

***A Comparative Analysis of Fastening and Bonding
Methods to PSAs in Industrial Design Applications:
The Pros and Cons***

Presented by

Cynthia Bellian

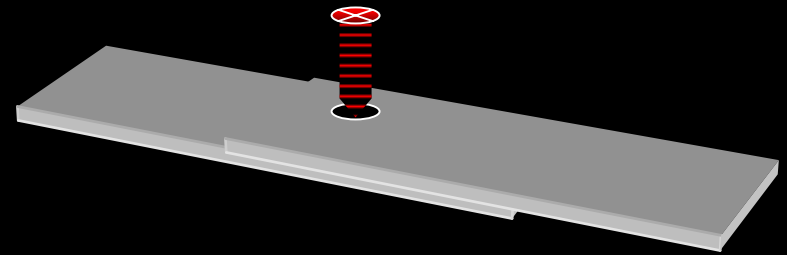
Project Manager – Market Development

Assembly Technology Expo, Rosemont, IL

September, 2004

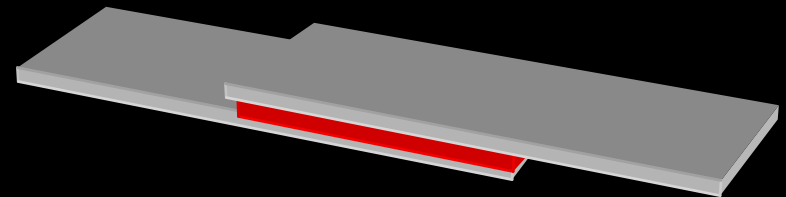
Mechanical Engineering Solutions

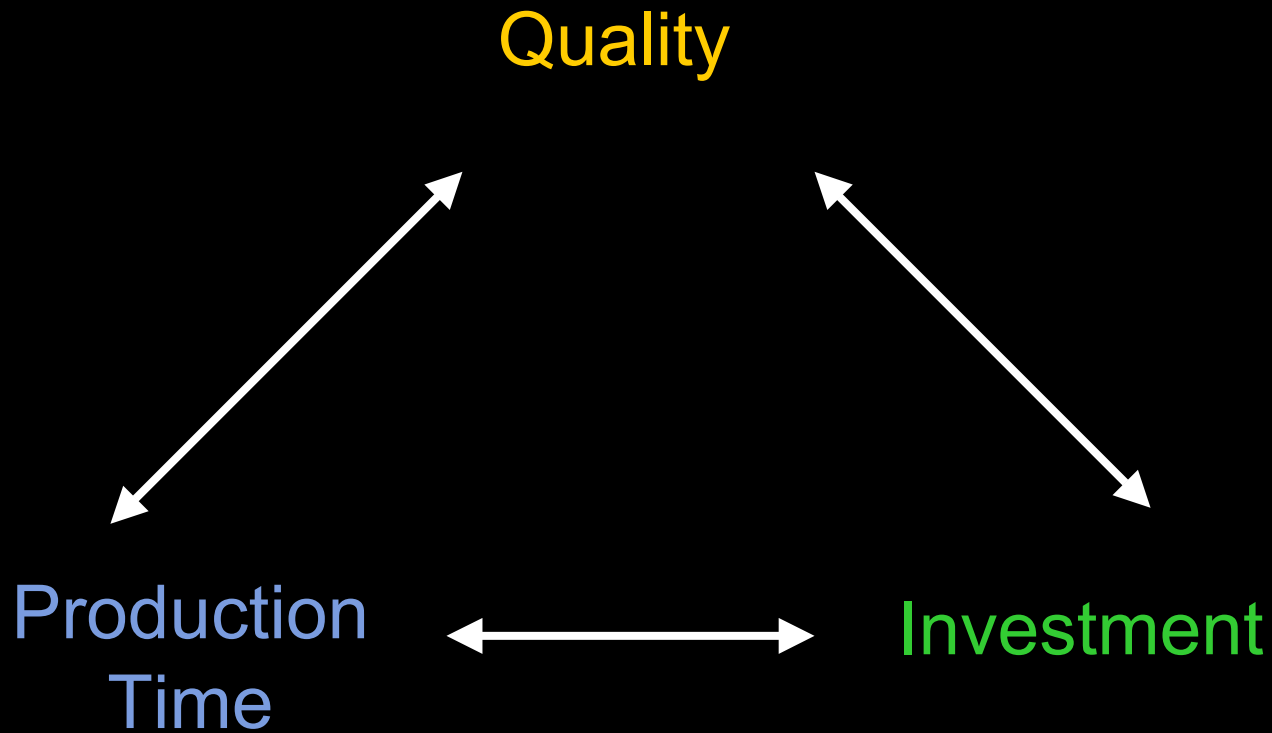
- Fasteners -nuts, bolts, nails, staples, screws, tap, posts
- Rivets
- Welds/Solder



