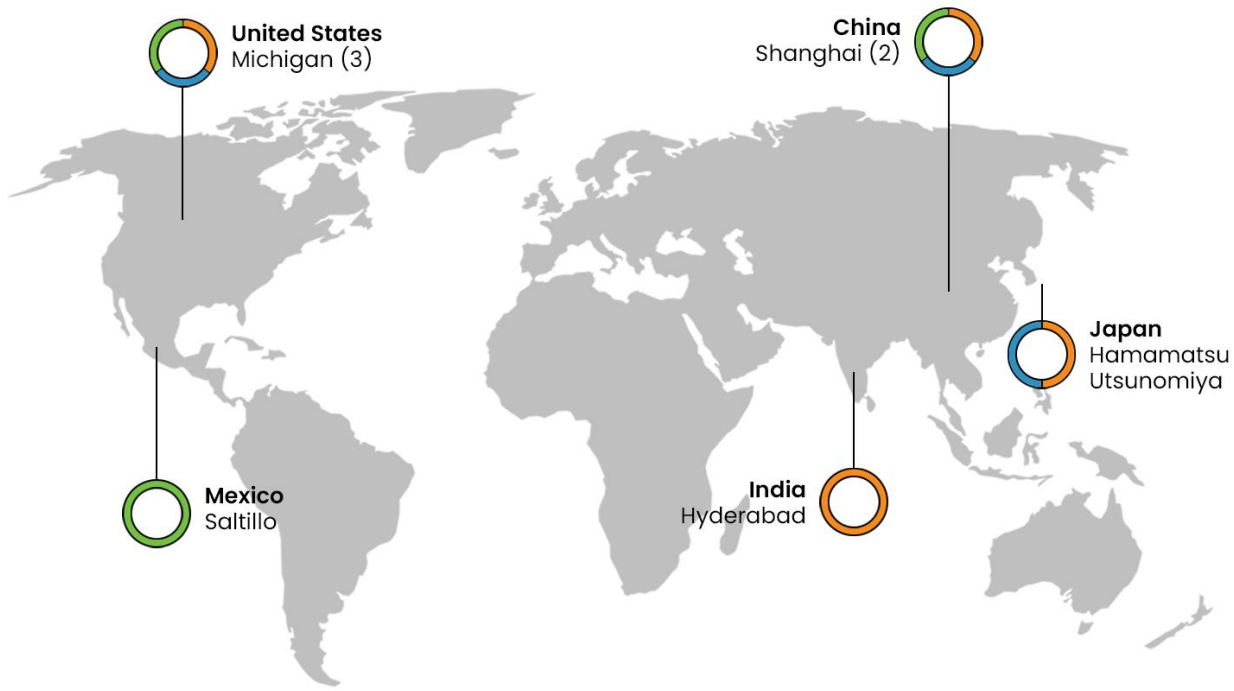
GHSP's DFMA Transformation

Company Overview

Established 1924
Headquarters Holland, MI
Employees 1,400
Annual Sales $300M
Ownership Privately owned within JSJ Group
Customers, Partners

TOYOTA, HONDA, NISSAN, gm, Ford, STELLANTIS, SAIC, SAIC-GM, FAW, GEELY, BYD 比亚迪汽车, TREMEC, AAM, LINAMAR, BORGWARNER, SL, Parker Lord, BILSTEIN, SUB-ZERO WOLF

Global Presence



01 Sales
02 Engineering
03 Manufacturing

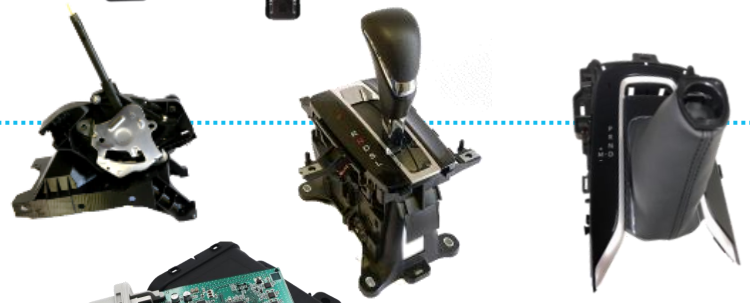
Core Products (Automotive)

Shift-by-wire systems

- All embodiments across multiple global OEMS
- Flexible core platforms
- Powertrain and multifunction controls

Conventional shifters

- Common core components
- Decoration & lighting

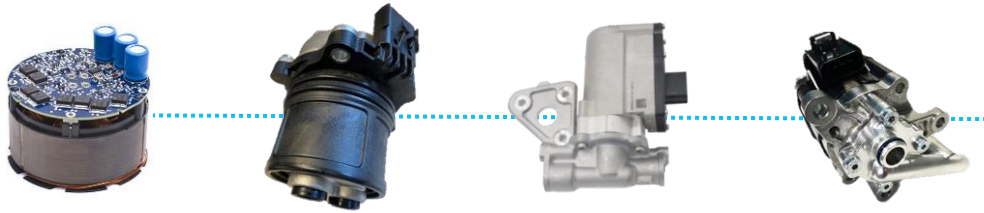


Controllers/ECUs

- Shift by wire
- Trailer brake & lighting
- Active dampening & ride height

E-pumps

- Cooling & Lubricating across all powertrains & applications
- Oil, Water, Glycol, Dielectric

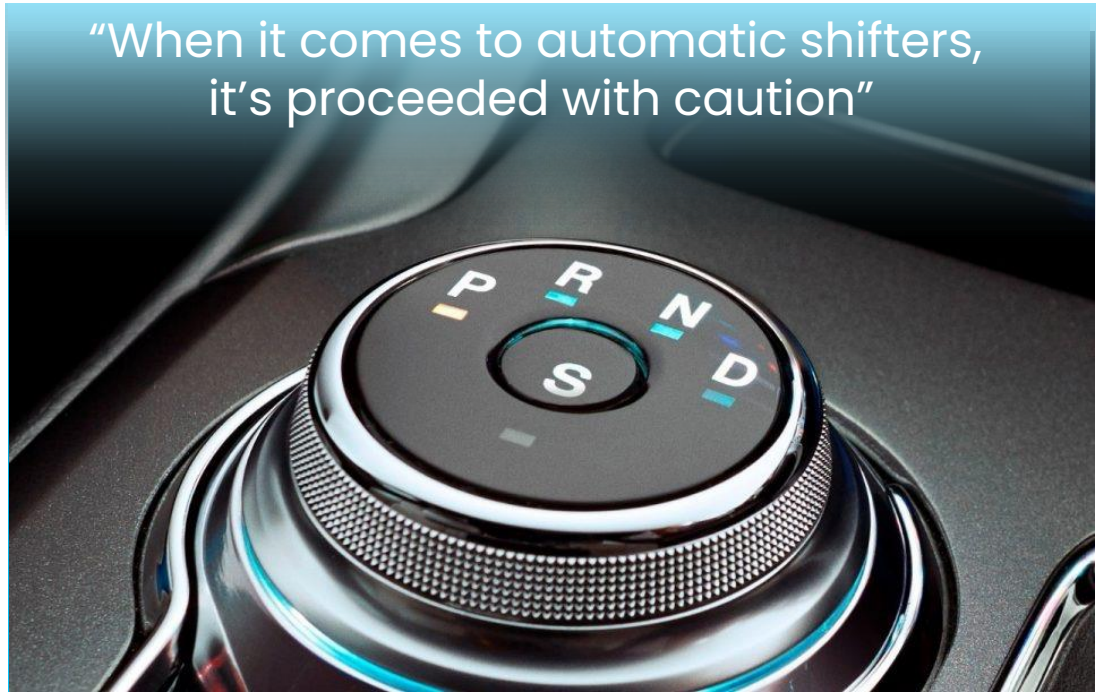


Actuators

- Axle disconnect, Sway Bar, Transmission/Park Lock
- Vibration Control & Enhancement

Shift-by-Wire

Consumer Reports™



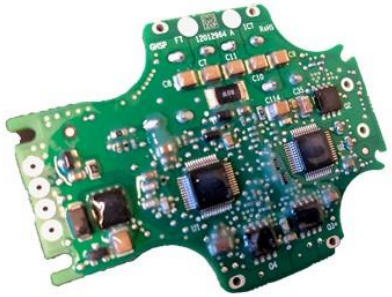
"The rotary shifter on the 2017 Ford Fusion represents an **innovation** that actually **improves safety**."

