

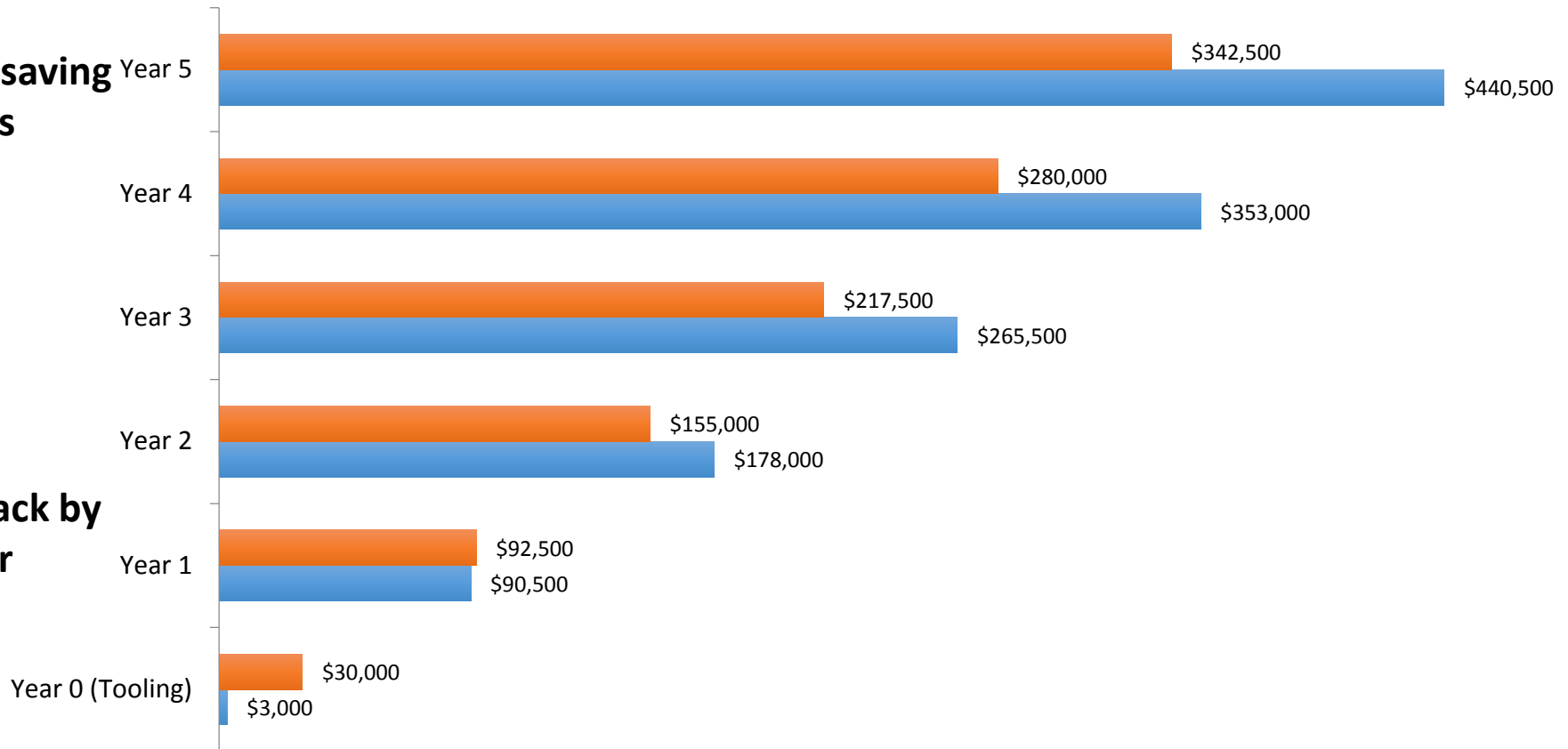
Casting vs Fabrication

Cumulative Cash Outflow Based on 500 Units per Year
Fabricated Parts @ \$175 Each, Ready to Assemble
Cast/Machined Parts @ \$125 Each, Ready to Assemble

■ Casting ■ Fabrication

**\$100,000
cumulative saving
after 5 years**

**Tooling payback by
savings 1 year
production**



Disposable Mold Casting Methods

- **Sand**
 - Green Sand
 - Petrobond (oil sand)
 - Dry Sand (chemically bonded, no-bake)
- **Shell Molded (Resin sand)**
- **Investment (Lost Wax)**
 - Ceramic Shell (Dipped in slurry and stucco)
 - Solid Mold (Poured into flasks)