Chemical Engineering Solutions

- Hot Melt Adhesives
- Spray Adhesives
- Liquid Adhesives
- Pressure-sensitive adhesives (PSAs)





BTI Study

- Performance/Durability
- Costs (raw materials, labor, tooling)
- Manufacturing Productivity
- Maintenance/Servicibility
- Availability
- Functionality
- Bonding/Strength

Specialty Tape Division

Joining Technologies

	Radial/ Orbital Riveting	Clinching	Self Piercing Riveting	Screws Bolts – Fasteners	Spot Welding	Adhesive Bonding	PSA Bonding
Corrosion	Little	Little	Little	Little	High	None	None
Joining Point Alteration	None	None	None	None	Yes	None	None
Dynamic Load	Good	Very Good	Very Good	Less Good	Less Good	Very Good	Very Good
Crush Load	Less Good	Less Good	Very Good	Less Good	Less Good	Very Good	Very Good
Static Load 1-Shear 2-Head	Very Good	Good	Very Good	Very Good	Very Good	Good	Good
Edges- Burring- Splinters	None	None	None	Yes	None	None	None
Consumable	Rivet	None	Punch Rivet	Nuts, bolts, tap	None	Adhesive	PSA
Energy	Little	Little	Little	Little	Very High	Very High	Little
Materials	Solid Material	Metals Only	Metals Only	Solid Material	Some Metals	Solid Material	Solid/Flex Materials

Choice in fastening/joining/attaching/method introduces set of cost factors.

Greater knowledge in the design phase prevents costly mistakes and improves profitability.

Joining Technologies System total costs include:

- **CAPITAL COSTS**
- **ANNUAL FIXED COSTS**
- **ANNUAL VARIABLE COSTS**

CAPITAL COSTS

Machine Costs

Auxiliary Equipment, Options and Accessories

Installation

Subtotal

(Less Investment Tax Credits)

Total Capital Costs

ANNUAL FIXED COSTS:

Floorspace Cost for Equipment

Opportunity Costs for Equipment Floorspace

Annual Depreciation of Capital Equipment

Total Annual Fixed Costs

ANNUAL VARIABLE COSTS

Adhesive or Fastener Costs

Floorspace Cost for Adhesive or Fastener Inventory

Opportunity Costs for Adhesive/Fastener Inventory and

Floorspace

Labor

Downtime

Scrap

Energy

Maintenance

Total Annual Variable Costs

Total Annual Cost

Bolts, screws, rivets, staples, tabs, posts, and nuts, attach/join component. Device inserted to hold material or substrate in place.

Advantages:

- Fairly easy application, low capital for equipment needed to apply, nominal labor and provides good product aesthetics.

Disadvantages:




- Higher component costs: ↑ pre-fabricated fasteners inventory.
- Smaller contact limits bond to materials: ↓ load performance.
- Prone to loosening, weakening, rusting: ↑ noise source

EVA-based materials, applied as a molten substance and forms a bond when cooled. Bond achieved by applying adhesive in beads or swirls on substrate.

Advantages:

- Inexpensive low raw material costs.

Disadvantages:

- Constant inspection by user to ensure quality --  labor.
- Equipment to melt & deliver adhesive is needed, difficult to apply adhesive to very edge of parts. -  higher capital/maintenance.
- Performance impacted by time between application of adhesive on one substrate until contact to second substrate -  performance.

Solvent based, emulsion, epoxies or acrylates applied via air pressure mist or dispensing applicator, a brush, or roller coating. Additional equipment may be required to activate curing to set and establish the bond. May or may not be tacky to the touch after drying. Upon application of adhesive second substrate can be bonded.

