DELTA PT®

State-of-the-Art Fastening Technology in Thermoplastics and Thermosets

Presented by: Joe Gobernatz

Threadforming Program Manager – ATF, Inc.

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Agenda

- Technical Overview and History of Fastening into Plastics
- DELTA PT® - Design Features and Benefits
- Boss Design Guidelines for Plastic Components
- Case Studies
  - Metal Replacement
  - Thermal Conductive Plastics
- Performance Advantages of DELTA PT® vs Traditional Threadformers for Plastics
- ATF Applications Laboratory Services

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Plastic Joint Design Considerations

- Low radial stress
- Joint stability
- High mechanical strength
- Vibration resistance
- Serviceability
- High strip-to drive ratio

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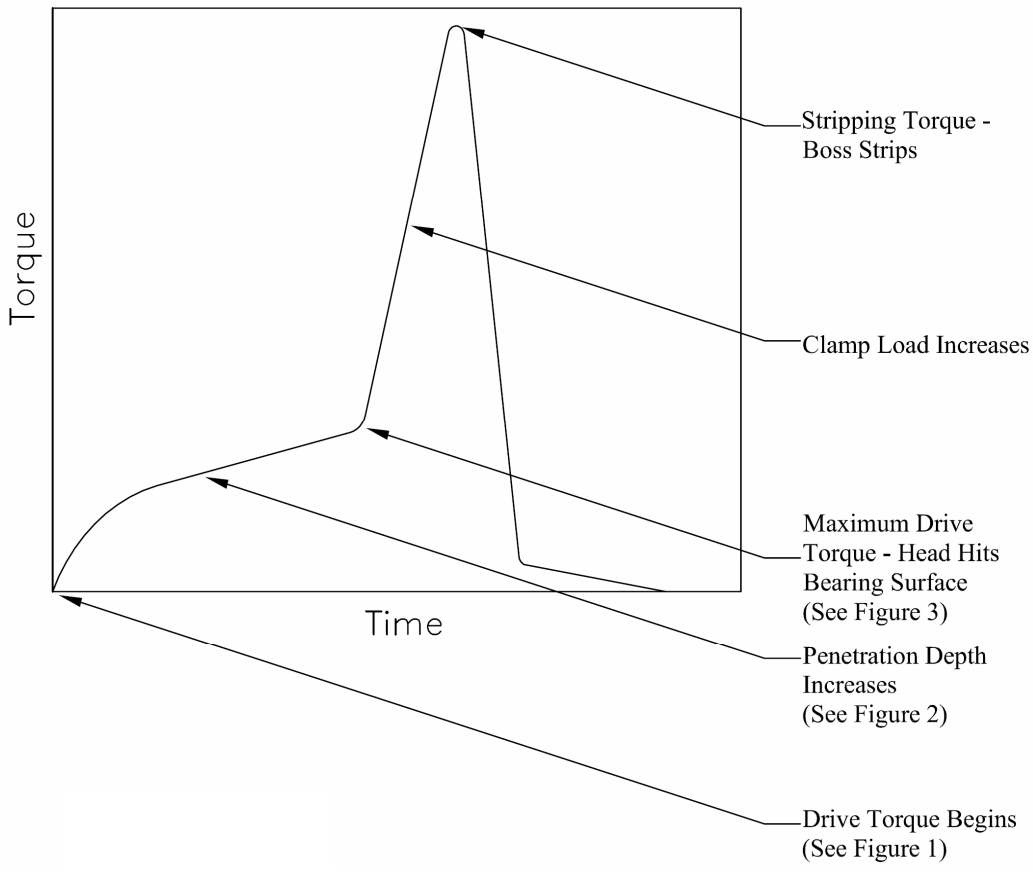
Drive and Strip Torque Explanation