Disposable Mold Casting Methods

- **Plaster Mold (Shaw Process, Split P/L mold)**
- **-V- Process**
- **Lost Foam**

Reusable Mold Casting Methods

- **Pressure Diecast**

- Conventional
- Squeeze Casting
- MFT Vacuum

- **Permanent Mold**

- Static
- Tilt Pour
- Low Pressure

- **Semi Solid Molding (MAINLY AUTOMOTIVE)**

- Thixotropic casting (SSM from Billet)
- Rheocasting (billet produced at machine)

Sand Casting

Advantages

- ✓ Quick Turnaround
- ✓ Low tooling dollars
- ✓ Low to high volume capable
- ✓ Many vendors available
- ✓ Easy to revise tooling
- ✓ Process/Equipment is easily scalable to large parts

Disadvantages

- Minimum wall is 3/16" + draft required
- 250-400 RMS finish
- Limited definition of features and details
- Loose tolerances often require secondary machining.

Plaster Mold Casting

Advantages

- ✓ Low Tooling Cost.
- ✓ Good for prototyping of diecastings
- ✓ Vendors typically “agile” to leadtime and revisions.

Disadvantages

- Unit prices are higher than sand and -V- Process.
- Daily output limited to low quantities
- Poor plating and pressure tightness due to gas porosity.

Investment Casting

Advantages

- ✓ Thin wall
- ✓ Unlimited design freedom
- ✓ Accurate, fine details
- ✓ Smooth surface finish (125 RMS)
- ✓ Relatively low tooling costs.
- ✓ SLA and 3d Printer output can be used as patterns for Rapid Prototypes.

Disadvantages

- Highest casting unit price
- Not shortest leadtime for production tool and parts
- Not appropriate for most large parts (>16")

V - Process

Advantages

- ✓ Zero Draft
- ✓ Smooth surface finish and accurate details
- ✓ Tolerances better than sand cast
- ✓ Thin wall capability
- ✓ Suitable for low to intermediate lot sizes
- ✓ Eliminate secondaries and finishing

Disadvantages

- Unit pricing not lowest
- Tooling not transferable

Lost Foam

Advantages

- ✓ Low unit price
- ✓ Long Tool life
- ✓ Excellent repeatability and consistency
- ✓ Easily produce cored and “undercut” features
- ✓ Rapid Prototypes available.

Disadvantages

- Tooling cost and leadtime.
- Very few “job shop” vendors for this production oriented process.
- Used mainly in “core intensive” automotive plumbing, pump and valve applications.

Permanent Mold Casting

Advantages

- ✓ Low unit price . Long Tool life. Excellent repeatability and consistency.
- ✓ High quality , Machinability. Sand Cores can be used.
- ✓ Cast Integral Inserts, Sleeves and elements etc

Disadvantages

- Need 2-3 degrees draft.
- 3/16" minimum wall.
- Tooling is more costly than Sand or –V- Process.

Diecasting

Advantages

- ✓ High Speed process
- ✓ Smooth surface finish and accurate details
- ✓ Tolerances best of all casting methods
- ✓ Thin wall capability
- ✓ Suitable for high quantity lot sizes
- ✓ Eliminate secondaries and finishing
- ✓ Dimensionally stable

Disadvantages

- Tooling cost
- Tooling leadtime

Semi-Solid (SSM) Thixotropic

Advantages

- ✓ Low unit price
- ✓ Long Tool life
- ✓ Excellent repeatability and consistency
- ✓ “Forging-like” metal properties for strength and safety critical applications
- ✓ Random defects eliminated

Disadvantages

- Very few “job shop” vendors for this production oriented process.
Mainly used in Automotive industry
- Tooling cost and leadtime
- Sometimes difficult to modify steel tooling
- Used mainly in automotive, motorcycle and bicycle industries

Recap of Processes

Sand	Reusable Pattern equipment makes impression in compacted or bonded sand dispensable mold.
Investment	Wax Pattern "invested" in liquid ceramic media and Stucco. Wax removed leaving cavity. Ceramic "fired", metal poured into cavities created in Shell
Plaster Mold	Reusable Pattern equipment and flask filled with plaster to make impressions. Dispensable mold halves fired and assembled, then fill with metal.
Permanent Mold	Cavities cut into Steel/Iron then coated with refractory material. Metal is poured or "pushed" into these reusable molds.
Lost Foam	Expendable Polystyrene Patterns are enveloped in compacted sand mold. Metal is poured into mold. EPS evaporates as metal fills resultant cavities.
Diecast	Liquid Metal is injected into Hardened Steel Cavities using high pressure hydraulics.
Semi Solid (SSM)	Similar to Diecast. Precisely heated Semi-Solid Billet is transferred into Hardened Steel Cavities using high pressure hydraulics.
-V- Process	Split (Cope and Drag) Pattern equipment used to make impressions in fine, unbonded sand mold halves. Vacuum is used with plastic films to compact/ hold sand mold through molding and pouring cycle.