Automotive News

"The 2018 GMC Terrain may elevate General Motors into a **design leader** for the next generation of automatic transmission shifters."

Electronic Pump Applications

- External Electric Oil Pumps
- Internal Electric Oil Pumps
- Hydraulic Clutch Actuator
- Internal Electric Motor
- External Electric Motor
- Electric Water Pumps
- Dual Electric Pumps
- High Voltage 1KW



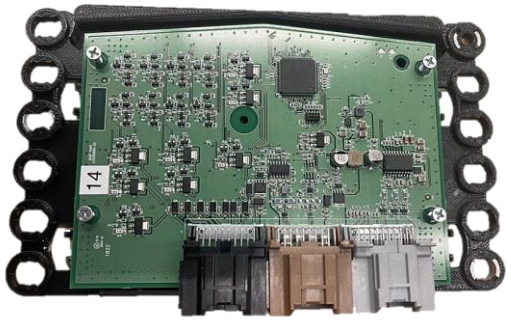
Integrated Embedded Controls
- LIN, CAN and PWM Communication
- Speed, Torque and Pressure Control
- Signal Processing
- Diagnostics
- Models

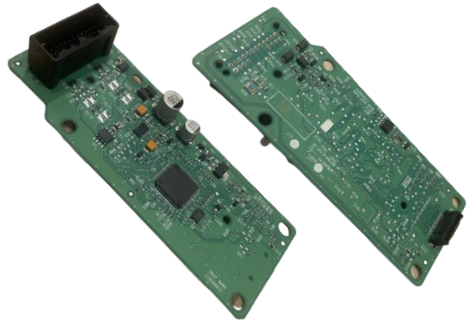
Compact eMachines
- In-Slot, Segmented, Optimized Power and Density Stator
- Sintered, Bonded and Sensor (Less) Rotor
- Die Cast, Molded and Stator-Only Housing

Multi-function, Fluid Controls
- Pressure, Flow and Power Capacity
- Temperature
- Response
- Stability
- Cooling
- Pressure Control

Control Module Applications

- Trailer Brake
- Trailer Lighting
- Active Dampening
- Standard Interface Board (SIB)
- Vibration Emulation/Cancellation





Software Capabilities

- AutoSAR
- ISO 26262 - ASIL A/B
- GM Cybersecurity
- Diagnostics / DTC
- FOTA Capable
- Control Algorithm Development

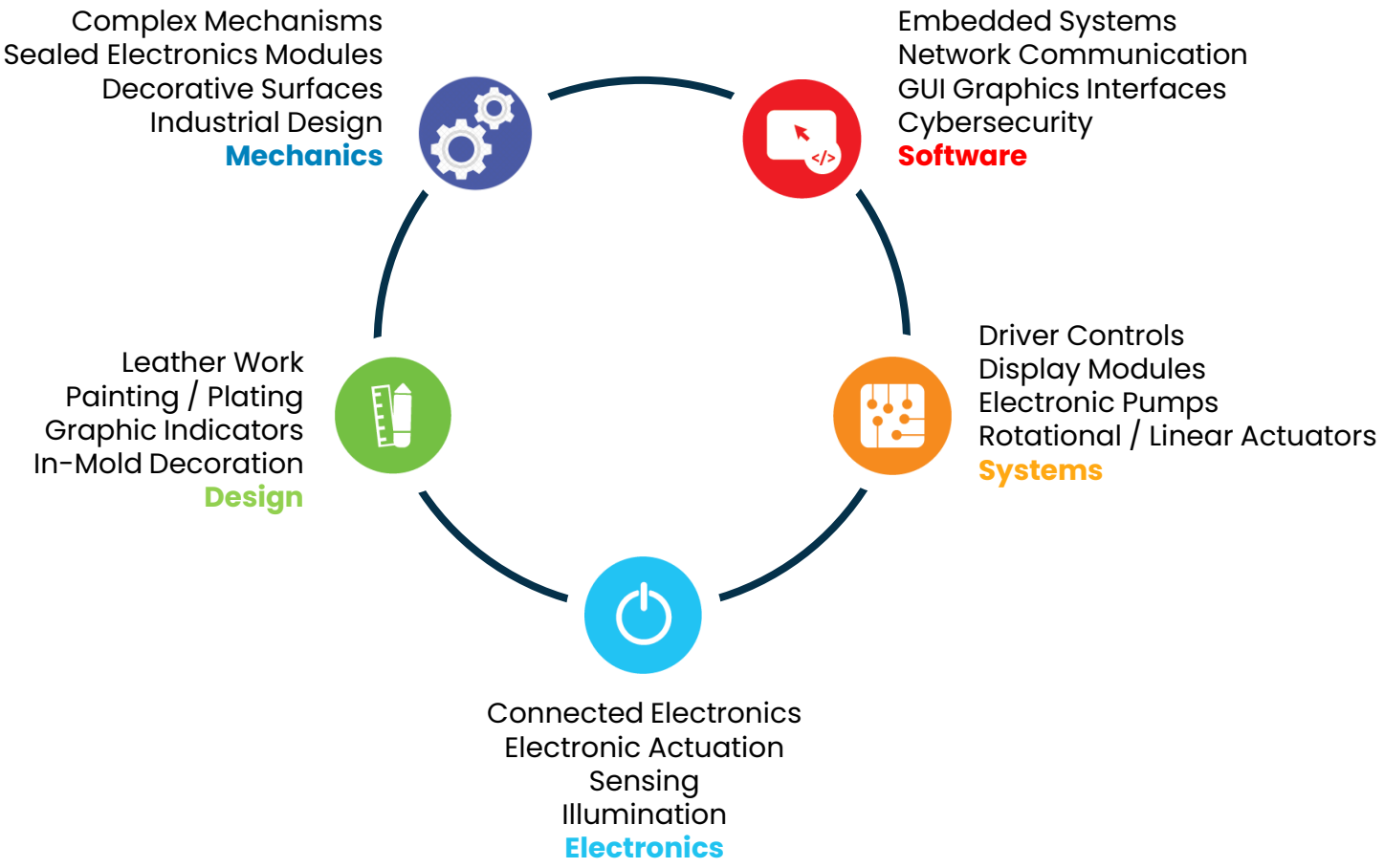
Sensors

- Body Accelerometers
- Ride Height
- Wheel Hub Accelerometers
- Tri-Axis Hall Effect Position

Communication

- CAN / CAN-FD
- LIN
- PWM

Core Competencies



Vertical Integration

- Software, hardware and mechanical design
- Full performance and validation testing
- SMT manufacturing – PCBAs
- ESD-controlled clean room production
- Wire harness manufacturing
- Laser welding
- Plastic injection molding
- Stator over-molding
- Motor winding
- Leather stitching and wrapping – Knobs, Boots
- Complex assembly – Controllers, Pumps

In the Beginning…

- Before 2016, DFMA was a single task in our Product Development Process.
- It usually consisted of 2 people (Mechanical Engineer and Process Engineer) who would review the design on a screen.

Progression

- Excel form created to give some sort of guidence.

Design for Manufacturing and Assembly Checklist / Review

Date
OEM
Program
Project #
Team Members
Fulfillment Location

Ranking Legend
0 - 23 = Green (Approved)
23 - 47 = Yellow (Requires signoff)
48 - 70 = Red (Redesign)

Author
PPAP Timing
PV Test / SOP
Revision Date
PLANT MGR SIGNATURE
LAUNCH MGR SIGNATURE

				DFAM Assessment																
No.	Part	Number of Parts	Lesson Learned - Best People Practice (Program #)	LL/BPP Status	1. Part Need	2. Fabrication	3. Handling	4. Size and Weight	5. Orientation	6. Assy Access	7. Insertion	8. JFS	9. NVH / BSR	10. Rework	11. Lot Trace	Total	Issue	Requirements / Action / Comments	Docs / Pics / Drawings	Responsible	Due Date
Part Assembly - A																					
1	Housing	1			0	0	0	0	0	0	0	0	0	5	0	5					
2	PCBA	1			0	5	0	0	2	0	4	0	3	0	0	14					
3	Lower Housing	1			10	0	0	0	2	0	4	0	0	0	0	16					
4	Screw	4			15	0	0	0	0	0	0	5	0	0	0	20					
5																0					
6																0					
7																0					
8																0					
9																0					
10																0					

Solution!