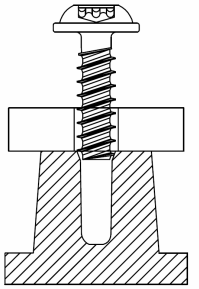


Figure 1

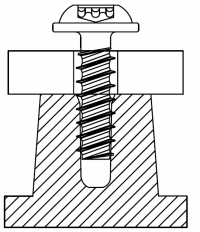


Figure 2

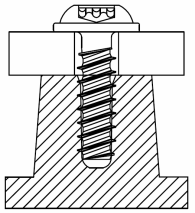


Figure 3

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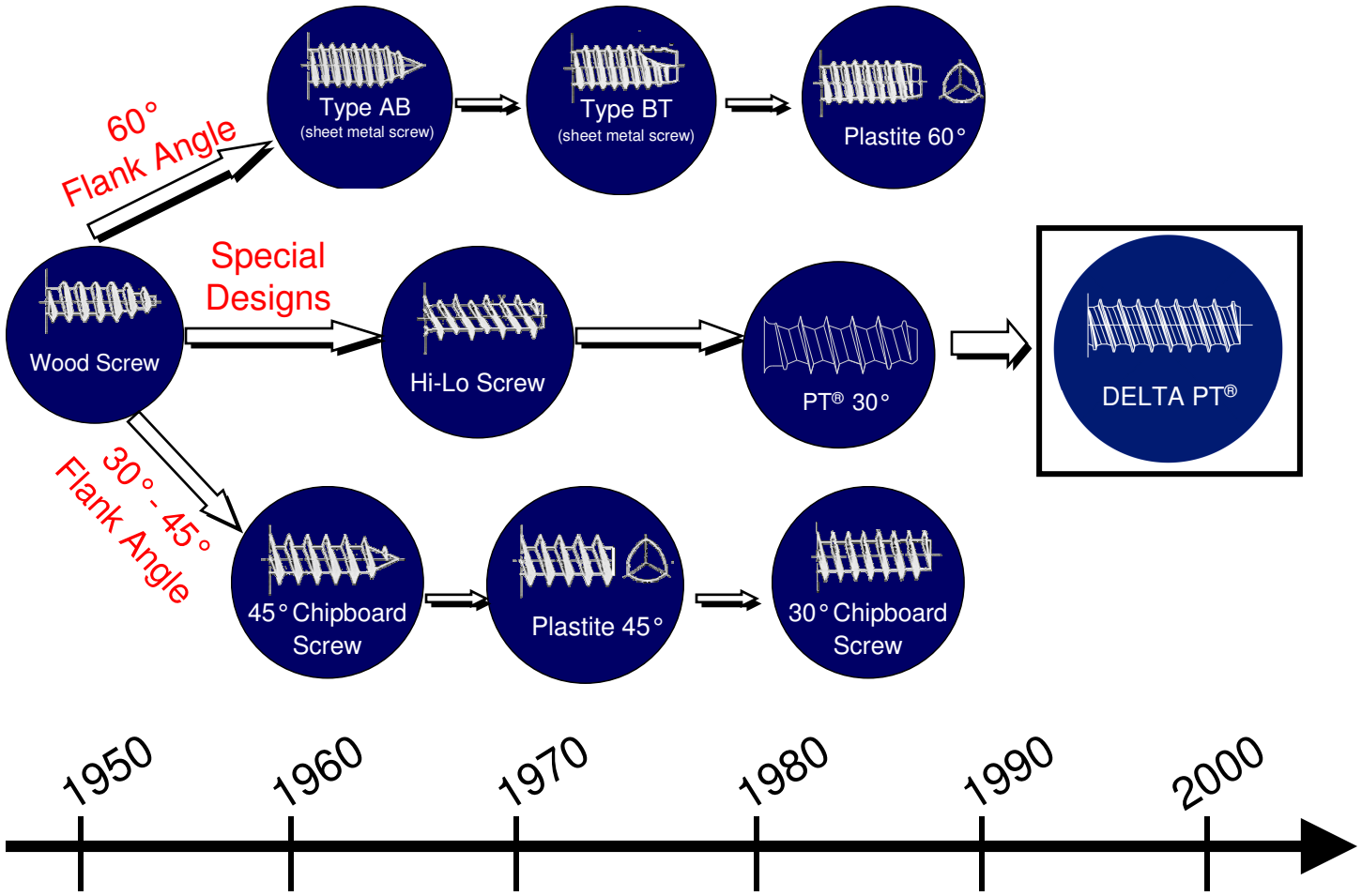
Evolution of Thread-Forming Fasteners



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DELTA PT® Features

- Innovative flank geometry
- Reinforced cored root
- Large minor diameter
- Refined helix angle
- Optimized head geometry

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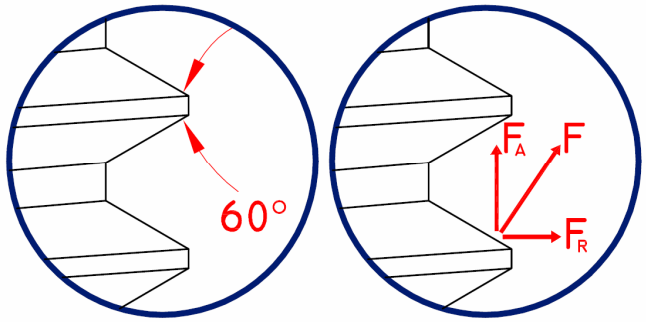
Reduced Radial Stress

Innovative Flank Geometry

- allows reduced wall thickness (2xD)
- reduces sink marks
- permits shorter molding cycle times
- leads to significant material savings

Other Thread-Formers



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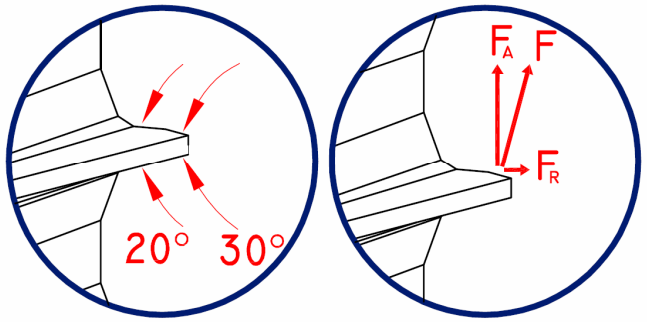
DELTA PT®