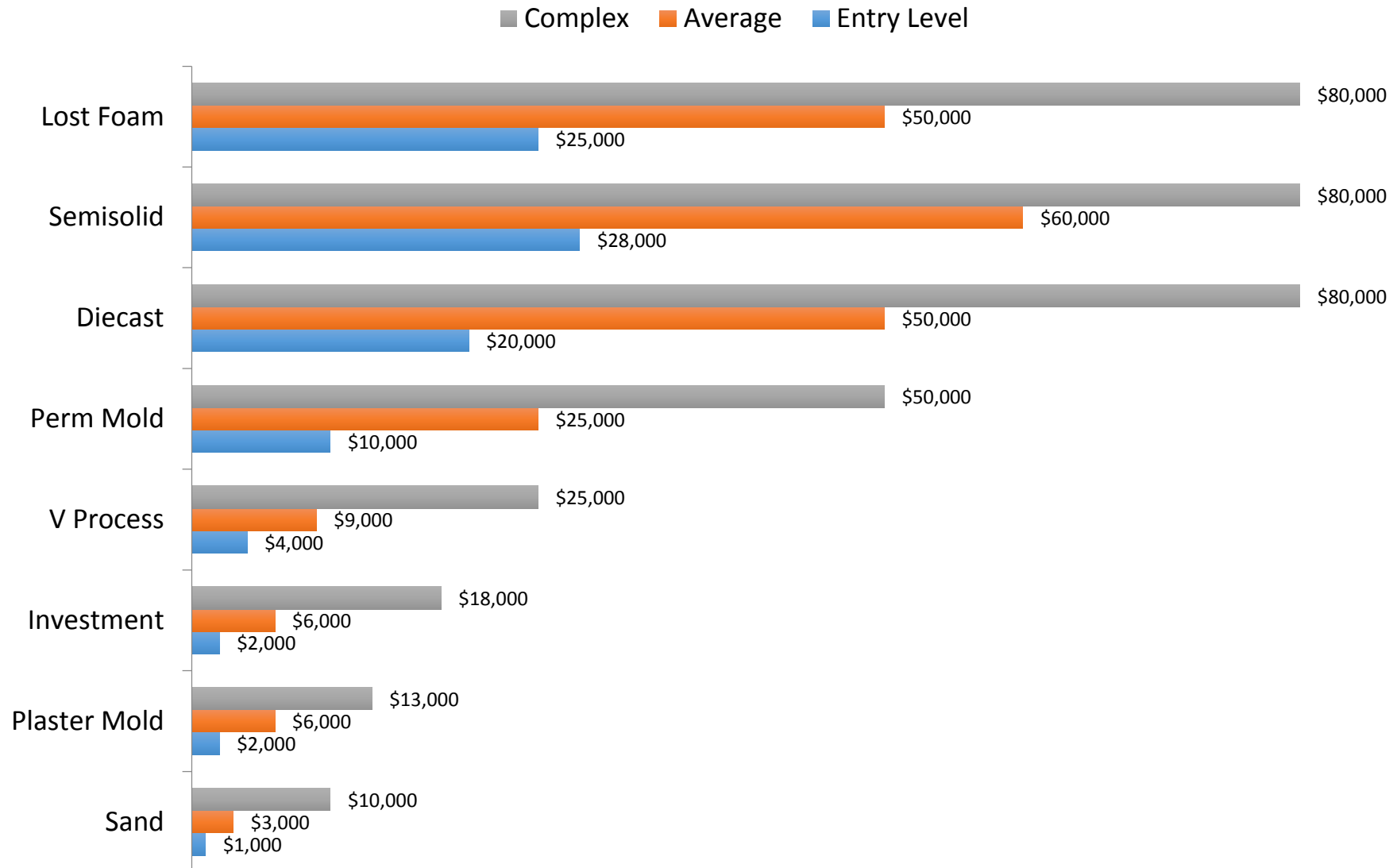
Linear Tolerances Comparison

Casting Method	3 Inches	6 Inches	12 Inches	24 Inches	Parting Line Shift in inches	Surface Finish As Cast (RMS)
V-Process	±.014	±.020	±.032	±.056	±.010	125-150
Sand Cast	±.030	±.035	±.060	±.125	±.020-.060	250-500
Die Cast	±.006	±.009	±.015	±.027	±.015	30-60
Plaster Mold	±.015	±.024	±.042	±.078	±.015	90-125
Investment Cast	±.009	±.015	±.027	±.051	±.000	90-125
Permanent Mold	±.019	±.025	±.037	±.061	±.010-025	50-200

