Plastics News

CRAIN

PolySource

Resin • Solutions • Delivered

Selecting The Right Resin To Meet the Requirements of the Application

Cliff Watkins & Jeremy Bland

PolySource LLC

PolySource
Resin • Solutions • Delivered

Plastics News

Selecting The Right Resin To Meet the Requirements of the Application

Presented By: Cliff Watkins & Jeremy Bland

PolySource
Resin • Solutions • Delivered

Plastics News

Or…..

How to Avoid the Costly Mistake of Using the Wrong Material in the Wrong Application

Presented By: Cliff Watkins & Jeremy Bland

Selecting The Right Resin To Meet the Requirements of the Application

PolySource
Resin • Solutions • Delivered

- 41-year plastics industry veteran
- Past owner of TP Composites- bought by Techmer PM in 2013
- PhD Chemistry
- 14 years with PPG Fiber Glass

Cliff Watkins PhD
Direction, Application Development
(302) 528-2036 / cliff@polysource.net

- 24-year plastics industry veteran
- Pittsburg State University-Plastics
- Process Engineering Expertise
- Six Sigma Black Belt

Jeremy Bland
Materials Technology Manager
(515) 782-2056 / jeremy@polysource.net

Presented By: Cliff Watkins & Jeremy Bland

Materials for Design

- ***Wood***
- ***Glass***
- ***Metals***
- ***Polymers***
  - ***Thermoplastics***
  - ***Thermosets***
  - ***Rubber***
    - ***Natural Rubber***
    - ***Synthetic Elastomers***

PolySource
Resin • Solutions • Delivered

Fabricating Methods

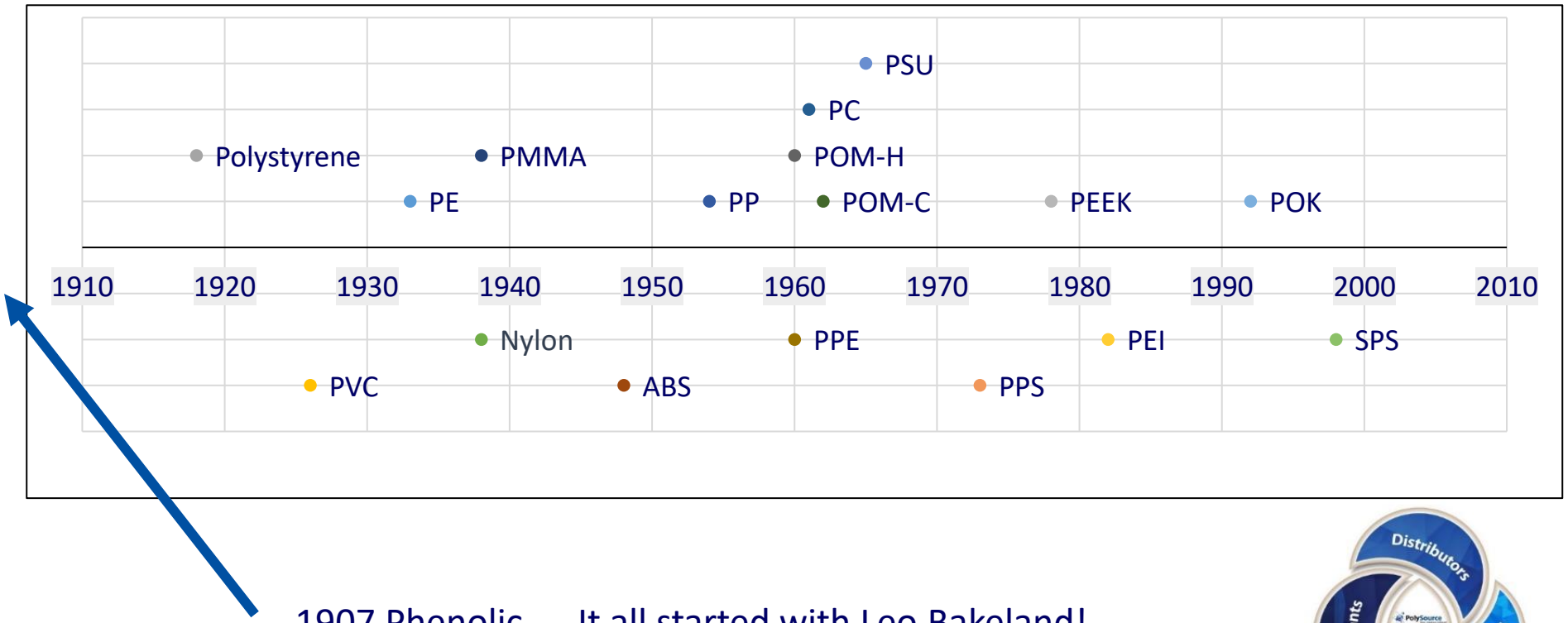
- Casting
- Stamping
- Injection Molding
- Extrusion
  - Machining
  - Sheet & Profile
- Thermoforming
- Compression Molding
- Compression & Sintering
- 3D Printing