- 2016 a team of 5 GHSP employees traveled to BDI
- Spent 3 days using the DFMA software, allowing BDI to showcase its capabilities
- Returned to GHSP and purchased the software immediately

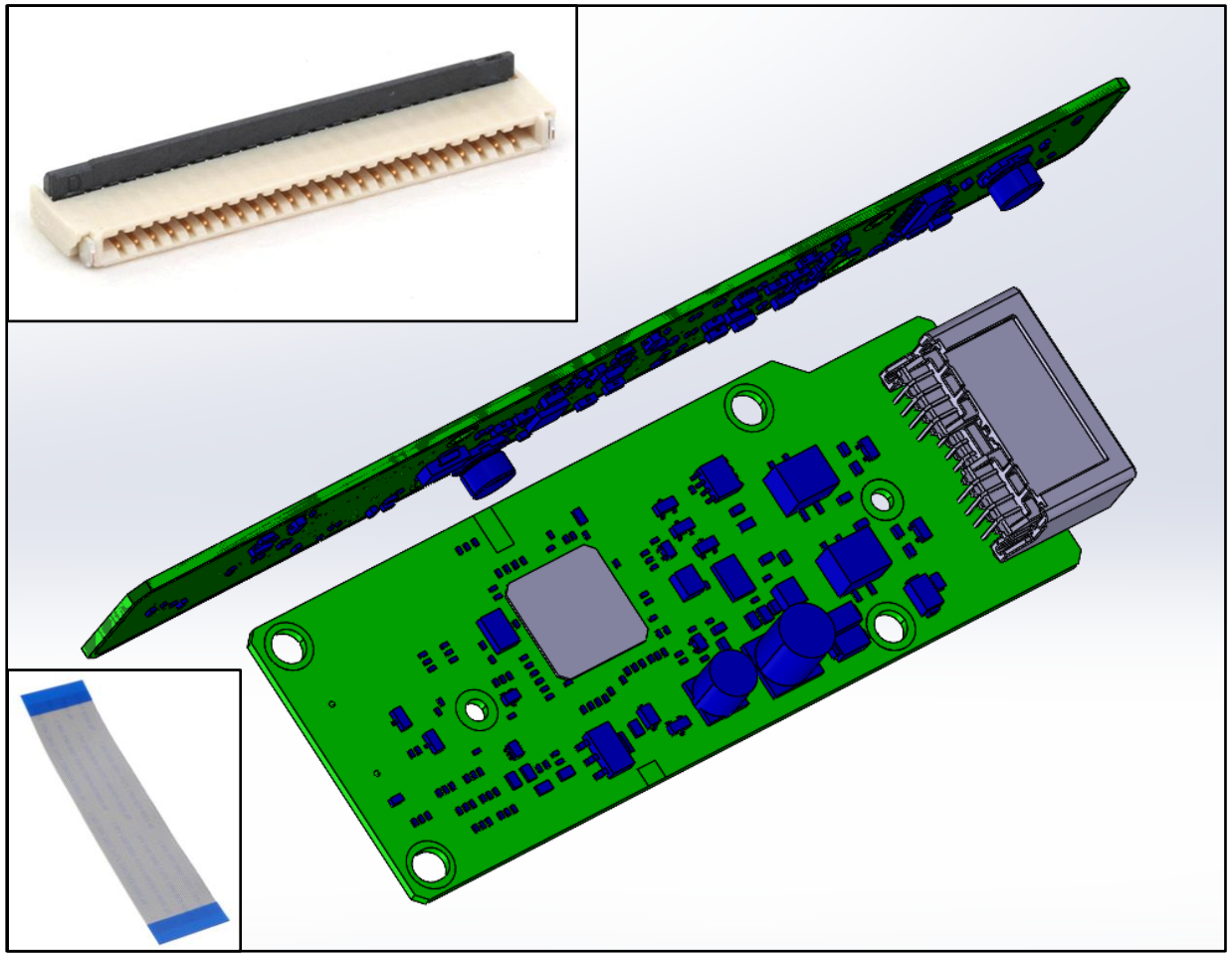
Success Stories: GM SIB's

Original Design:

1) Main PCBA with a ZIF Connector
2) LED PCBA with a ZIF Connector
3) FFC to connect the 2 PCBAs

Original Assembly Process:

1) Operator would install one end of FFC into Main PCBA
2) Then fish the FFC through a slot in a plastic housing, before placing the Main PCBA into the housing
3) Then connect the other end of the FFC, with very limited length of cable, into the LED PCBA
4) Last, place the LED PCBA into the housing



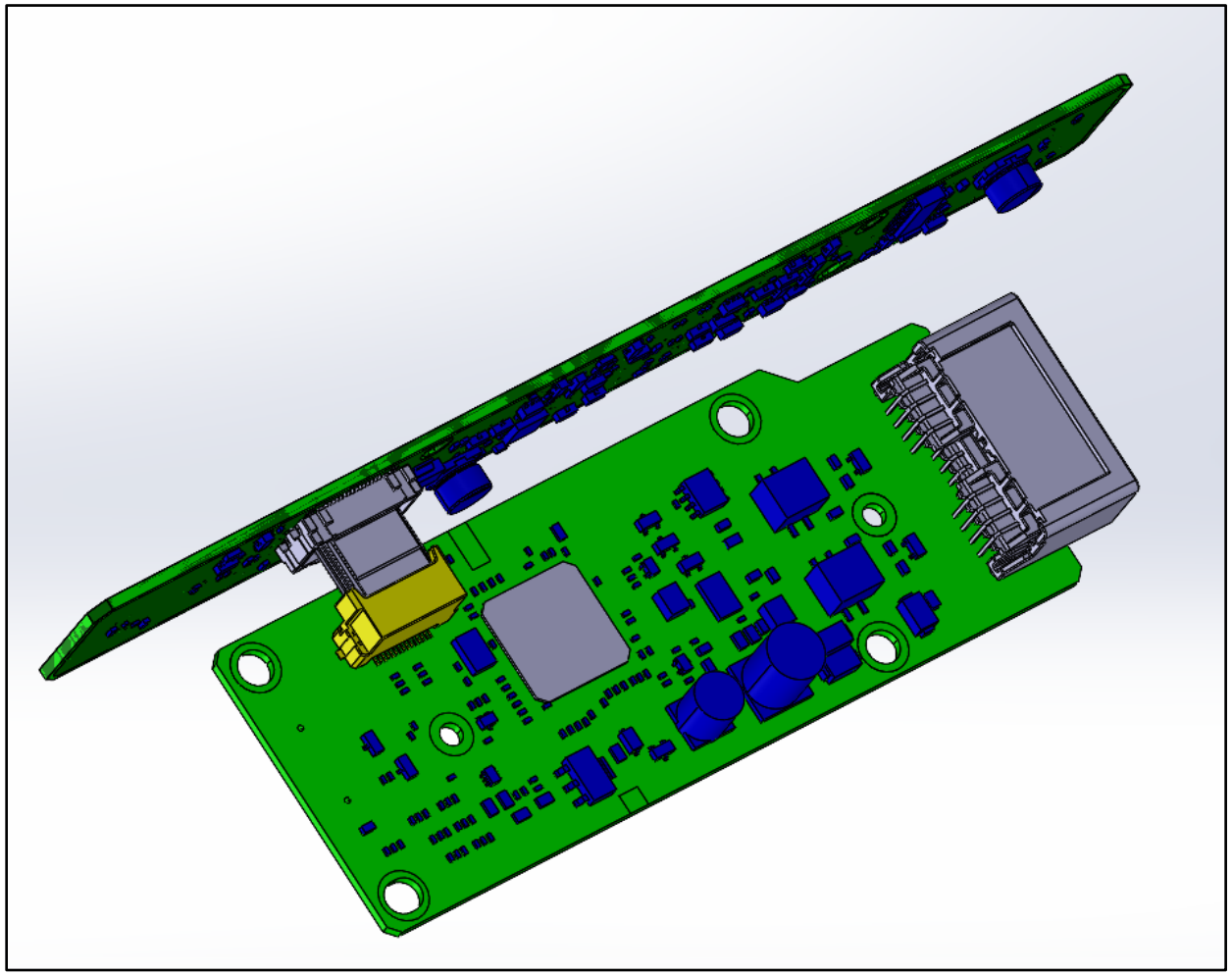
Success Stories: GM SIB's

Production Design:

1) Main PCBA with a Board-to-Board Connector
2) LED PCBA with a Board-to-Board Connector

Production Assembly Process:

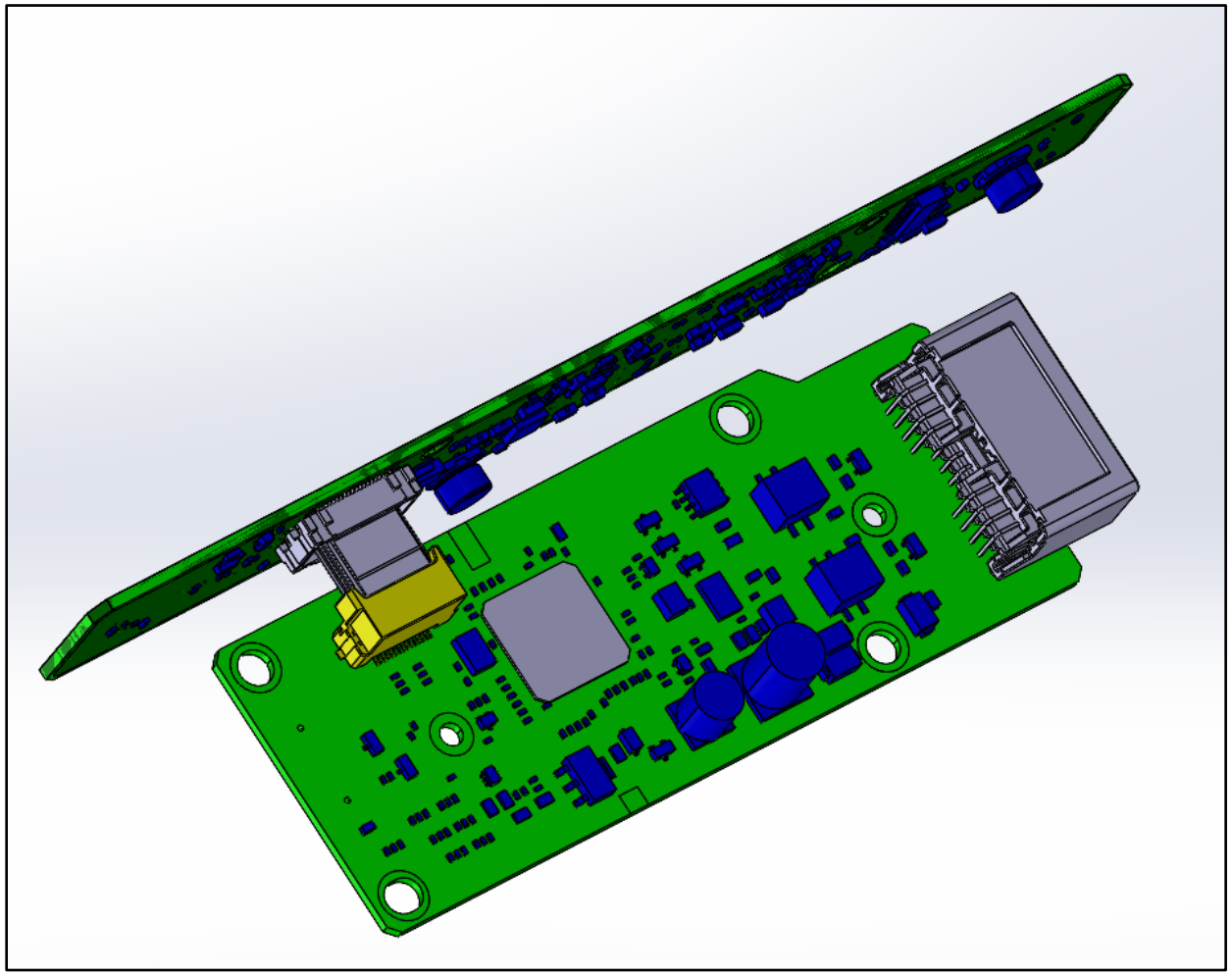
1) Operator places Main PCBA into housing
2) Operator places LED PCBA into housing, automatically making connection between PCBAs



Success Stories: GM SIB's

Benefits:

1) Removes 1 component from BOM
2) Reduces cycle time
3) Reduces machine complexity
4) Easier confirmation of connection, reducing potential quality/warranty issues
5) Reduces ergonomics issues not having to pinch the FFC between thumb and fore finger



Success Stories: GM SIB's

DFMA® - Boothroyd Dewhurst, Inc.

Analysis Totals for Design for Manufacture and Assembly (DFMA)

Thursday, June 6, 2024

Ribbon Cable Scenarios.dfax

Per product costs, $	Baseline ZIF Connector_5/15/19	Right Angle B2B_5/15/19	Difference		Right Angle B2B_5/15/19_Actual	Difference	
Assembly process	0.32	0.08	-0.24	-75%	0.08	-0.24	-75%
Manufacturing piece part	1.46	1.50	0.04	2%	1.56	0.09	6%
Total cost without tooling	1.79	1.58	-0.21	-12%	1.64	-0.15	-8%
Total tooling cost	0.00	0.00	0.00	-50%	0.00	0.00	-50%
Total cost	1.79	1.58	-0.21	-12%	1.64	-0.15	-8%
Total tooling investment, $							
Assembly tools and fixtures	6,000	3,000	-3,000	-50%	3,000	-3,000	-50%
Manufacturing tooling	0	0	00	0%	0	00	0%
Total investment	6,000	3,000	-3,000	-50%	3,000	-3,000	-50%
Production life data							
Life volume	2,867,800	2,867,800	0	0%	2,867,800	0	0%
Total production life cost, $	5,130,353	4,533,600	-596,753	-12%	4,699,933	-430,420	-8%

Assembly Process Cost Avoidance:
-$0.24

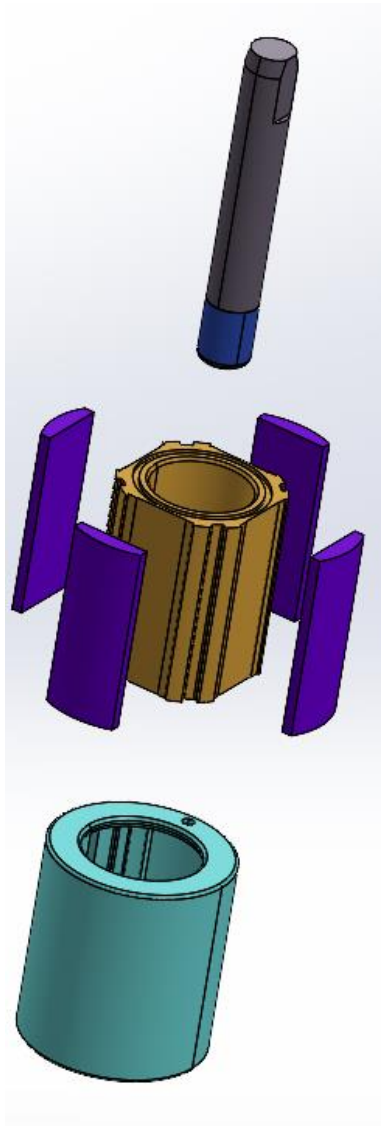
Manufacturing Piece Part Cost Avoidance:
+$0.09

Total Life (5 yrs) Cost Avoidance:
~$430,000

Success Stories: Ford 1T50

Original Design:

1) GHSP to make Rotor, which consist of:
    a) Core
    b) 4 Magnets
        i. Requires Adhesive and Activator
    c) Shaft
    d) Plastic Overmold



Original Assembly Process:

1) Place Core into fixture
2) Press Shaft into Core
3) Apply Activator to Magnets
4) Apply Adhesive to Core
5) Install Magnets onto Core, allowing proper dry time (~60 seconds)
6) Overmold the assembly

Success Stories: Ford 1T50

Production Design:

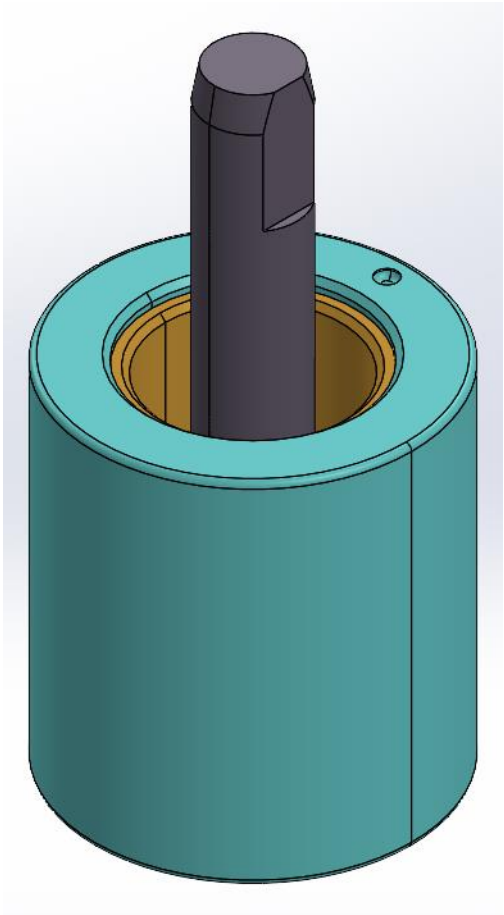
1) Purchase Rotor from Supplier

Production Assembly Process:

1) Operator (or machine) loads Rotor into fixture

Benefits:

1) Removes 5 components from BOM
2) Reduces cycle time
3) Removes a whole assembly station (less Capital investment)



Success Stories: Ford 1T50

DFMA® - Boothroyd Dewhurst, Inc.

Analysis Totals for Design for Manufacture and Assembly (DFMA)

Thursday, June 6, 2024

12550 Ford 1T50 Pump.dfax

Per product costs, $	Baseline New Design_7/25/19_Quoted Caps	New Design_7/25/19_Purchased Rotor	Difference		New Design_7/25/19_Purchased Rotor_Actual	Difference	
Assembly process	10.34	8.54	-1.81	-17%	8.54	-1.81	-17%
Manufacturing piece part	23.79	22.70	-1.09	-5%	22.66	-1.13	-5%
Total cost without tooling	34.14	31.24	-2.90	-8%	31.20	-2.94	-9%
Total tooling cost	0.59	0.56	-0.03	-5%	0.56	-0.03	-5%
Total cost	34.73	31.80	-2.93	-8%	31.76	-2.97	-9%
Total tooling investment, $							
Assembly tools and fixtures	0	0	00	0%	0	00	0%
Manufacturing tooling	815,261	776,738	-38,523	-5%	775,738	-39,523	-5%
Total investment	815,261	776,738	-38,523	-5%	775,738	-39,523	-5%
Production life data and weight							
Life volume	1,380,000	1,380,000	0	0%	1,380,000	0	0%
Total production life cost, $	47,924,937	43,883,976	-4,040,961	-8%	43,828,776	-4,096,161	-9%
Total weight, kg	0.52	0.46	-0.05	-11%	0.46	-0.05	-11%

Assembly Process Cost Avoidance:
-$1.81

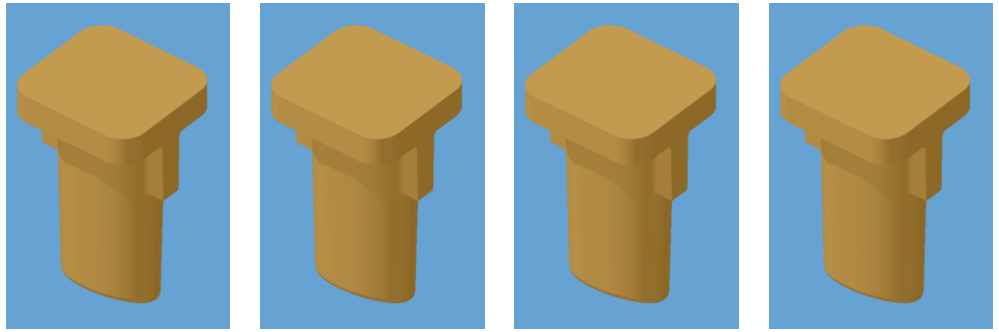
Manufacturing Piece Part Cost Avoidance:
-$1.13

Total Life (6 yrs) Cost Avoidance:
~$4,096,000

Success Stories: Stellantis TCSM

Original Design:
1) 4 Individual Light Pipes

Original Assembly Process:
1) Operator loads each individual Light Pipe into housing