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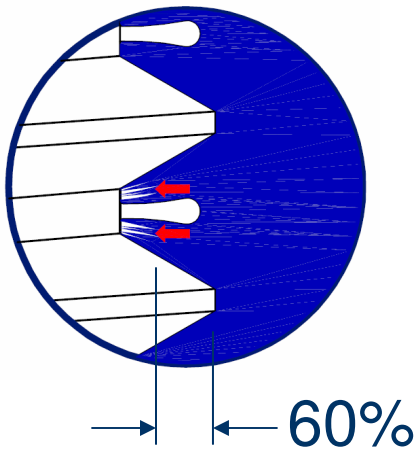
Increased Joint Stability

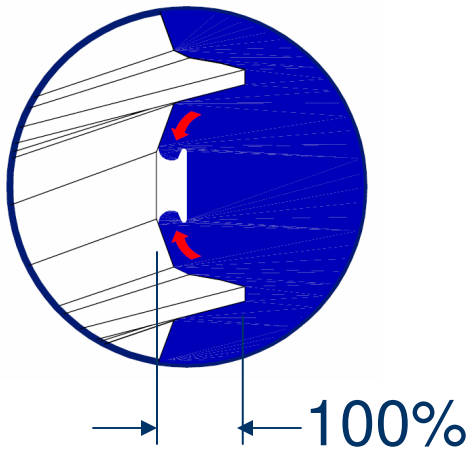
Reinforced cored root

- prevents material jam
- eliminates cracking due to stress concentrations
- provides nearly 100% flank engagement

Other Thread-Formers



DELTA PT®



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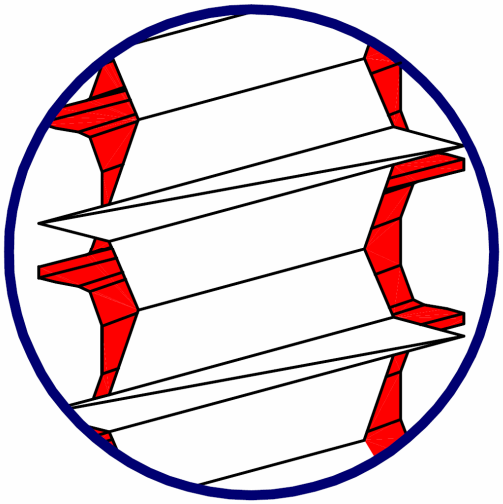
High Mechanical Strength

Large Minor Diameter

- increases torsional and tensile strength
- allows fastener to withstand the high torque requirements presented by thermoset and highly glass filled thermoplastic materials



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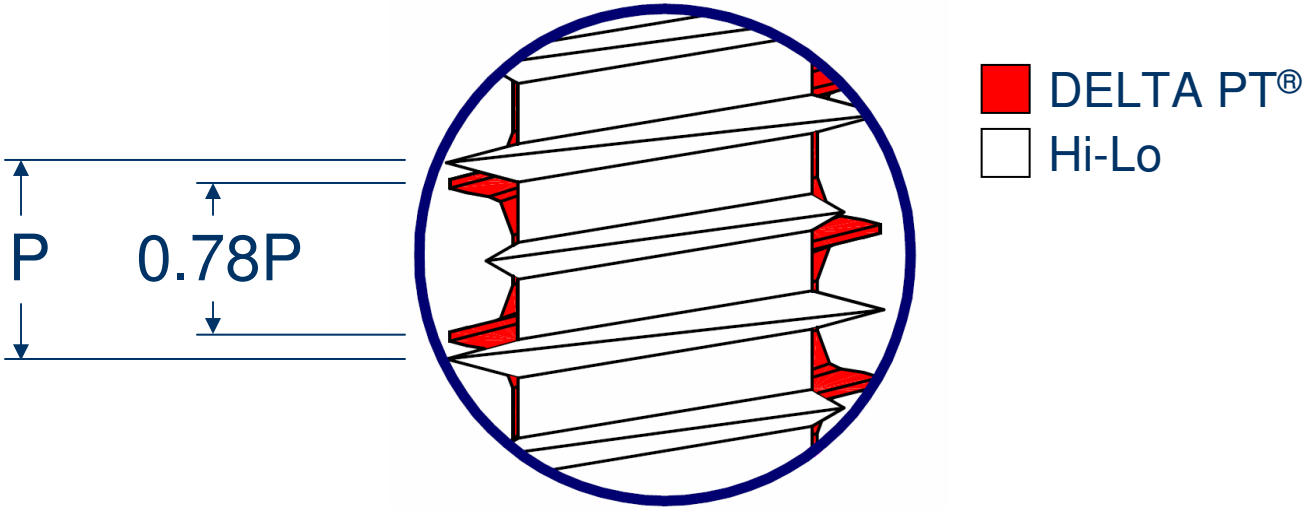
Superior Vibration Resistance

Refined helix angle (pitch)

- increases number of engaged threads by almost 30% compared to other thread formers at same penetration depth
- leads to a joint with high dynamic safety