Fabrication Methods With Polymers Directly Contribute to Design Flexibility

History of Plastics

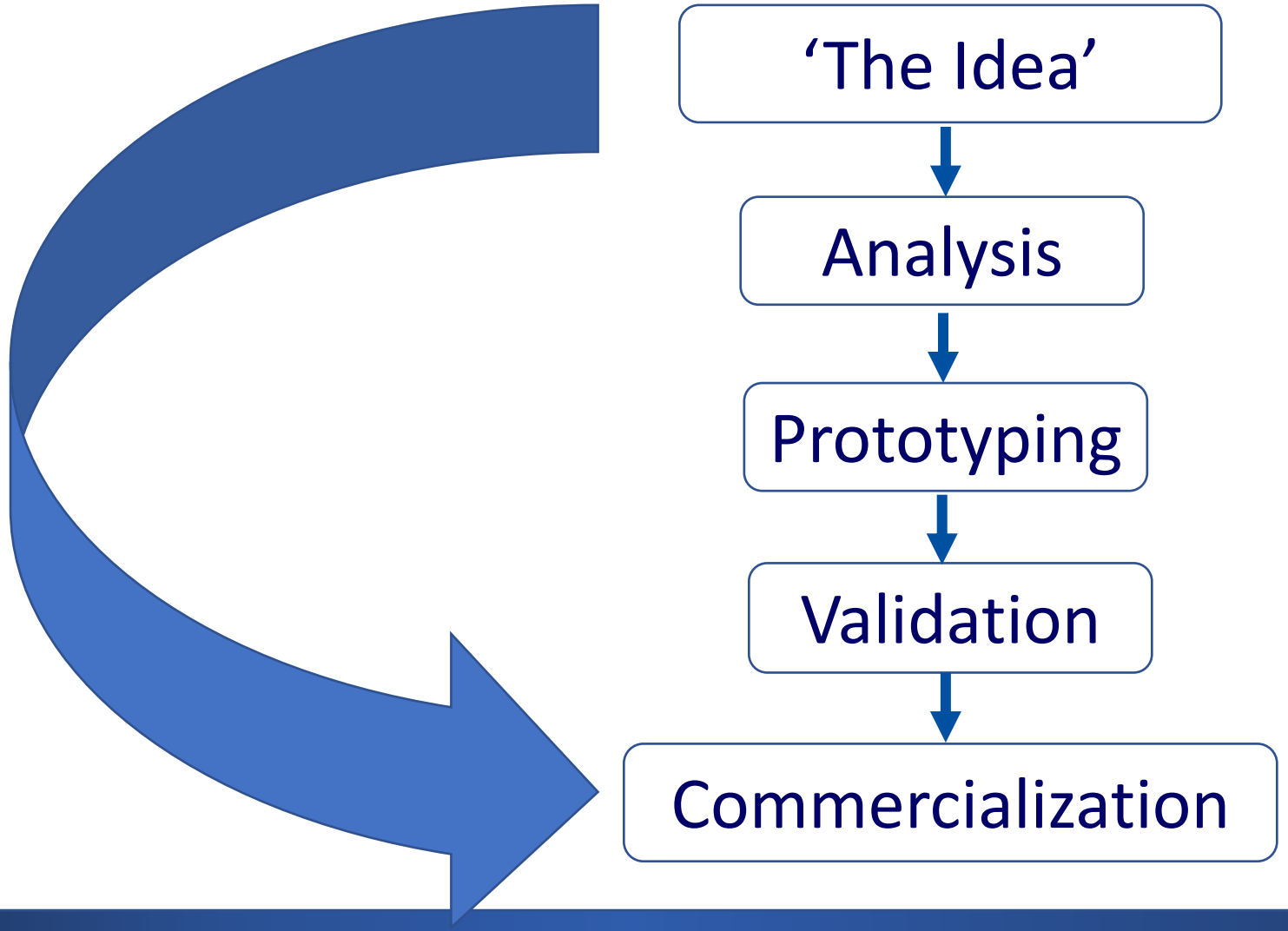
Celluloid, Replaces Ivory in 1864

Nylon Stockings debut,1939 World's Fair NYC



1907 Phenolic……It all started with Leo Bakeland!

Nearly Limitless Options in ETPs, How do you pick the "Best One"?



PolySource
Resin • Solutions • Delivered

Process Flow

‘The Idea’

PolySource
Resin • Solutions • Delivered

What are the Objectives?

1. Better performance
2. Cost savings
3. Weight savings
4. Parts consolidation
5. Material substitution
6. Other

Process Flow

‘The Idea’

PolySource
Resin • Solutions • Delivered

What are the Objectives?

1. Better performance
2. Cost savings
3. Weight savings
4. Parts consolidation
5. Material substitution
6. Other

Can you objectively measure these??

Process Flow

‘The Idea’

↓

Analysis

PolySource
Resin • Solutions • Delivered

Key Questions & Unknowns

- Determining technical feasibility.
- Can you actually produce your design?
- Cost calculations from reasonable assumptions.
- How will you validate your design?