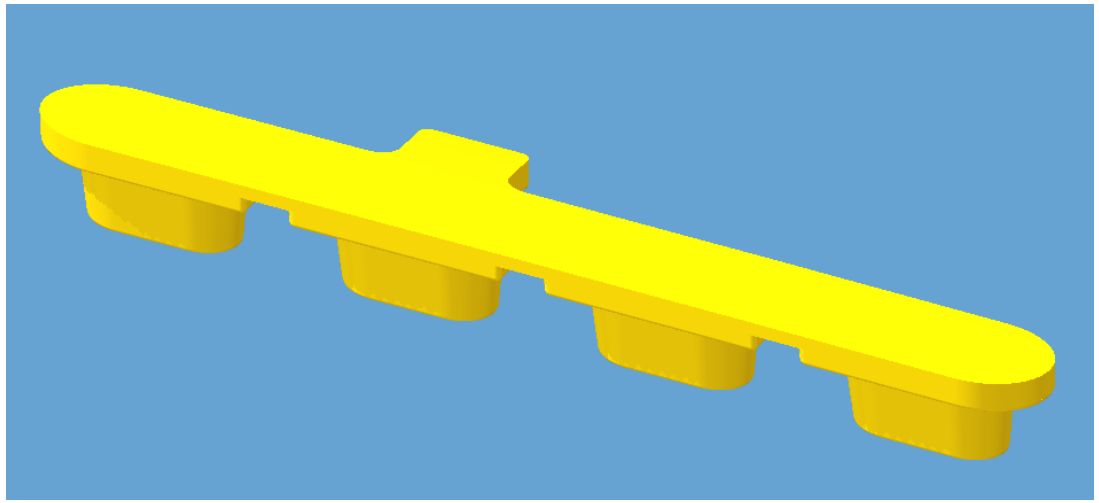


Success Stories: Stellantis TCSM

Production Design:
1) 1 Light Pipe

Production Assembly Process:
1) Operator loads Light Pipe into housing

Benefits:
1) Reduces cycle time
2) Reduces cost



Success Stories: Stellantis TCSM

Original Design:
1) 8 Screws

Original Assembly Process:
1) Operator (or machine) drives 8 Screws

Success Stories: Stellantis TCSM

Production Design:
1) 4 Screws

Production Assembly Process:
1) Operator (or machine) drives 4 Screws

Benefits:
1) Reduces cycle time
2) Reduces cost

Success Stories: Stellantis TCSM

Original Design:
1) 7 Individual Light Pipes
2) 7 Individual Button Plungers

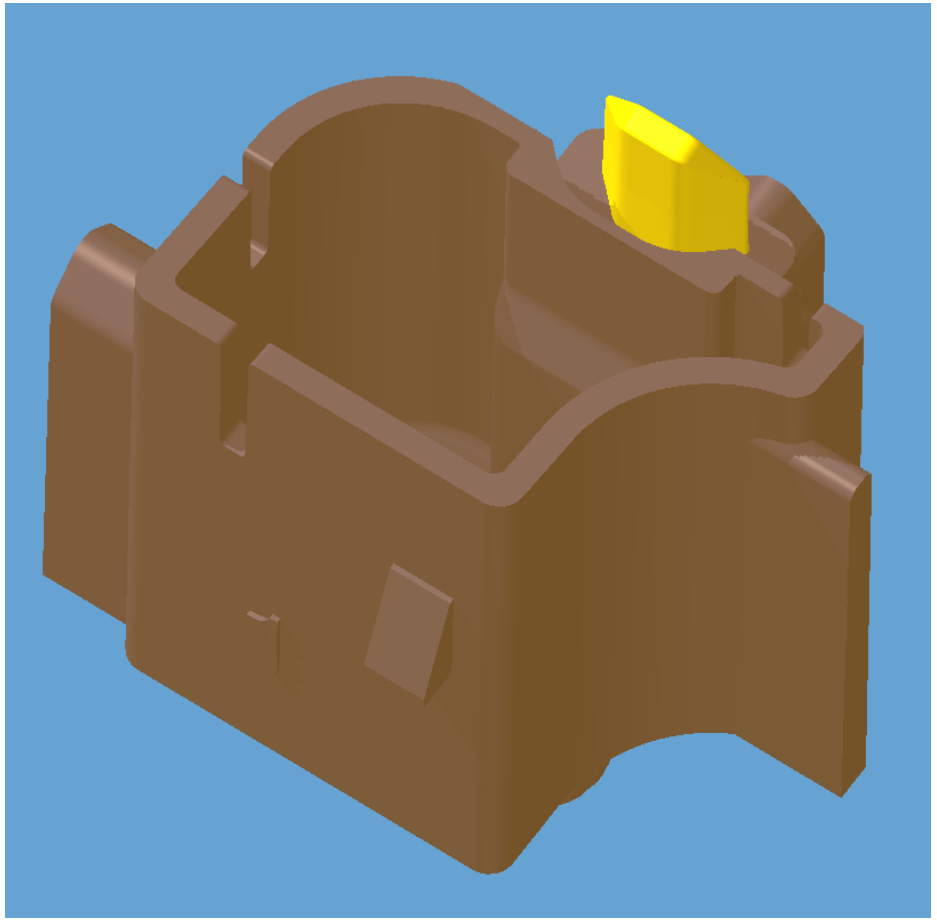
Original Assembly Process:
1) Operator loads Light Pipe into Plunger
2) Operator loads Plunger/Light Pipe assembly into housing

Success Stories: Stellantis TCSM

Production Design:
1) 7 2-Shot Light Pipe/Button Plunger

Production Assembly Process:
1) Operator loads Light Pipe/Button Plunger into the housing

Benefits:
1) Removes 7 components from BOM
2) Reduces storage space at the assembly station for each component
3) Reduces cycle time
4) Reduces machine complexity
5) Reduces number of Injection Molding Tools needed



Success Stories: Stellantis TCSM

DFMA® - Boothroyd Dewhurst, Inc.

Analysis Totals for Design for Manufacture and Assembly (DFMA)

Thursday, June 6, 2024

12614 RAM Button Pack.dfax

Per product costs, $	Baseline Original_DFMA Metrics	Original_DFMA Metrics_3 Ideas	Difference		Original_DFMA Metrics_3 Ideas_Actual	Difference	
Assembly process	1.14	0.91	-0.23	-20%	0.90	-0.24	-21%
Manufacturing piece part	6.40	5.13	-1.27	-20%	5.39	-1.01	-16%
Total cost without tooling	7.54	6.03	-1.51	-20%	6.29	-1.25	-17%
Total tooling cost	0.85	0.81	-0.04	-4%	0.89	0.04	5%
Total cost	8.39	6.85	-1.54	-18%	7.18	-1.21	-14%
Total tooling investment, $							
Assembly tools and fixtures	0	0	00	0%	0	00	0%
Manufacturing tooling	1,695,688	1,625,688	-70,000	-4%	1,775,231	79,543	5%
Total investment	1,695,688	1,625,688	-70,000	-4%	1,775,231	79,543	5%
Production life data and weight							
Life volume	2,000,000	2,000,000	0	0%	2,000,000	0	0%
Total production life cost, $	16,774,365	13,691,032	-3,083,333	-18%	14,363,810	-2,410,556	-14%
Total weight, kg	0.04	0.03	-0.01	-26%	0.03	-0.01	-26%

Assembly Process Cost Avoidance:
-$0.24

Manufacturing Piece Part Cost Avoidance:
-$1.01

Total Life (7 yrs) Cost Avoidance:
~$2,410,000

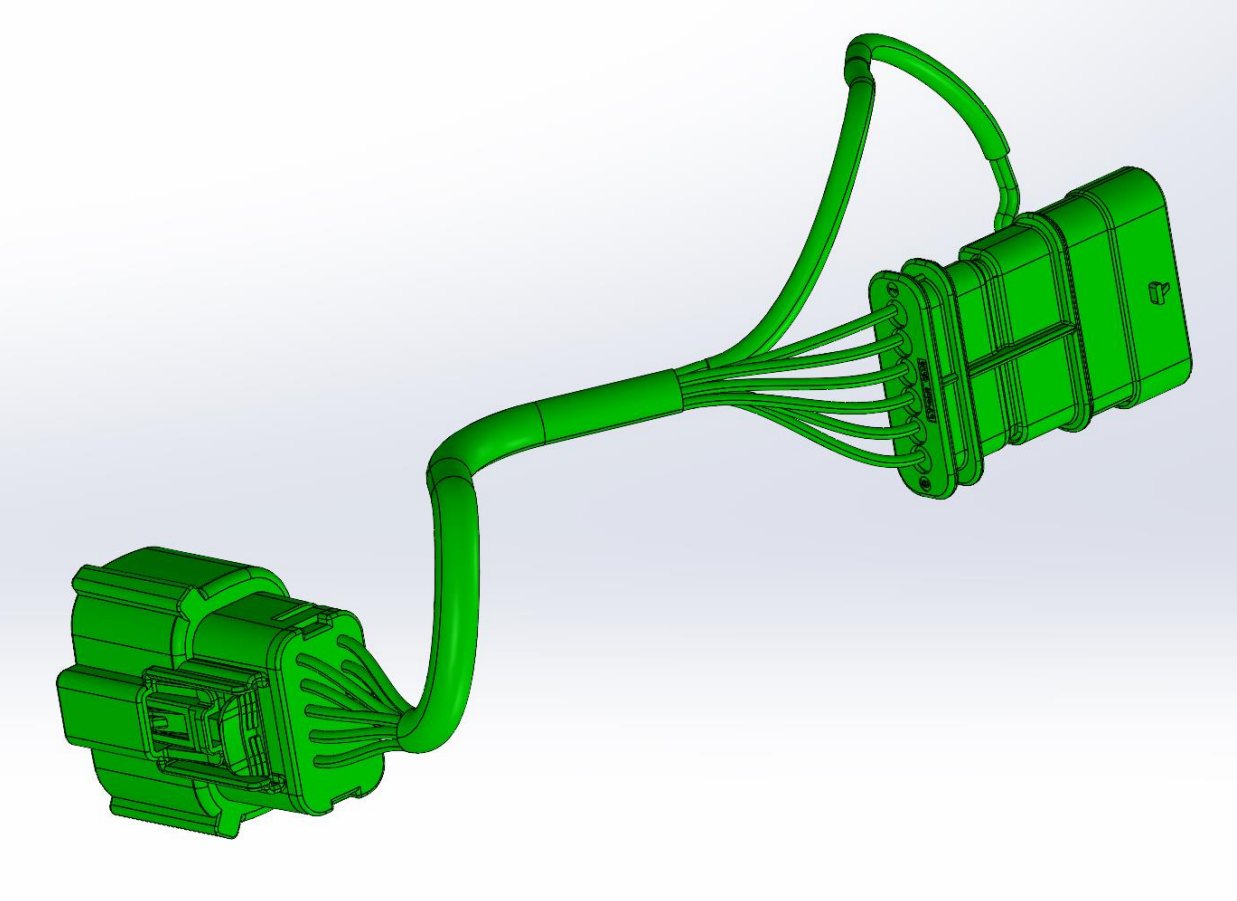
Success Stories: Stellantis Pursuit

Original Design:

1) 1 Lever Wire Harness

Original Assembly Process:

1) Operator installs Wire Harness Connector 1
2) Operator routes Wire Harness
3) Operator installs Wire Harness Connector 2

