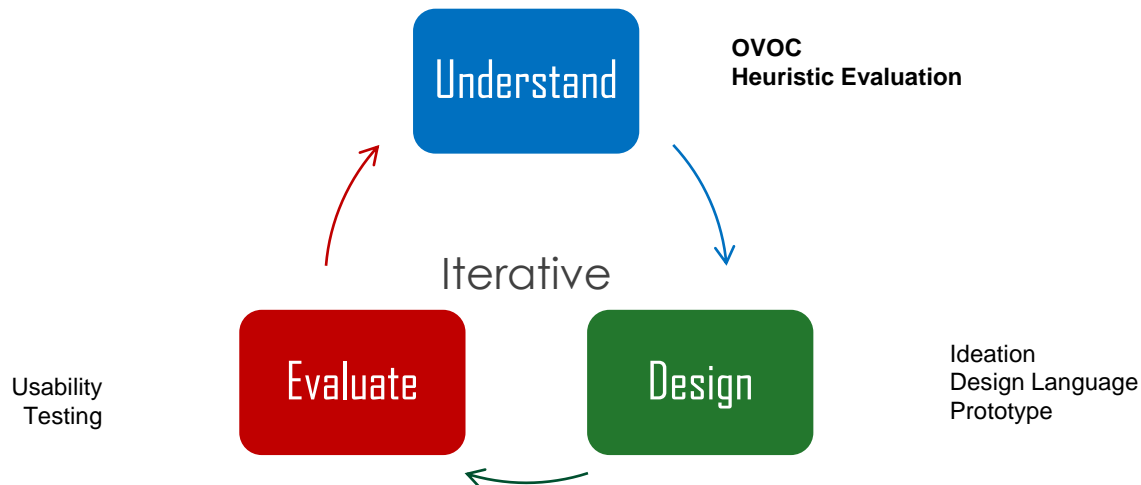


# FM&T Work Instructions Research

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## OVOC Details

- Observed 6 assembly levels
- 4 videos



# FM&T Work Instructions Research

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## OVOC Results

- Too Descriptive
  - ❖ Would prefer quick text to serve as a reminder
  - ❖ Difficulty building a mental model
- Inaccurate Information (7 instances)
  - ❖ Order of operations
  - ❖ Part numbers
  - ❖ Tool numbers
  - ❖ Reference material inconsistency
- Difficulty Tracking Progress Within an Operation
  - ❖ Due to the length of instructions



# FM&T Work Instructions Research

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## OVOC Observations

- None of the operators read each step *before* performing a task
  - ❖ Many operators read instruction after performing step  
(To flatter the observer)
- Some operators summarized the provided work instructions and created a checklist to follow

# FM&T Work Instructions Research

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## Create a WI prototype

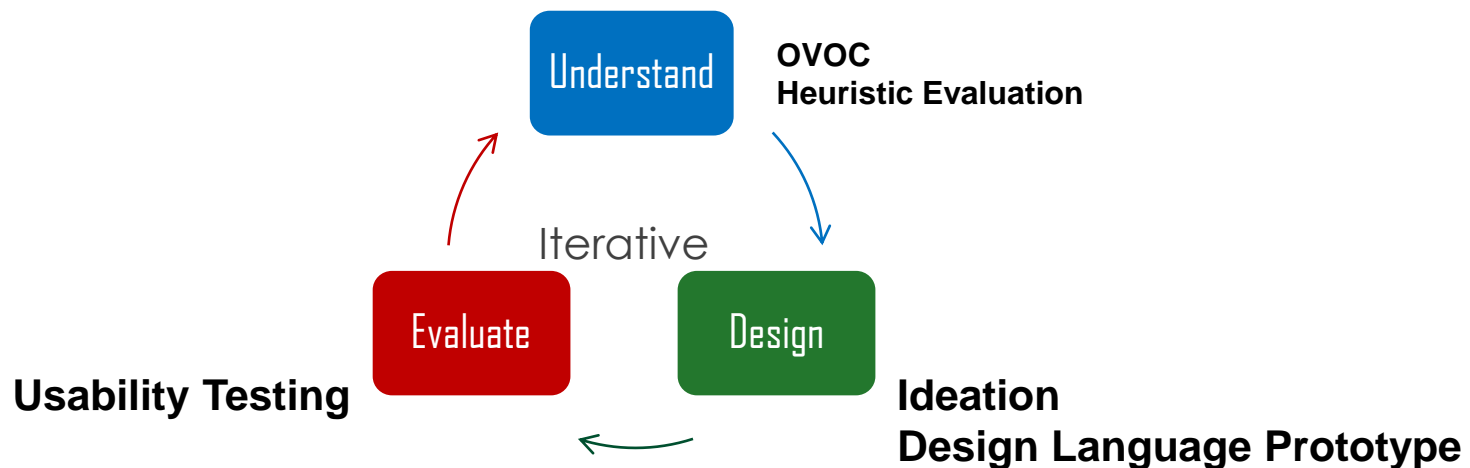
- Using the data collected through analysis