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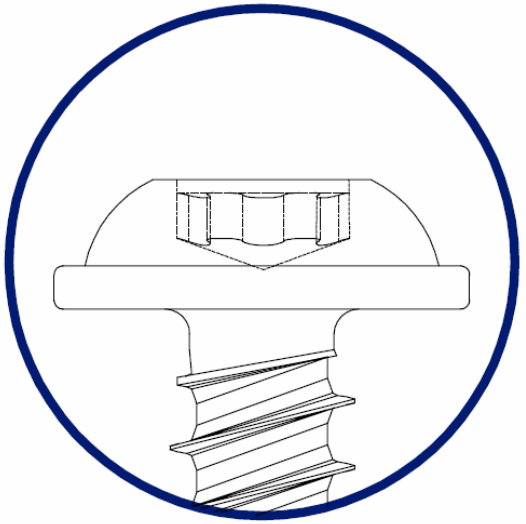
Excellent Serviceability

Optimized Head Geometry

- large bearing surface distribute pressure over large area to reduce creep and increase break-loose torque
- deep drive recess penetration eliminates possibility of recess stripping and allows for multiple installations and better in-line torque transfer



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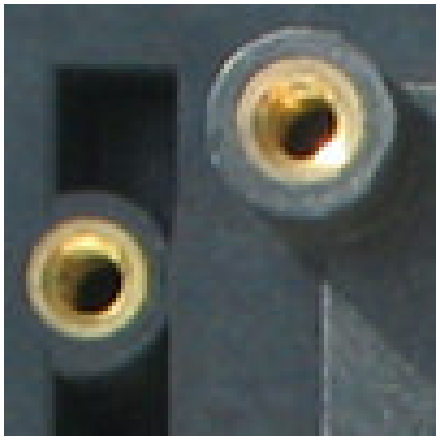
Eliminate Costly Brass Inserts

Improve Quality and Reduced Cost by using DELTA PT®

- Plastic cracking, Partially seated
- Plastic flows over the top of the insert
- Plastic fills threaded bore of the insert
- Eliminate chasing inserts with a tap after molding
- Reduce mold cycle times
- Eliminate inserts not molded flush
- Excess sorting costs to guarantee molded correctly
- Increasing brass costs (200% increase in 2007)
- Improved joint quality and performance



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Boss Design

- Counterbore:
  - ensures favorable edge stress reduction and prevents cracking
  - acts as a guide during installation
- Deviations from 0.8 x d hole recommendation may occur due to:
  - local textures caused by additives and filling
  - processing conditions of the material
  - design of the injection molding tool
  - distance to the injection point
  - formation of weld lines
  - variations in application components

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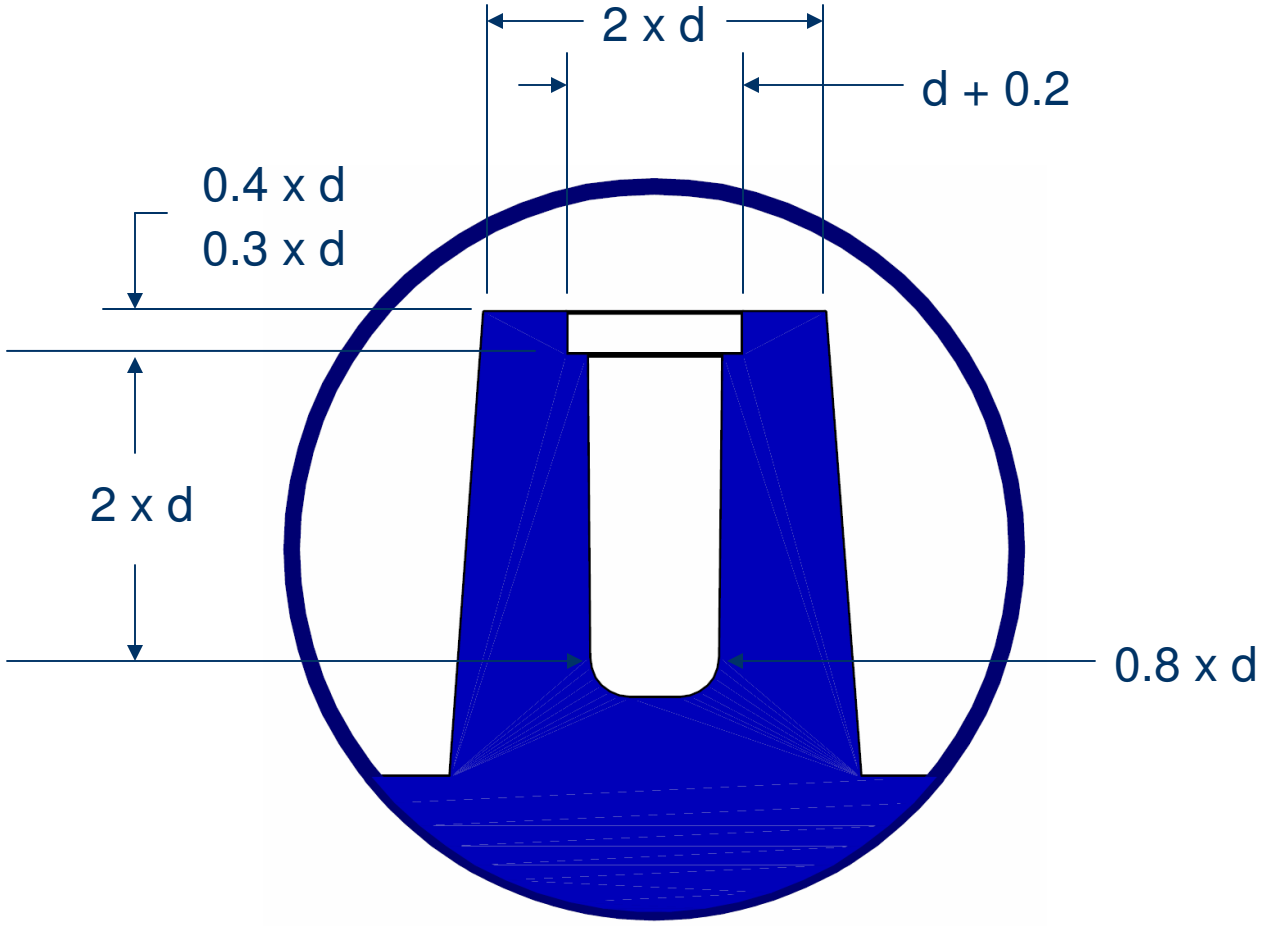
Boss Design