Process Flow

‘The Idea’

↓

Analysis

To be Successful Designing with Plastic Materials

- ✓ Metal to plastic system cost analysis (CAE)
- ✓ Structural analysis (FEA)
- ✓ Process analysis (Mold flow)
- ✓ Material selection

Process Flow

Analysis Tools Critical to Designing With Plastics

PolySource
Resin • Solutions • Delivered

1. Computer Aided Materials Analysis [*Computer Aided Engineering*] Will a concept be less expensive and can a plastic device 'work'?

2. Computer Aided Design [*Finite Element Analysis*] – What are the mechanical limits of the design, and will candidate materials meet the requirements?

3. Computer Aided Design [*Mold Flow Analysis*] – Will the candidate materials allow for proper molding and deliver satisfactory appearance and performance?

4. Prototyping & Validation – Machine prototype parts or build a prototype mold and make tests under real or simulated use environment

5. Commercialization

Critical Steps/Options !

Materials for Design

- ***Wood***
- ***Glass***
- ***Metals***
- ***Polymers***
  - ***Thermoplastics***
  - ***Thermosets***
  - ***Rubber***
    - ***Natural Rubber***
    - ***Synthetic Elastomers***

PolySource
Resin • Solutions • Delivered

What are the Objectives?

1. Better performance
2. Cost savings
3. Weight savings
4. Parts consolidation
5. Material substitution
6. Other

Some Fabrication Methods Are Not Conducive to Maximizing Design Flexibility

The Design Funnel

PolySource
Resin • Solutions • Delivered

Physical
Dimensional Stability
Flatness & Warp
Color & Appearance

Chemical
Exposed to Chemicals
Environmental Humidity
Immersion / Splash Contact

Thermal
Use Temperature
Min / Max Boundaries
Spike Temperature

Mechanical
Impact
Strength
Stiffness

Static & Dynamic Load
Sliding or Rotating
Snap-fit, Screw Boss, Threads

Weathering
Flammability
Electrical

Regulatory
UL, ATEX, FDA, USP Class VI, ISO 10993, EU 10/2011
Automotive Approval

Material Options
1
2
3
4

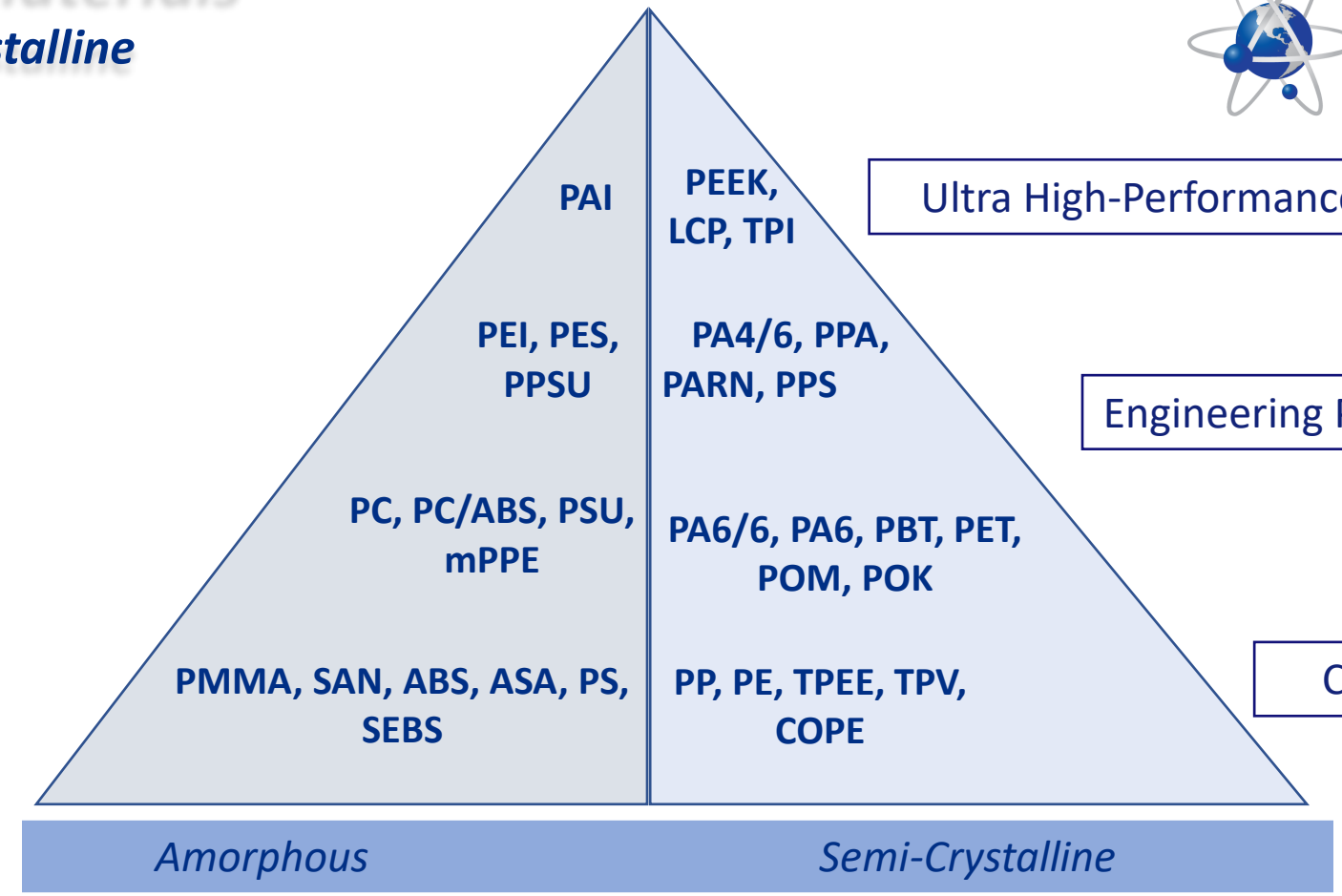
What are the CTQ's for a successful design?