## Test the prototype

- Conduct usability tests

## Generate guidelines for creating work instruction

- Considering feedback from usability tests



# Case Studies

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## ➤ **“Examining the Use of Model-Based Work Instructions in the Aviation Maintenance Environment” (FAA Study conducted by Purdue University)**

“It has been noted that properly applied visualization and component presentation of technical or complex systems is critical for improving daily maintenance tasks in both efficiency and accuracy”

## ➤ **“Three-dimensional Model Based Manufacturing Work Instructions” (The Boeing Company Study)**

“The MBI format leverages features and capabilities associated with 3D engineering to provide additional information to the mechanic previously not available in the conventional 2D engineering and textual work instruction format. Quality is better as this approach minimizes mistakes associated with 2D engineering drawing sheet ambiguity. Mechanics learn their tasks more rapidly and can assemble the product easier. MBIs enable flexibility in the work force so product can be produced at an increased rate with fewer defects and at a lower cost.”

# Assembly Process Animations

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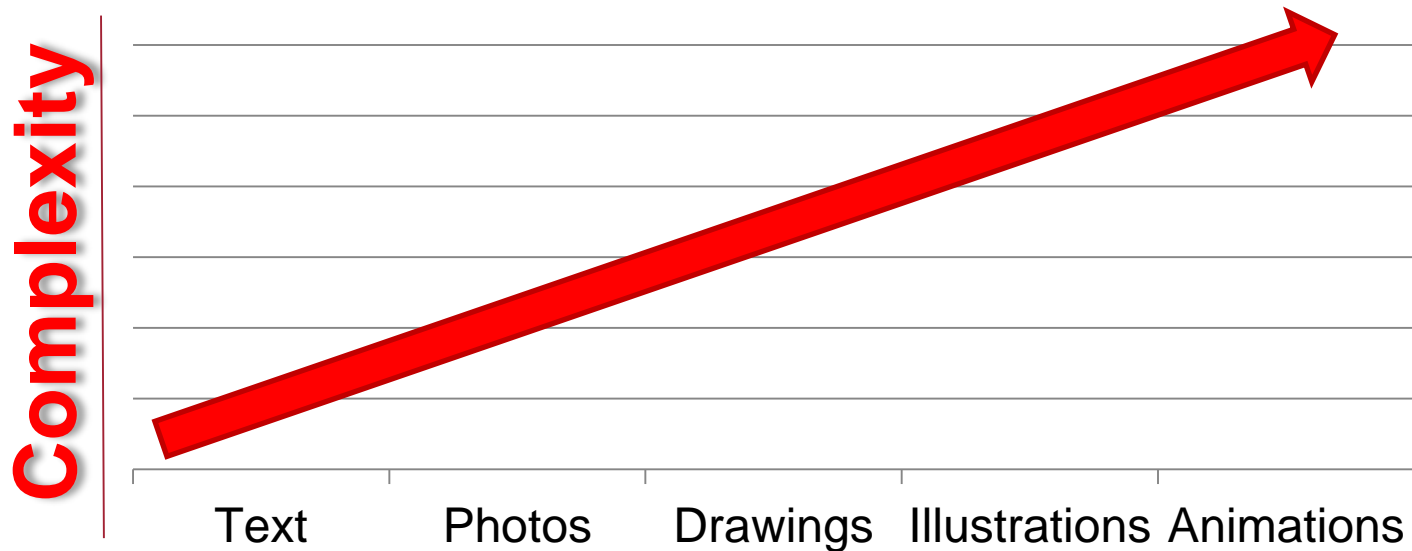


Enhance work instruction  
communication utilizing...