d: diameter of fastener

1 ° max draft angle recommended

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DELTA Calc

Datei Bearbeiten Ansicht Einfügen Format Extras Daten Fenster ?

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Schraube			Tubus			Auflage			Durchmesser des Ersatzylinders nach VDI 2230 ermitteln			
Schraubentyp		Delta - PT	Kunststoff		PA 6 GF30	Auflagematerial		Stahl				
Außendurchmesser	do [mm]	5.00	Schraubloch	d [mm]	4.00	Durchgangsloch	d_l [mm]	5.20	D_Ersatz.	D_zyl [mm]	10.00	
Kopfdurchmesser	Dk [mm]	10.0	Tub. Außen Dmr.	D [mm]	10.0	Auflagedicke	l_k [mm]	10.00	gedr.Quersch.	A_ers[mm²]	57.3	
Kopfform u. Oberfl.		Plan-Zink	kristallin (techn.Kunstst./ Hochleist.-Polym)			freie Schr.-Länge	l_s [mm]	10.00				

Vorgaben		
Belastung		dynamisch
Verspannung		Druck

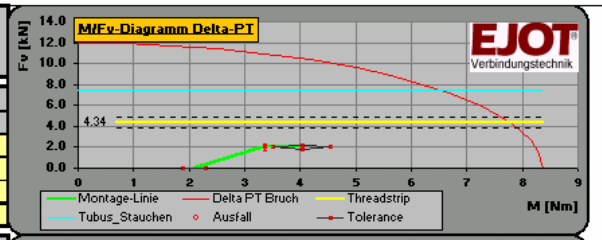
Verschrauben	---	
Einschraubtiefe	te [mm]	10.00
Vorspannkraft	Fv [kN]	2.00
Betriebskraft (axial)	FA [kN]	5.00
Restklemmkraft	FA [kN]	1.35
	---	

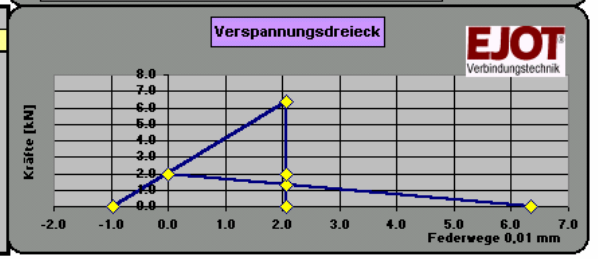
	mittel	min	max
Vorspannkraft			
Anzieh-Ma [Nm]	4.03		
Eindreh-Me [Nm]	2.09	1.90	2.29
Überdreh-Mü]Nm]	6.31	5.49	7.13

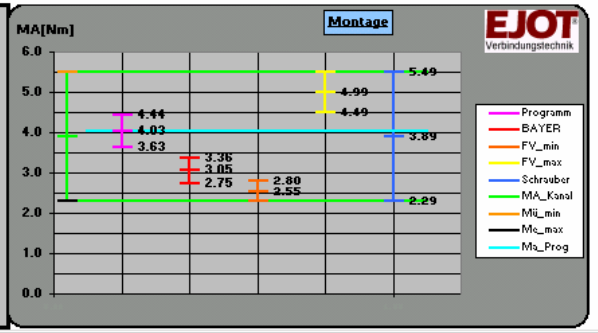
Auswertung	kein Ausfall				
Versagen bei:	Fv [kN]:			mittel	min	max
			Threadstrip[kN]	4.34	3.83	4.86
Lastwechsel [1x10³]	62					