Lots of Upfront Questions, to Generate Answers That lead to a Better Design

Thermoplastics Materials

Amorphous & Semi-Crystalline

PolySource
Resin • Solutions • Delivered



Ultra High-Performance Polymers

Engineering Polymers

Commodities

Nearly Unlimited Problem-Solving Options with Thermoplastic Materials – Where to start the selection process?

Typical Properties – Engineering Resins

PolySource
Resin • Solutions • Delivered

Amorphous

- Transparent (in many instances)
- Good Mechanical Properties (strength, stiffness, impact, etc.)
- Ease of Processing
- Dimensional Stability
- Predictable shrinkage (uniform)
- Softens, does not have melting point

Semi-Crystalline

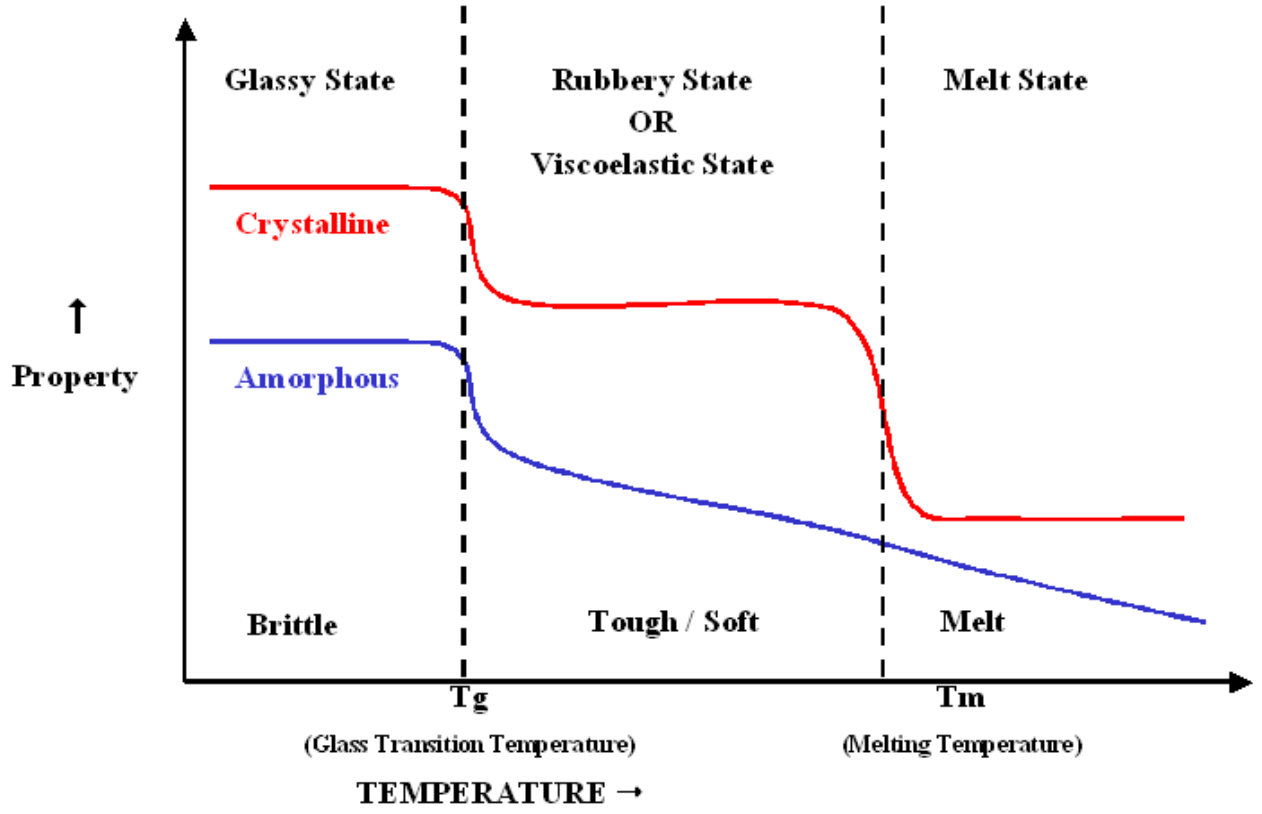
- Good Chemical Resistance
- Anisotropic Shrinkage (not uniform)
- Fatigue Resistance
- Good Electrical Properties
- High Heat Resistance (reinforced)
- Lubricity
- Sharp Melting Point