**Assembly Process Animations**

# Assembly Process Animations

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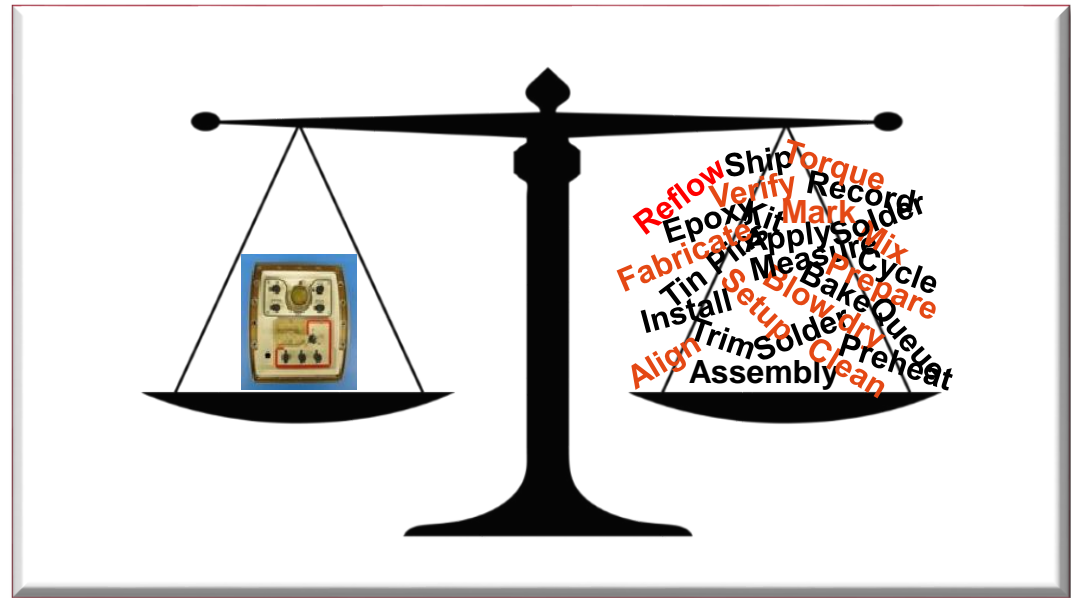


**As assembly process complexity increases, the need to more clearly communicate process details increases.**

# Assembly Process Animations

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If...



What's an animation worth?!!

# Model-Based Process Documentation Benefits

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	Performance Benefits	MBE Contributors to Savings
1	<b>Easier to Accurately Interpret Information</b>	<ul style="list-style-type: none"><li>• Accelerates execution of process steps and overall pace of assembly.</li><li>• Eliminates costly errors caused by misinterpretation.</li></ul>
2	<b>50% Reduction in Tooling Design &amp; Fabrication Costs</b>	<ul style="list-style-type: none"><li>• There is no need to remodel the original design (typically from 2D Drawings) around which the Tooling/fabrication processes will be designed</li><li>• 'Original engineering design intent' is more easily and quickly understood by the tooling designer</li></ul>
3	<b>30% Reduction in Overall Assembly Time</b>	<ul style="list-style-type: none"><li>• Complete Assembly process can all be seen within 1 - 3D PDF MBE document.</li><li>• The exact assembly process, animated in 3D leaves less room for shop floor confusion or delays</li></ul>
4	<b>20% Reduction in Manufacturing and Supplier Scrap and Rework</b>	<ul style="list-style-type: none"><li>• Manufacturing and Supplier process documents automatically updated when an Engineering change or new version occurs</li><li>• Both Manufacturing and Quality gain a much clearer idea of the Engineering Designers Key Characteristics, Important Assembly Datums and Sequence</li></ul>

**Source:** US Dept. of Defense, Analyst reports & studies presented at conferences

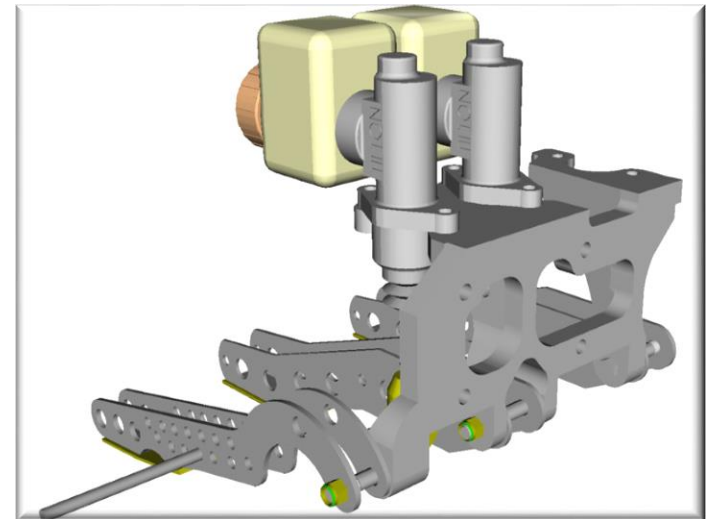


# Assembly Process Animations Benefits

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## ANIMATIONS

- Clearly Convey Complex Information
  - ❖ Increase operator's capacity to accurately interpret and understand complex or critical assembly work instructions.
- Reduce Translation Costs
  - ❖ Replace excessive text with illustrated step-by-step procedures, 3D animations, and other technical illustrations.
- Reduce Delays Between Builds
  - ❖ Allows for process planning and work instruction creation without actual parts in hand.
- Increase Routing Productivity
  - ❖ Model design changes auto-update, eliminating the need to retake process pictures and re-create SWD's.