Relaxation			
Zeit(min. Lebens.)	t_rel [h]bzw[J]	88000	10.1
Vorspannung	s_v [N/mm²]	56.34	
Verlustspannung	s_ver[N/mm²]	14.33	
Vorspannkraft-Rest	FA [kN]	0.51	

Montage				zul. Schraubertol.
Schraubertol. [%]		10%		41.1%
	BAYER	FV_min	FV_max	Schrauber
MA_max [Nm]	3.36	2.80	5.49	5.49
MA_mittel [Nm]	3.05	2.55	4.99	3.89
MA_min [Nm]	2.75	2.29	4.49	2.29
FV_mont_max[kN]	1.10	0.52	3.30	3.30
FV_mont_mittel[kN]	0.79	0.26	2.79	1.65
FV_mont_min[kN]	0.47	0.00	2.27	0.00







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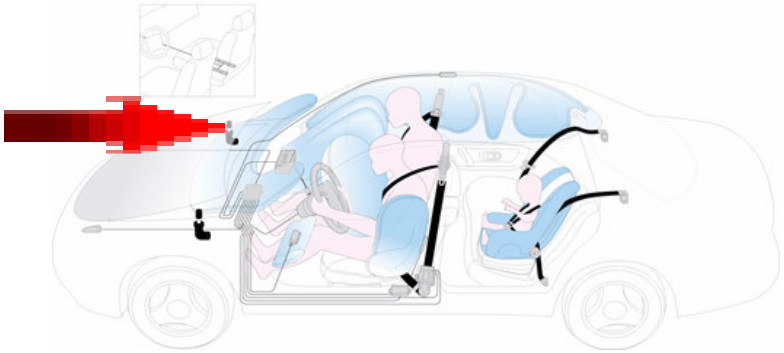
Case Study #1: Metal Replacement



- Safety critical redundant system, clamp load retention is critical.
- From Al, to Mg to Thermoset!!!
- Thermoset has similar properties to Al for a fraction of the cost and weight.

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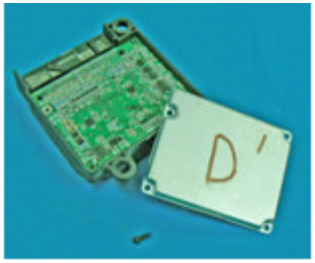
Case Study #1: Metal Replacement



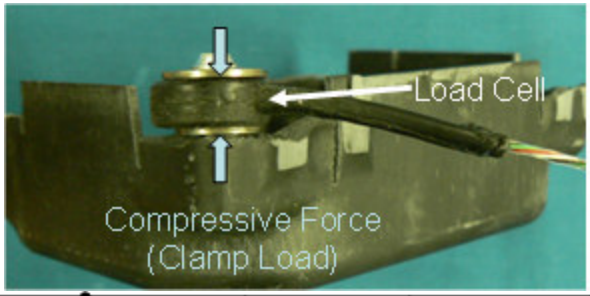
Fastener: DELTA PT® 30 x 1.12 x 9 Torx Plus® Pan Head

Application: Circuit Board Housing

- **Material:** BMC 605 **Average Hole Diameter:** 2.67 mm
- **Average Thread Engagement:** 6.6 mm

Testing Conditions:

Six 4-hr cycles of temperature variation from -20°C to 80°C



Fastener	Initial Clamp Load (lbs)	Final Clamp Load (lbs)	% Retention of Clamp Load	Installation Torque in-lbs (Nm)	Break-loose Torque in-lbs (Nm)	% Difference
DELTA PT® 30 x 1.12 x 9 Torx Plus® Pan Head	61.12	49.88	81.60%	3.36(0.38)	1.68(0.19)	50.00%
	73.39	56.50	77.99%	3.63(0.41)	1.95(0.22)	53.66%
	65.71	58.20	88.57%	3.54(0.40)	1.68(0.19)	47.50%
	69.26	53.75	77.61%	3.45(0.39)	1.86(0.21)	53.85%
Average:	67.37	54.58	81.44%	3.50(0.40)	1.79(0.20)	51.25%
Standard Deviation:	5.22	3.63	5.08%	0.12(0.01)	0.13(0.01)	3.07%

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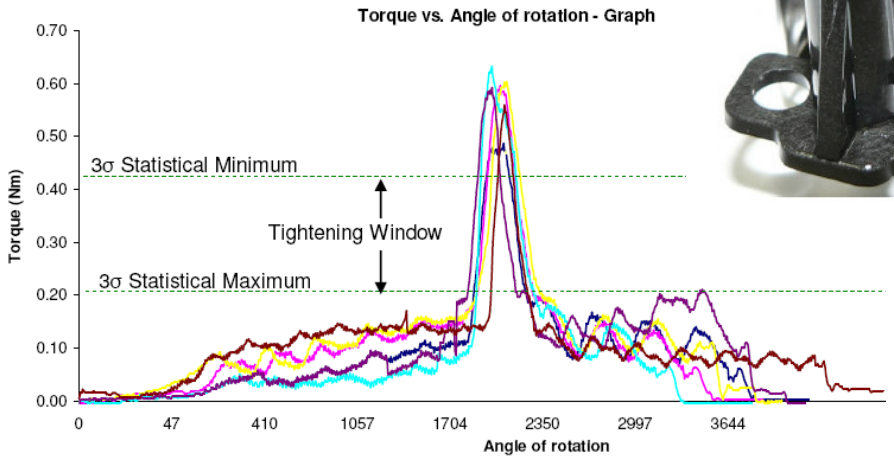
Case Study #2: Thermal Conductive Plastics