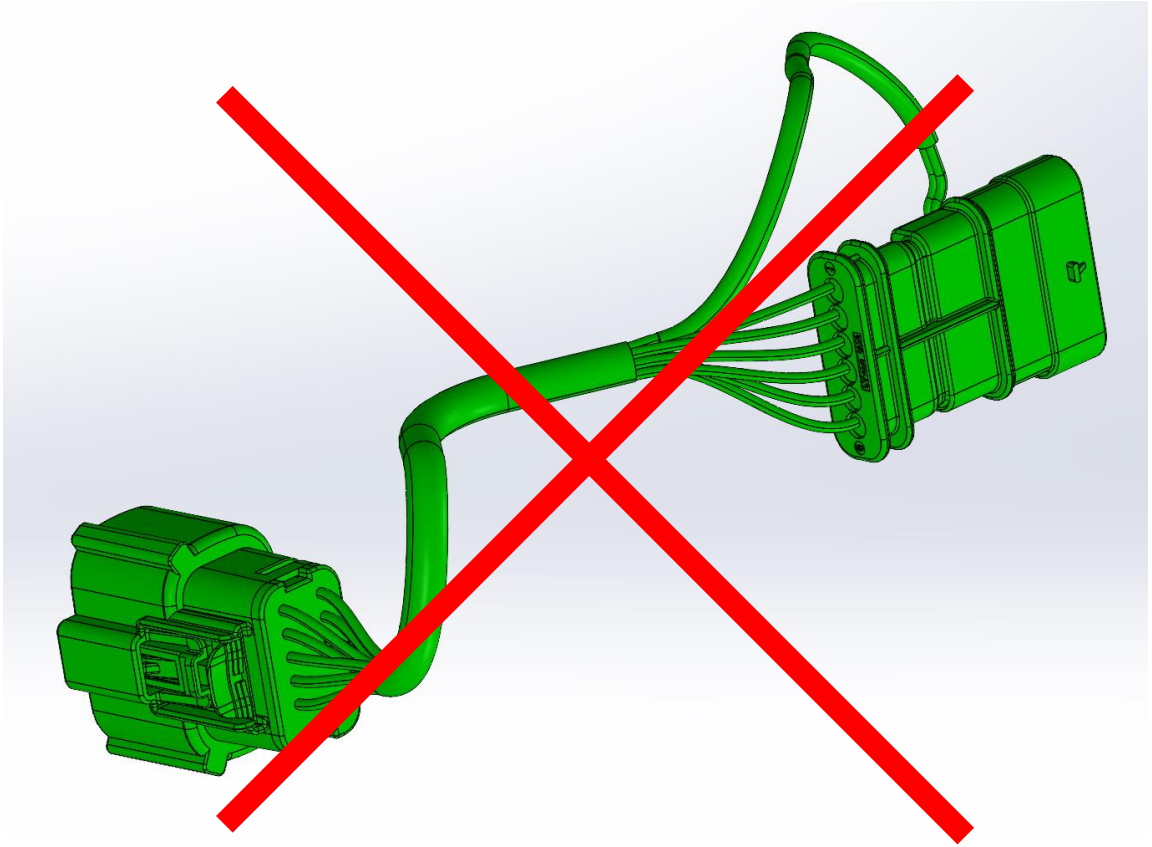


Success Stories: Stellantis Pursuit

Production Design:
1) No Lever Wire Harness

Production Assembly Process:
1) Was able to get the Customer to add a jumper to their Vehicle Wire Harness and have them make the connection.

Benefits:
1) Removes 1 components from BOM
2) Reduces cost
3) Reduces cycle time
4) Reduces possible ergonomics issues



Success Stories: Stellantis Pursuit

DFMA® - Boothroyd Dewhurst, Inc.
Analysis Totals for Design for Manufacture and Assembly (DFMA)

Thursday, June 6, 2024

12504 FCA Pursuit IP Shifter.dfax

Per product costs, $	Baseline Original_Production Volumes	Original_Production Volumes_Removed Wire Harness	Difference	
Assembly process	4.07	3.89	-0.19	-5%
Manufacturing piece part	31.10	29.82	-1.28	-4%
Total cost without tooling	35.17	33.71	-1.47	-4%
Total tooling cost	0.98	0.98	0.00	0%
Total cost	36.15	34.68	-1.47	-4%
Total tooling investment, $				
Assembly tools and fixtures	0	0	00	0%
Manufacturing tooling	702,760	702,760	00	0%
Total investment	702,760	702,760	00	0%
Production life data and weight				
Life volume	720,000	720,000	0	0%
Total production life cost, $	26,028,119	24,972,043	-1,056,075	-4%
Total weight, kg	0.20	0.20	0	0%

Assembly Process Cost Avoidance:
-$0.19

Manufacturing Piece Part Cost Avoidance:
-$1.28

Total Life (8 yrs) Cost Avoidance:
~$1,056,000

Success Stories: Metrics Page

- Adding a DFMA Metrics Page is valuable (thank you Kohler!)
  - We use Power BI on a SharePoint page
- Easy reference when questioned about the benefits of DFMA's
  - Especially when/if someone questions the worth of a group of people spending 2-3 days reviewing a product
- We like using Power BI because it is more interactive than Excel graphs/charts

Success Stories: Metrics Page

DFMA - Design for Manufacturing & Assembly

Pages

- Utilizition
- Metrics
- Ideas
- Ideas Implemented Cos...
- Cost Avoidance_Actual ...

File | Export | Share | Get insights | ...

61

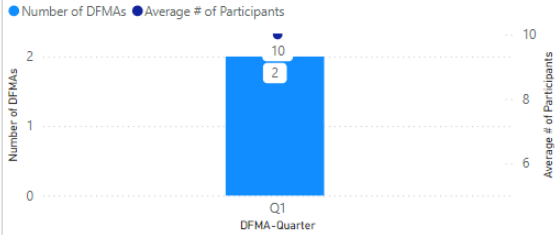
Total Programs Utilizing DFMA

Current Quarter DFMAs

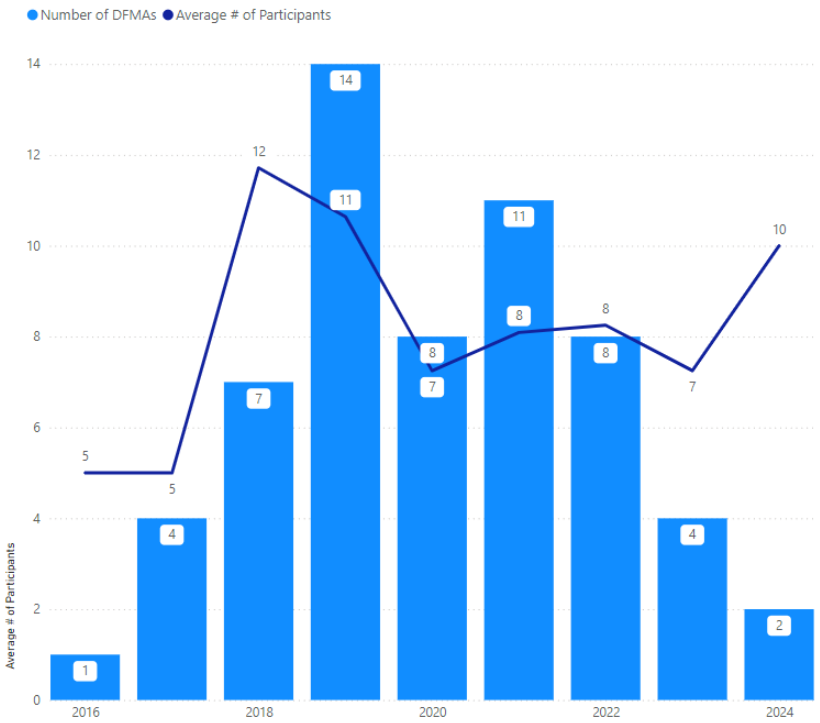
Program | Customer | Comodity | Program Manager

None

2024 DFMA Usage



DFMA Usage



Our DFMA objective is to reduce development time, improve cost position, and foster early collaboration through rapid data driven design decisions.

DFMA Experts

Nate Taylor
Advanced Process Engineer III

Quick Links

DFMA® Software and Services Website

Success Stories: Metrics Page

Pages

- Utilizition
- Metrics
- Ideas
- Ideas Implemented Cos...
- Cost Avoidance_Actual ...

File | Export | Share | Get insights | ...