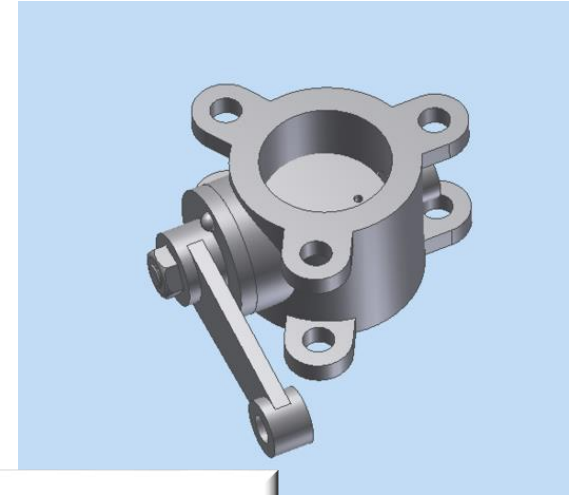
# Assembly Process Animations Benefits

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## ANIMATIONS

### ➤ IMPROVES ASSEMBLY SKILLS

- ❖ The less experienced operator is enabled to perform on more complicated assemblies due to increased visualization and communication



# Assembly Process Animations Benefits

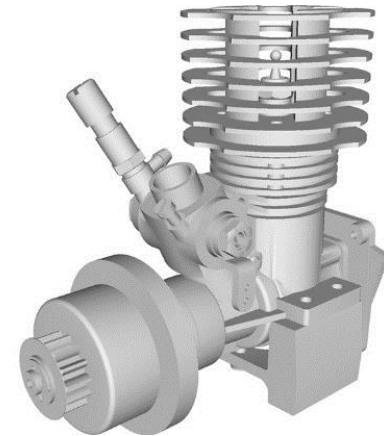
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## ANIMATIONS



### ➤ TIME = MONEY...

- ❖ Time for engineers (low learning curve that allows engineers to create animations in the same time or less than it takes to create most SWD's)
- ❖ Time for Training
- ❖ Time for Qualifications



# Delivery Formats

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Windows Media



3D PDF

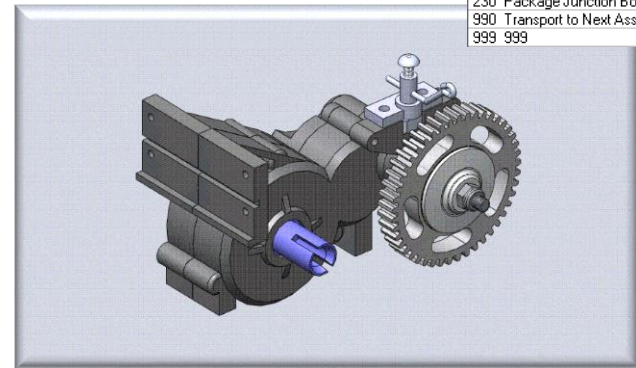
# Assembly Process Animations Use Cases

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## ANIMATIONS

- **Step-by-step Assembly Process Animations**
  - **Complete Assembly Work Instruction**
  - **Single Operation Process Instruction**
- **Assembly Process Planning**
- **Assembly Process Training**

010	Create Production Tag
020	Install Printed Wire Assembly in Housing
030	Install Backplate
050	Queue for Inspection
060	Pre-Pot Visual Inspection
070	Pre-Potting Electrical Test-PT3800
072	Monitor Installation of Jackposts
073	Secure Backplate
074	Cure Time for Backplate
075	Clean Junction Box
080	Ship to Encapsulation
090	Encapsulation Preparation
091	Pre Heat Cycle
100	Encapsulation
105	Cure
106	Cure Cycle
110	Clean Unit
120	Queue for Inspection
130	Post-Potting Visual/Mechanical Inspection
150	Post-Potting Electrical Test
155	Post-Potting Impedance Testing
160	Ship to Laser Marking
170	Laser Mark Unit
179	Monitor-Install Jackposts
180	Install Jack Posts
190	Queue for Final Inspection
210	Final Vis/Mech Inspection
230	Package Junction Box for Shipping
990	Transport to Next Assembly
999	999



# Voice of the Customer

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## ANIMATIONS

- “This looks really good. It provides a good visual of how the product is assembled.”
- “It gives you a complete colored overview and step-by-step of the process, which is good!”
- “On the more complicated assemblies I've seen animation used and I tend to like it. It gives the operators a chance to look at the process.”
- “I think that it is a helpful tool... both instructions are good, but the animated one is good for some who work best with a visual learning curve. It may help with being able to visualize the process. Some operators need that extra info.”
- “I know exactly how things should come together before I actually start the assembly.”



# Assembly Process Animations

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# Thank you