Cool Polymers E4501
(Thermally Conductive Plastic)



- Due to the brittle nature of the plastic, boss cracking is a serious issue.
- In the current design the strip to drive ratio was 2.15.
- Due to the boss cracking and low strip to drive ratio, the customer planned on abandoning the use of this plastic type.

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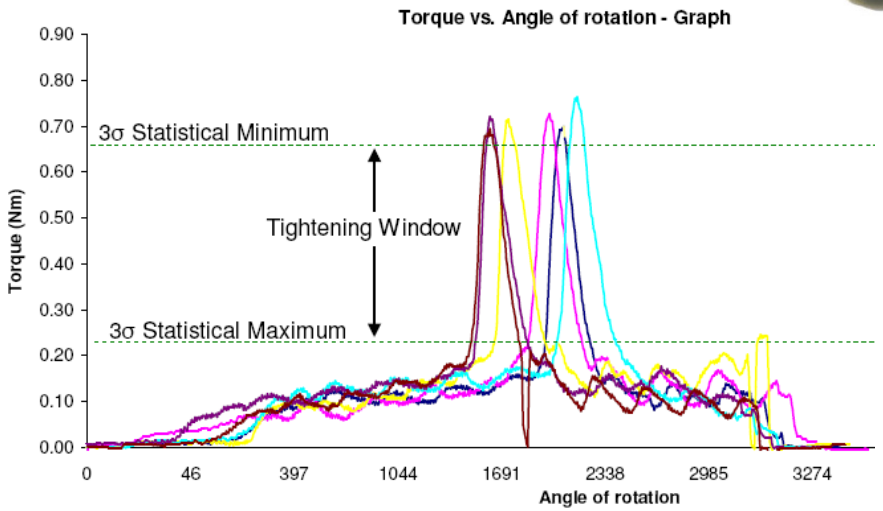
Case Study #2: Thermal Conductive Plastics



- By understanding the performance values of DELTA PT, low radial stress coupled with knowledge of the application ATF was able to design the proper boss
- Strip to Drive ratio of 3.05.
- ATF was also able to develop a boss design to commonize all 7 fasteners.

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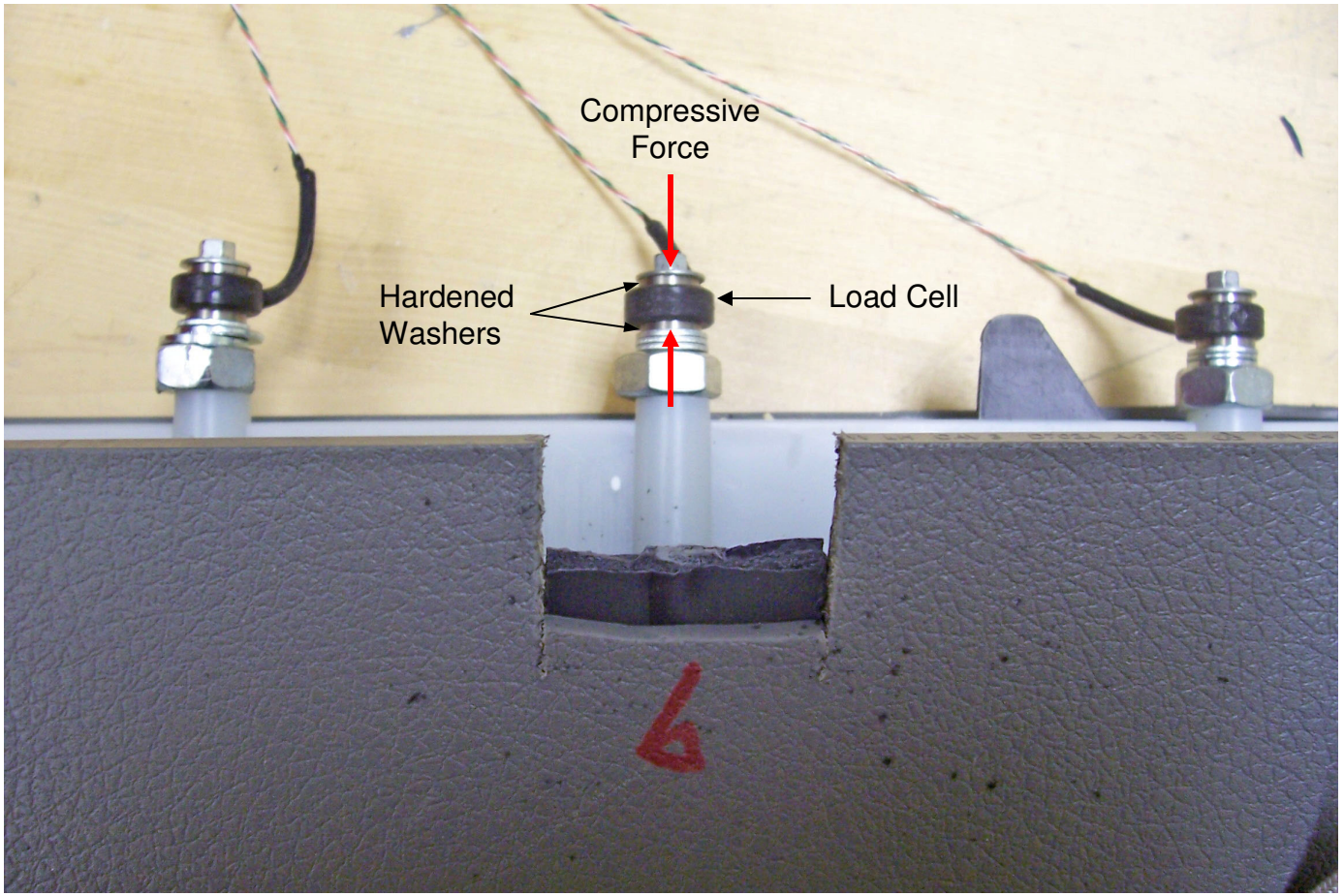
Clamp Load Testing Capabilities