Advantages:

- Inexpensive, low material costs, can achieve 100% coverage.

Disadvantages:

- Overspraying, difficult to limit to specific areas.
- High capital for application equipment, maintenance, labor intensive in use.
- Environmental and regulatory process implications: solvents.
- May be subject to labor intensive clean up.

Supplied on a webstock, PSAs can cover wide range of performance characteristics & properties for specific applications. Single-coated tape, double-coated, transfer adhesive, adhesive sandwich.

Advantages:

- Minimal capital costs to apply on substrates.
- Provides 100% coverage for optimal adhesion to bonding area.
- Can shorten assembly time and reduce labor needed -- **↑ productivity.**
- Can improve aesthetics by eliminating visible mechanical fasteners.

Disadvantages:

- PSAs range from \$1.00/MSI to \$25/MSI -- **↑ raw material cost.**

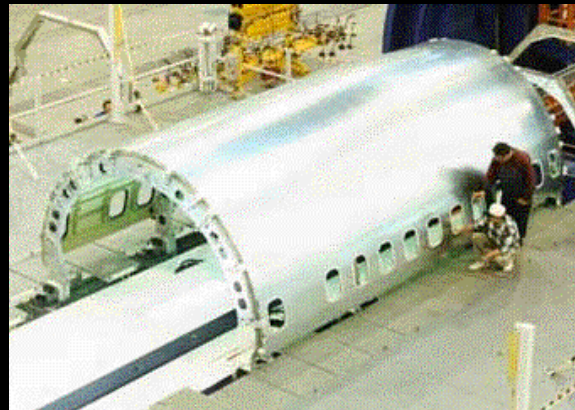
A term designating a distinct category of adhesives which in dry form are aggressive and permanently tacky at room temperature.

- ✓ Will adhere to a variety of substrates when applied with pressure.
- ✓ Do not require activation by water, solvent or heat.
- ✓ Have sufficient cohesive strength so they can be handled with the fingers.

- Total Cost of Ownership
- Adhesion/Bonding Performance
- Aesthetics
- Material Compatibility
- Lightweight Properties
- Barrier Properties
- Sound & Vibration Control
- Low Surface Energy Uses
- Consistent Adhesive Coating Application
- Flexible Assembly



- Automotive
- Aircraft
- Building/Construction
- HVAC
- General Industrial
- Electronics & Appliances



- The selection of the product for an application require as much detail about the needs of both the converter and end user as possible.
- Satisfaction of end use requirements without addressing concerns of processing the material does not insure successful use of the product.
- Identifying range of needs as early as possible improves ability to address requirements in the processing and application stages.

Application Factors which Should be Considered

Price target

Expected usage (Volume)

Timing of project

Materials to be joined

How will the product be processed

Migratory components of substrate

Life expectancy of product

Existing Specifications

Previous problems encountered

How the product is applied

Condition of substrates

What does the tape have to DO

Texture of substrates

Temperature at application

Temperature during use

Exposure to UV

Exposure to Solvents

There is NO substitution for actual testing of substrate materials to insure success in an application

- **Adhesion:** Measure of bond strength between an adhesive and a substrate.
- **Tack:** The initial attraction or grab of an adhesive to a substrate.
- **Shear:** The internal or cohesive strength of an adhesive film.

A universal all-purpose adhesive does not exist!

- Provides structural strength that can replace bolts, rivets, welds and other mechanical fasteners
- Permits use of lighter, thinner materials
- Bond dissimilar materials without incompatibility concerns
- Acts as moisture seal/environmental barrier
- Provides vibration dampening and noise reduction
- Shortens assembly time and boosts productivity
- Eliminates need for surface refinishing to remove weld distortions, etc.

- Eliminates visible mechanical fasteners for cosmetic aesthetic advantages
- Provides adhesion to difficult surfaces LSE
- Provides uniform thickness and gap filling properties
- Eliminates the need for bonding “both” substrates together at the same time and location providing optimum manufacturing flexibility
- Provides properties and functionalities beyond joining: sound/vibration damping, thermal conductivity, anti-friction/abrasion resistance, flame retardancy, etc.

Specialty Tape Division



**AVERY
DENNISON**