Understanding Your Requirements Enables Us to Select the Best Solution

Understanding the Thermal Conditions in Use

PolySource
Resin • Solutions • Delivered

- **THERMAL TRANSITIONS IN POLYMERS**



There Are Always Trade-offs in Engineering Plastics

The Design Funnel

PolySource
Resin • Solutions • Delivered

Physical
Dimensional Stability
Flatness & Warp
Color & Appearance

Chemical
Exposed to Chemicals
Environmental Humidity
Immersion / Splash Contact

Thermal
Use Temperature
Min / Max Boundaries
Spike Temperature

Mechanical
Impact
Strength
Stiffness

Static & Dynamic Load
Sliding or Rotating
Snap-fit, Screw Boss, Threads

Weathering
Flammability
Electrical

Regulatory
UL, ATEX, FDA, USP Class VI, ISO 10993, EU 10/2011
Automotive Approval

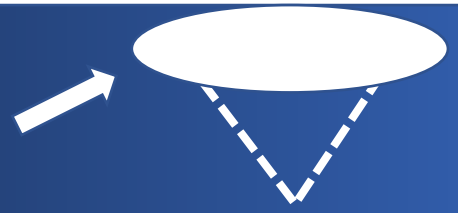
Material Options
1
2
3
4

Design Funnel……..Answers That lead to a Better Design!!

The Pros & Cons of Engineering Plastics

	Amorphous		*Semi Crystalline*	
	Unfilled	Filled/Fiber Reinf.	Unfilled	Filled/Fiber Reinf.
Mold Shrinkage	Low	Low	High	Low
Warpage	Low	Low	Moderate	High
Flatness & Dimensional Control	Excellent	Excellent	Moderate	Poor
Dimensional Stability in Use	Excellent	Excellent	Very Good	Excellent
Glossy Appearance	Excellent	Poor	Excellent	Moderate
Outdoor Use	Moderate	Moderate	Excellent	Moderate
Humidity & Temperature Ranges	Moderate	Moderate	Moderate	Excellent
UV / Sunlight Exposure	Moderate	Moderate	Moderate	Moderate
Industrial chemical exposure	Poor	Poor	Excellent	Excellent
Sanitizing chemical exposure	Poor	Poor	Excellent	Excellent
Thermal resistance	Moderate	Moderate	Excellent	Excellent

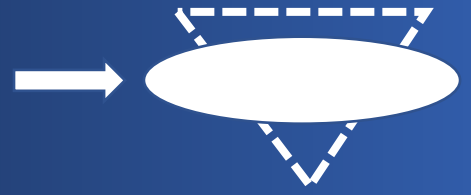
Physical	***Chemical***	***Thermal***
Dimensional Stability	Exposed to Chemicals	Use Temperature
Flatness & Warp	Environmental Humidity	Min / Max Boundaries
Color & Appearance	Immersion / Splash Contact	Spike Temperature



The Pros & Cons of Engineering Plastics

	Amorphous		Semi Crystalline	
	Unfilled	Filled/Fiber Reinf.	Unfilled	Filled/Fiber Reinf.
Creep Resistance, room temp.	Moderate	Excellent	Moderate	Excellent
Creep Resistance, elevated temp.	Poor	Poor	Moderate	Excellent
Structural Load Capability	Poor	Moderate	Moderate	Excellent
Exposed to Electrical Voltage	Moderate	Moderate	Moderate	Excellent
Flame Retardancy	Excellent	Excellent	Excellent	Excellent
Coefficient of Friction	Poor	Excellent	Excellent	Excellent
Screw bosses & self tapping screws	Moderate	Moderate	Excellent	Excellent

	Mechanical	
Impact	Static & Dynamic Load	Weathering
Strength	Sliding or Rotating	Flammability
Stiffness	Snap-fit, Screw Boss, Threads	Electrical Properties

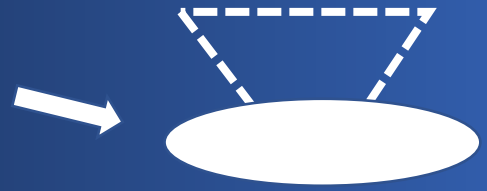


The Pros & Cons of Engineering Plastics

PolySource
Resin • Solutions • Delivered

	Amorphous		*Semi Crystalline*	
	Unfilled	Filled/Fiber Reinf.	Unfilled	Filled/Fiber Reinf.
Direct or indirect food contact (FDA)	Excellent	Excellent	Excellent	Excellent
Potable water contact (NSF)	Excellent	Excellent	Excellent	Excellent
USP Class VI, ISO 10993	Excellent	Excellent	Excellent	Excellent
UL, ATEX, EU, CSA, ETL	Excellent	Excellent	Excellent	Excellent
Automotive Powertrain	Poor	Poor	Excellent	Excellent
Automotive Interior	Excellent	Excellent	Excellent	Excellent
Automotive Exterior	Moderate	Moderate	Excellent	Excellent
Electrical / Electronic	Excellent	Excellent	Excellent	Excellent
Consumer Appliance	Excellent	Excellent	Moderate	Moderate