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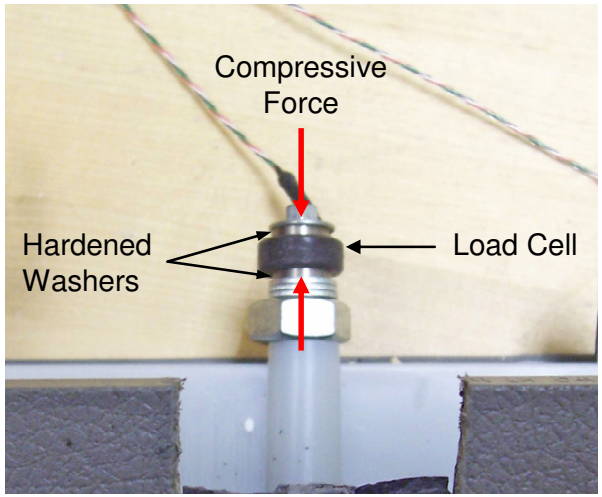
DELTA PT® vs AB and HiLo Screws
Clamp Load

Testing Setup



Boss Material: PC/ABS
Testing Conditions Requested: 8 hour thermal variation from 60℃ to -20℃
Installation Torque: 1.32 Nm

	DELTA PT® 40	M4.2 AB Screw	M4.2 HiLo Screw
Initial Clamp Load (lbs)	346.19	151.83	119.47
Final Clamp Load (lbs)	221.55	20.46	44.61
Percent Retention of Clamp Load	**64%**	13%	37%

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Clamp Load Retention Test Results

Fastener	Average Tightening Torque	Average Break-Loose Torque	Average Initial Clamp Load	Average Final Clamp Load	Percent Retention of Clamp Load
DELTA PT® 40	5.13 in-lbs (0.58 Nm)	4.25 in-lbs (0.48 Nm)	128 lbs (570 N)	88 lbs (391 N)	69%
M4.2 Hi-Lo	9.73 in-lbs (1.10 Nm)	2.12 in-lbs (0.24 Nm)	78 lbs (348 N)	35 lbs (156 N)	45%

Average Thread Engagement

DELTA PT® 40 : 11.5 mm

M4.2 Hi-Lo: 13.8 mm

Testing Conditions

Eight hour thermal variation from 60℃ to -20℃

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Applications

- Air Bag Modules
- Trunk and Door Latches
- Door Panels
- Power Window Motors
- Tail Lamps
- Fuel Rails
- Air Flow Sensors
- Cooling Fans
- Seatbelt Housings
- Instrument Panels
- Battery Housings

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Applications Laboratory Services

- Fastener Design Recommendations
- Boss Design Recommendations
- Drive and Strip Torque Testing
- Clamp Load Testing
- Environmental Testing
- Tensile Testing
- Serviceability Testing

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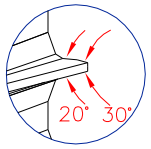
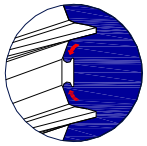
DELTA PT® Summary

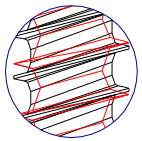


Innovative Flank Geometry → • Reduced radial stress

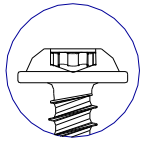


Reinforced Cored Root → • Increased joint stability

Refined Helix Angle → • Vibration resistance



Large Minor Diameter → • High mechanical strength



Optimized Head Geometry → • Excellent serviceability

DELTA PT®

A Superior Thread-former for Plastics