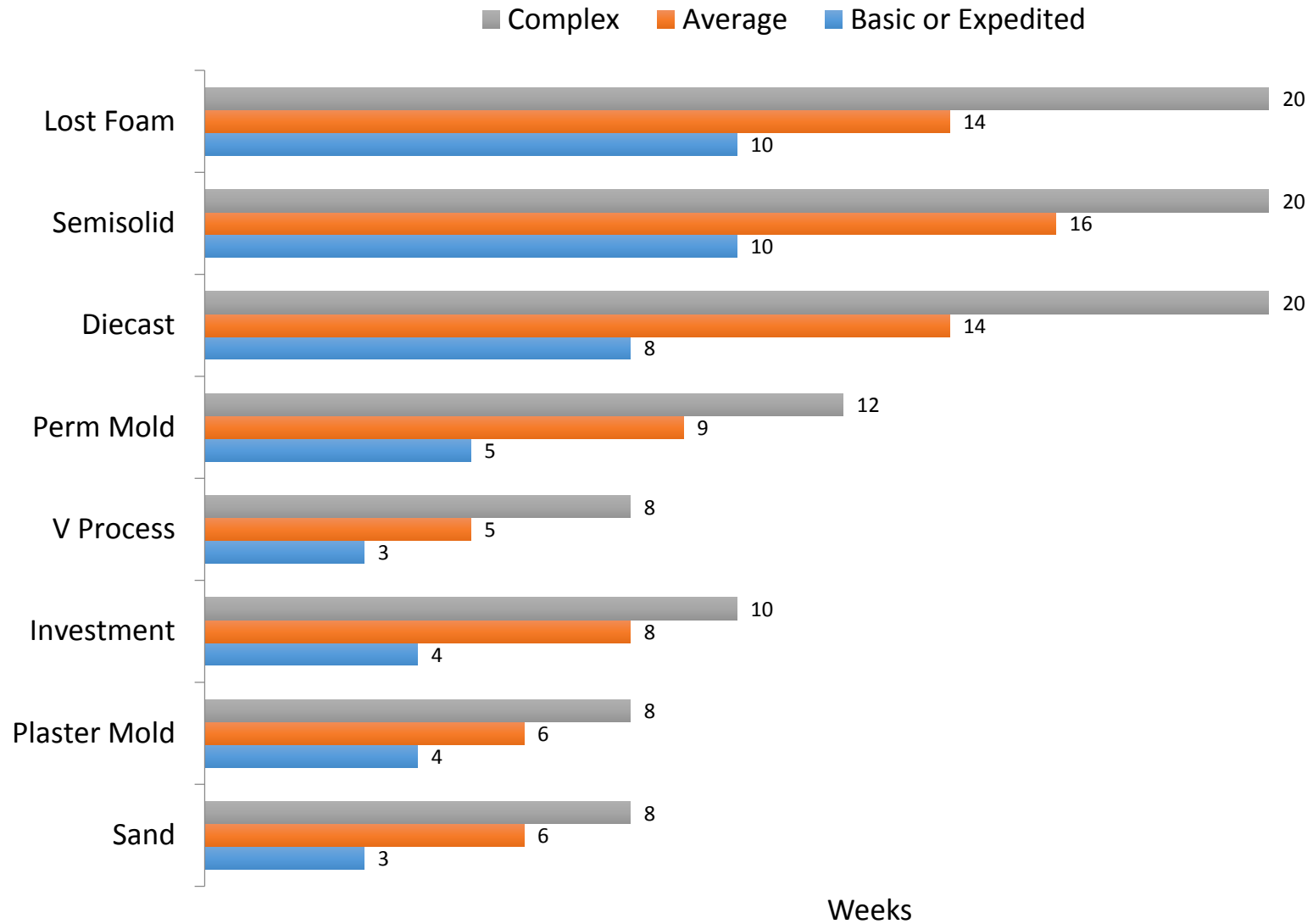
Tooling Descriptions

Sand	Wood, Metal, Urethane Patterns Mounted on Boards. Coreboxes of wood, metal and resin
Investment	Aluminum Molds to inject wax patterns
Plaster Mold	Urethane Patterns mounted on metal or wood boards. Coreboxes as required.
-V- Process	Urethane Patterns mounted on wood boards, Coreboxes as required, urethane or metal.
Permanent Mold	Low alloy Steel Cavities and Mold Frames, slides and cores as required. Disposable sand cores would require coreboxes.
Lost Foam	Steel or Aluminum cavities