All

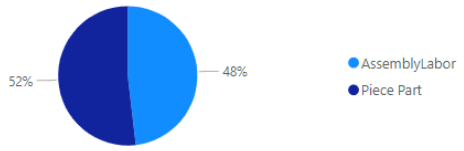
Quarter
All

Customer
All

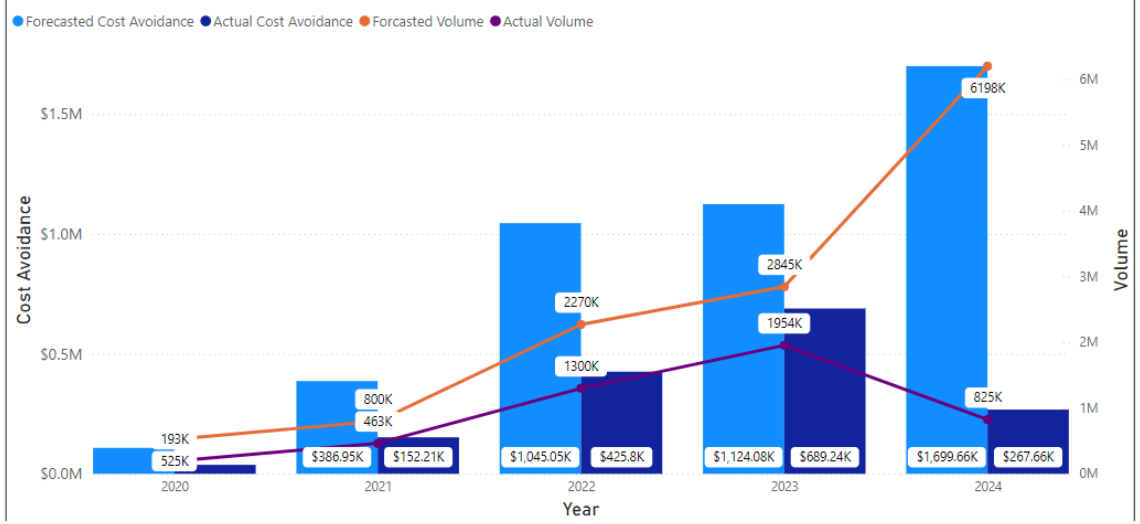
Program
- Select all
- 12093_SIBs
- 12382_DCT Aux Pump
- 12411_E-Series
- 12420_BEV40 Pump
- 12424/606/608_CRV/HRV/A...
- 12452_Adapt (2.0)
- 12476_Badger Knob
- 12504_Pursuit
- 12547_891B/892B Indicator
- 12550_1T50 Pump
- 12571_M-Series Refresh
- 12581_941B/942B Indicator
- 12601_TCSM
- 12606/607/608_HRV/ILX/Ac...
- 12606/607/608_HRV/ILX/Ac...
- 12803_LB/LF Mini Polystable
- 12854_AS33
- 12936_ADCM
- Stellantis Rotary

$4.36M	$1.7M
Total Forecasted Cost Avoidance	2024 Forecasted Cost Avoidance
$1.57M	$267.66K
Total Actual Cost Avoidance	2024 Actual Cost Avoidance

Cost Avoidance Breakdown



Cost Avoidance - Forecasted vs Actual



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DFMA Experts

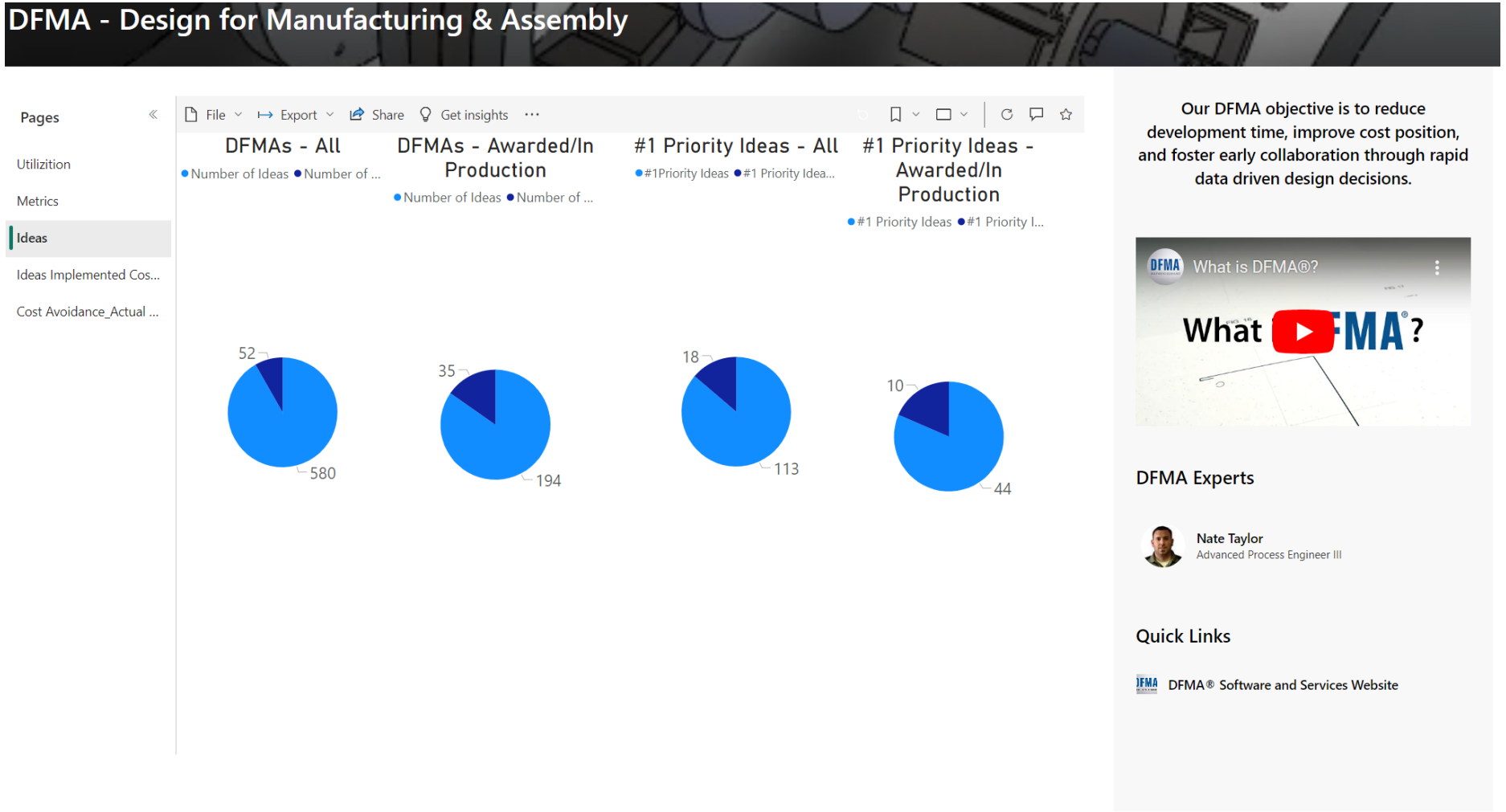
Nate Taylor
Advanced Process Engineer III

Quick Links

DFMA® Software and Services Website

Success Stories: Metrics Page

Not all sunshine and roses



Recommendations for New Users

1) 3 days can be a lot, especially when your products are similar to each other
   a) It's ok to do 1-2 day events, but at least do a review
   b) Helps to have the BOM created and CAD files loaded prior to the start

2) Online DFMA's
   a) Ok to do, but limit each meetings to 2 hours
      i. 2-hour meeting in morning and another 2-hour meeting in the afternoon
      ii. 2-hour meeting the morning (or afternoon) for 2-3 consecutive days
   b) Get back to in person DFMA's as soon as you can

Recommendations for New Users

3) Include an Exploded View Drawing/PowerPoint of the product with the meeting invite (or an email prior)

a) Gives attendee a chance to understand/grasp what they will be reviewing prior the meeting

4) Hold Follow Up/Open Issues meetings

a) Prioritize the ideas

b) Assign the ideas to people

c) Hold people accountable

Recommendations for New Users

5) It may take more than 1 DFMA

a) Depending on the length of the product development phase, you may need to hold 2 or even 3 DFMAs

b) These can be shorter ½ to 1-day events

Thank You

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