	Regulatory	
UL, ATEX, FDA, USP Class VI, ISO 10993, EU 10/2011		
Automotive Approval		



Use the Tools Critical to Designing with Plastics

PolySource
Resin • Solutions • Delivered

1. Computer Aided Materials Analysis
2. Finite Element Analysis
3. Mold Flow Analysis
4. Prototyping & Validation
5. Commercialization

$3,000 in Mold Flow Analysis is Much More Betterer than a $50,000 Boat Anchor

Designing with Engineering Plastics

PolySource
Resin • Solutions • Delivered

Early-Stage Innovation
'The Idea' → Analysis & Validation First

Fixing the 'Oops'
'Salvaging the Project' → Correcting & Adjusting with an Existing Mold

Blends, Alloys & Additives Enable "Limitless"
Problem Solving Options with Thermoplastic Materials

Incremental Design Changes

A common practice in incremental design & innovation

“use an approved resin, because we stock it”

While that is efficient it can result in expanding the use of an over engineered resin

- Negating the potential for real cost savings
- Missing the opportunity to truly achieve the best design

Example: Designing with 33% Glass PA6/6 when 30% Glass PA6 would suffice or Over-Looking the Potential of Using 30% Glass PP

Designing with Engineering Plastics

PolySource
Resin • Solutions • Delivered

- Material Substitution for System Cost Savings &/or Weight Savings
- Ease of Assembly & Parts Consolidation
- Stronger, Stiffer, Tougher
- More Shrink or Less Shrink
- Consider Exposure Conditions
- Control Part Dimensions

Considerations and Issues at Prototyping Stage or After Commercialization

The Engineering Plastics Toolbox

PolySource
Resin • Solutions • Delivered

Reinforcements	***Lubricants***	***Specialties***
Glass Fiber	PTFE	Metal Powders
Carbon Fiber	Silicone	Inorganic Powders
Clay	p-Aramid	Thermal Conduction
Talc	MoS_2 (moly)	Laser Marking
Glass Beads	Graphite	Performance Additives

Tweaking Performance to Minimize Trade-Offs

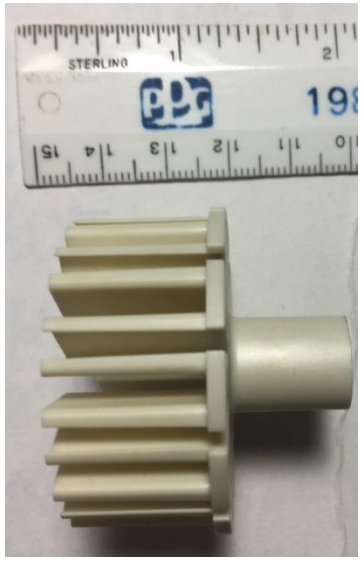
Examples:

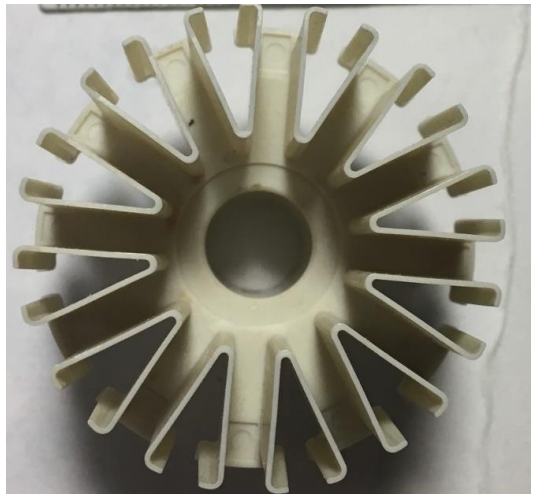
PolySource
Resin • Solutions • Delivered

Distributors
Consultants
Entrepreneurs

Sometimes, you just Have to Make Tests with Delicious, Steamy Hamburgers on a Steam Table

Examples:

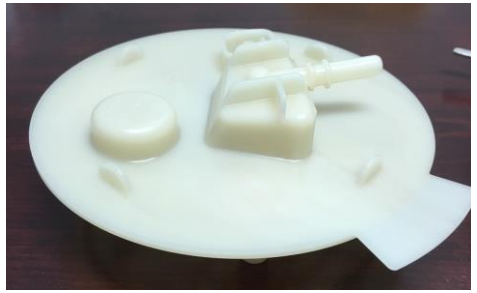




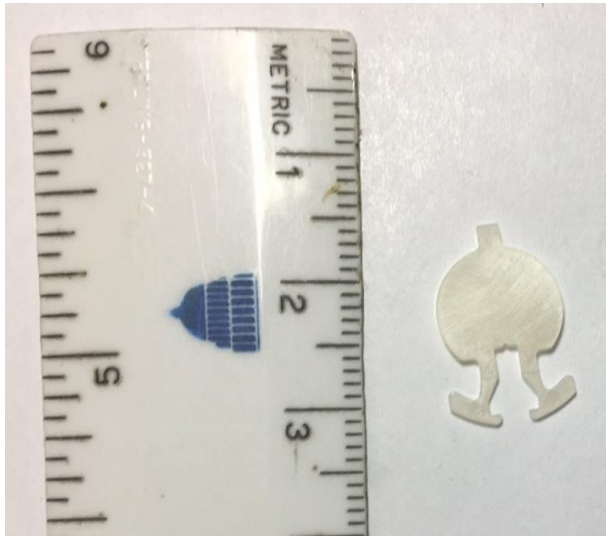
PolySource
Resin • Solutions • Delivered

Given the Chance, Polyamides will Change in Performance with the Seasons

Examples:

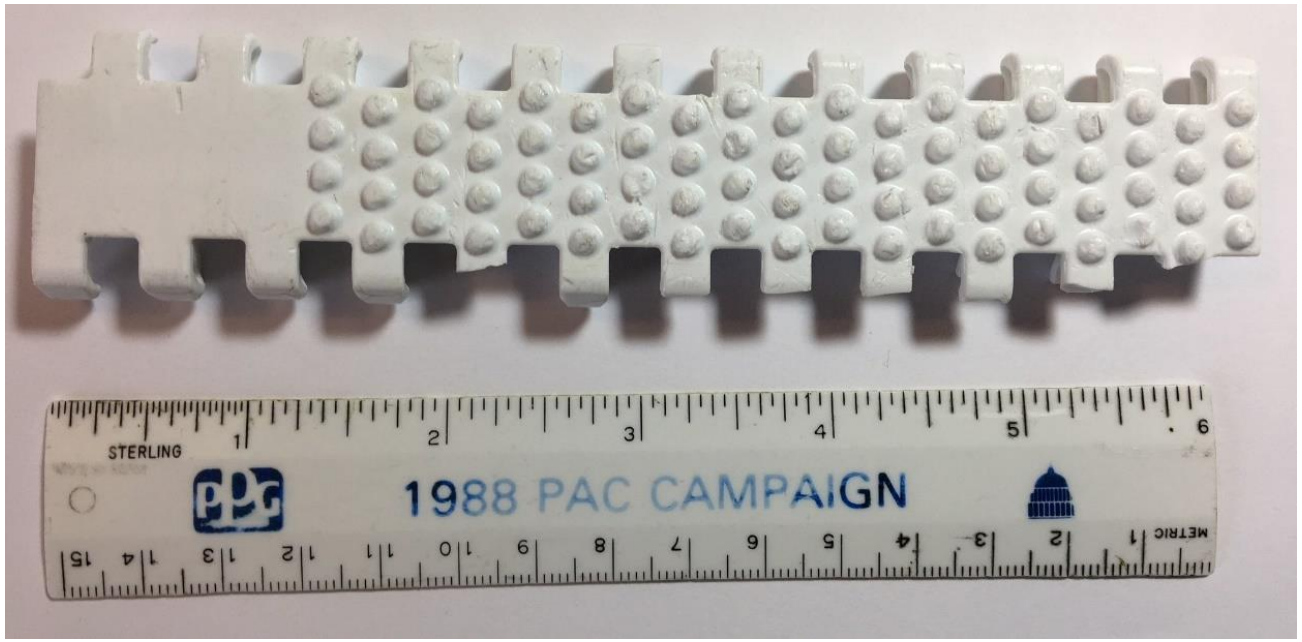


PolySource
Resin • Solutions • Delivered



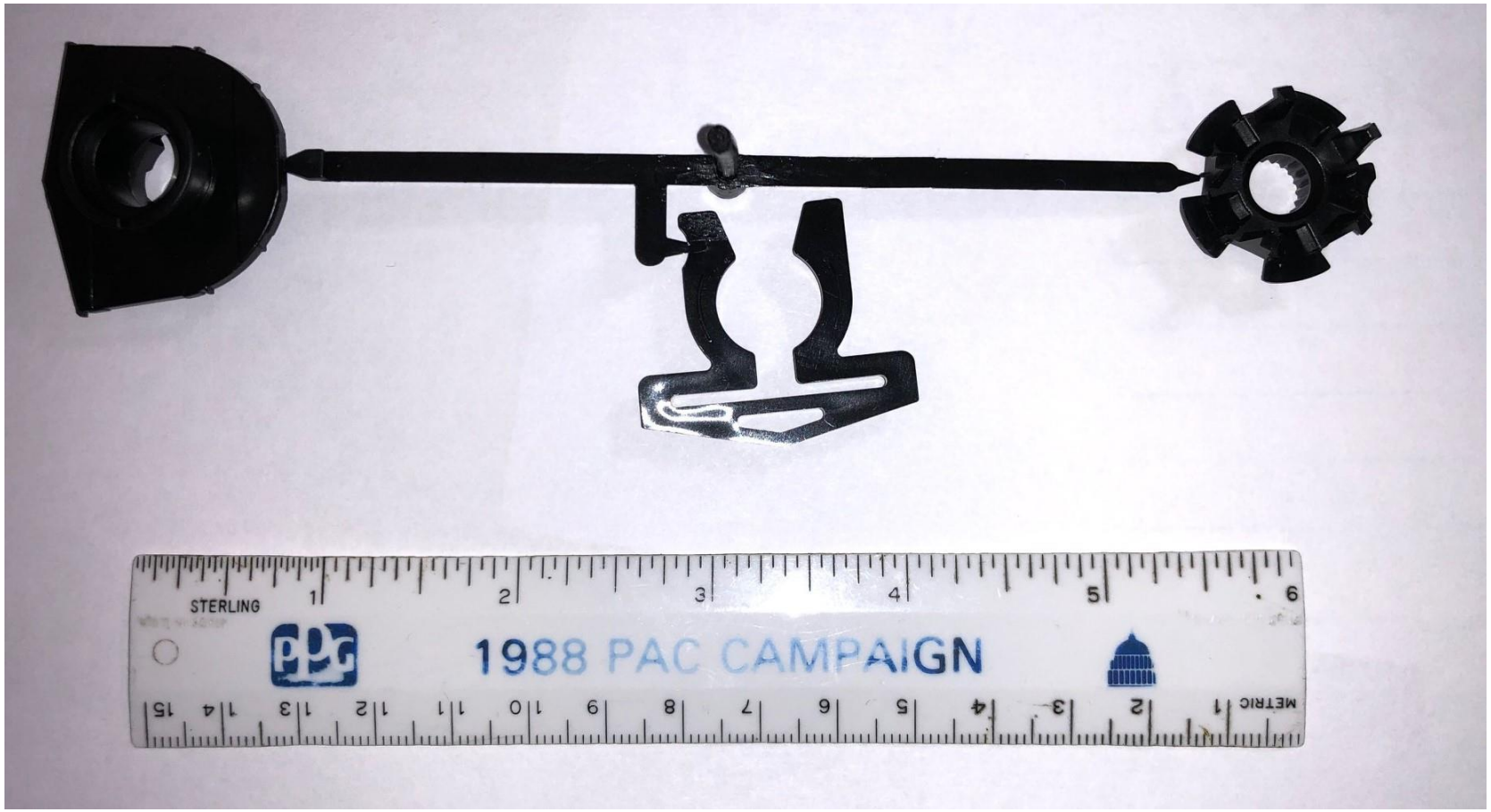
Dimensions, Gloss Surface, Resistance to Motor Fuel….> 10,000 Hours of Testing

Examples:



Sanitizing Cleaners and Sprays can Wreak Havoc on Plastics

Examples:



PolySource
Resin • Solutions • Delivered

Dimensions, Flatness, Strength… Family Molds always seem like a Great Idea

The Design Funnel

PolySource
Resin • Solutions • Delivered

Physical
Dimensional Stability
Flatness & Warp
Color & Appearance

Chemical
Exposed to Chemicals
Environmental Humidity
Immersion / Splash Contact

Thermal
Use Temperature
Min / Max Boundaries
Spike Temperature

Mechanical
Impact
Strength
Stiffness

Static & Dynamic Load
Sliding or Rotating
Snap-fit, Screw Boss, Threads

Weathering
Flammability
Electrical

Regulatory
UL, ATEX, FDA, USP Class VI, ISO 10993, EU 10/2011
Automotive Approval

Material Options
1
2
3
4

Design Funnel……..Answers That lead to a Better Design

‘The Idea’

Analysis

Prototyping

Validation

Commercialization

PolySource
Resin • Solutions • Delivered

The Design Funnel

Physical
Dimensional Stability
Flatness & Warp
Color & Appearance

Chemical
Exposed to Chemicals
Environmental Humidity
Immersion / Splash Contact

Thermal
Use Temperature
Min / Max Boundaries
Spike Temperature

Mechanical
Impact
Strength
Stiffness

Static & Dynamic Load
Sliding or Rotating
Snap-fit, Screw Boss, Threads

Weathering
Flammability
Electrical

Regulatory
UL, ATEX, FDA, USP Class VI, ISO 10993, EU 10/2011
Automotive Approval

Material Options
1
2
3
4

Utilizing the PolySource Design Funnel makes ideas a reality!!

Plastics News

PolySource
Resin • Solutions • Delivered

Thank You for Joining the Discussion Today!!

- 39-year plastics industry veteran
- Past owner of TP Composites- bought by Techmer PM in 2013
- PhD Chemistry
- 14 years with PPG Glass

Cliff Watkins PhD
Direction, Application Development
(302) 528-2036 / cliff@polysource.net

- 22-year plastics industry veteran
- Pittsburg State University-Plastics
- Process Engineering Expertise
- Six Sigma Black Belt

Jeremy Bland
Materials Technology Manager
(515) 782-2056 / jeremy@polysource.net

Questions ???