Diecasting	Tool Steel Cavities/Slides, Alloy Steel Mold Frames
Semi Solid (SSM)	Tool Steel Cavities,. Alloy Steel Mold Frames

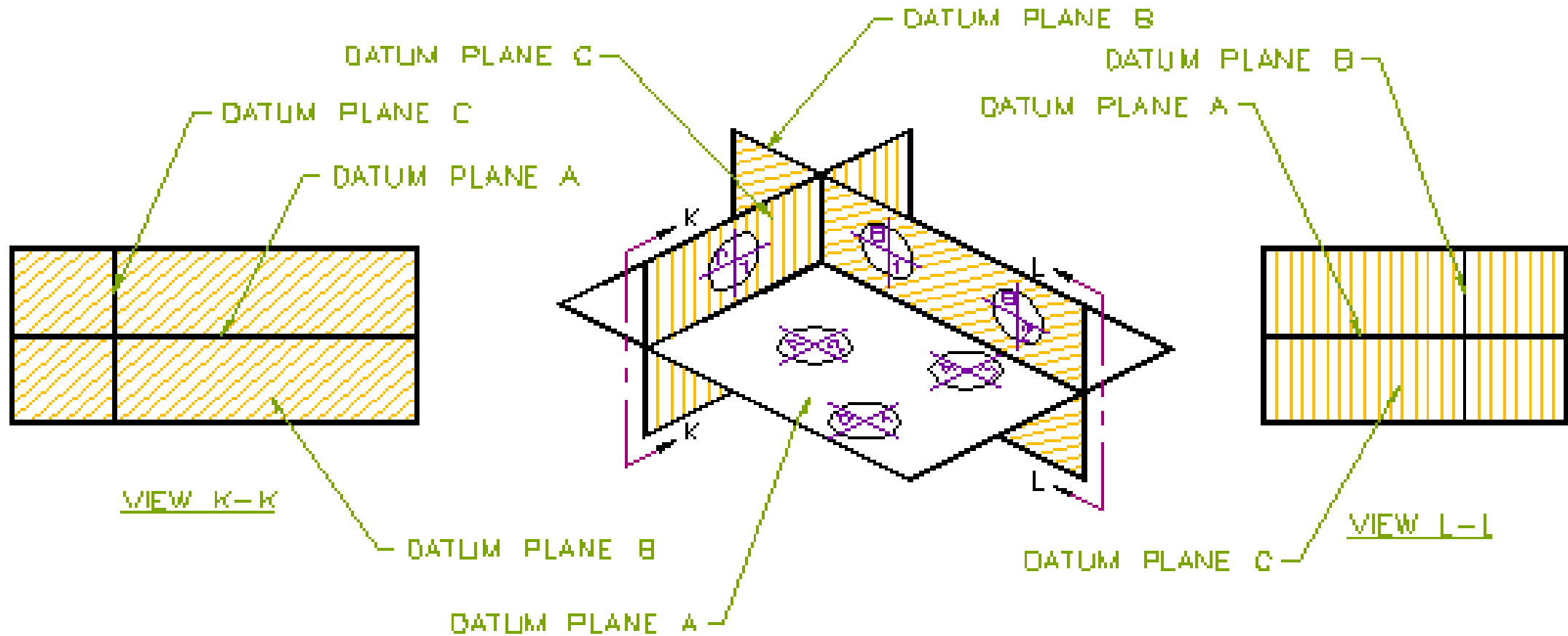
Tooling Cost



Tooling Lead Times



Target Zones for Cast to Machine Datums



Commonly referred to as 3-2-1 Datum structure

Trade Organizations

NADCA - North American Die Casting Association



DDC - Diecasting Development Council

AA - The Aluminum Association

ICI - Investment Casting Institute



AFS - American Foundrymen Society



SME - Society of Manufacturing Engineers



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