

Lecture #13

ERDM

Prof. John W. Sutherland

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The Product Design Process

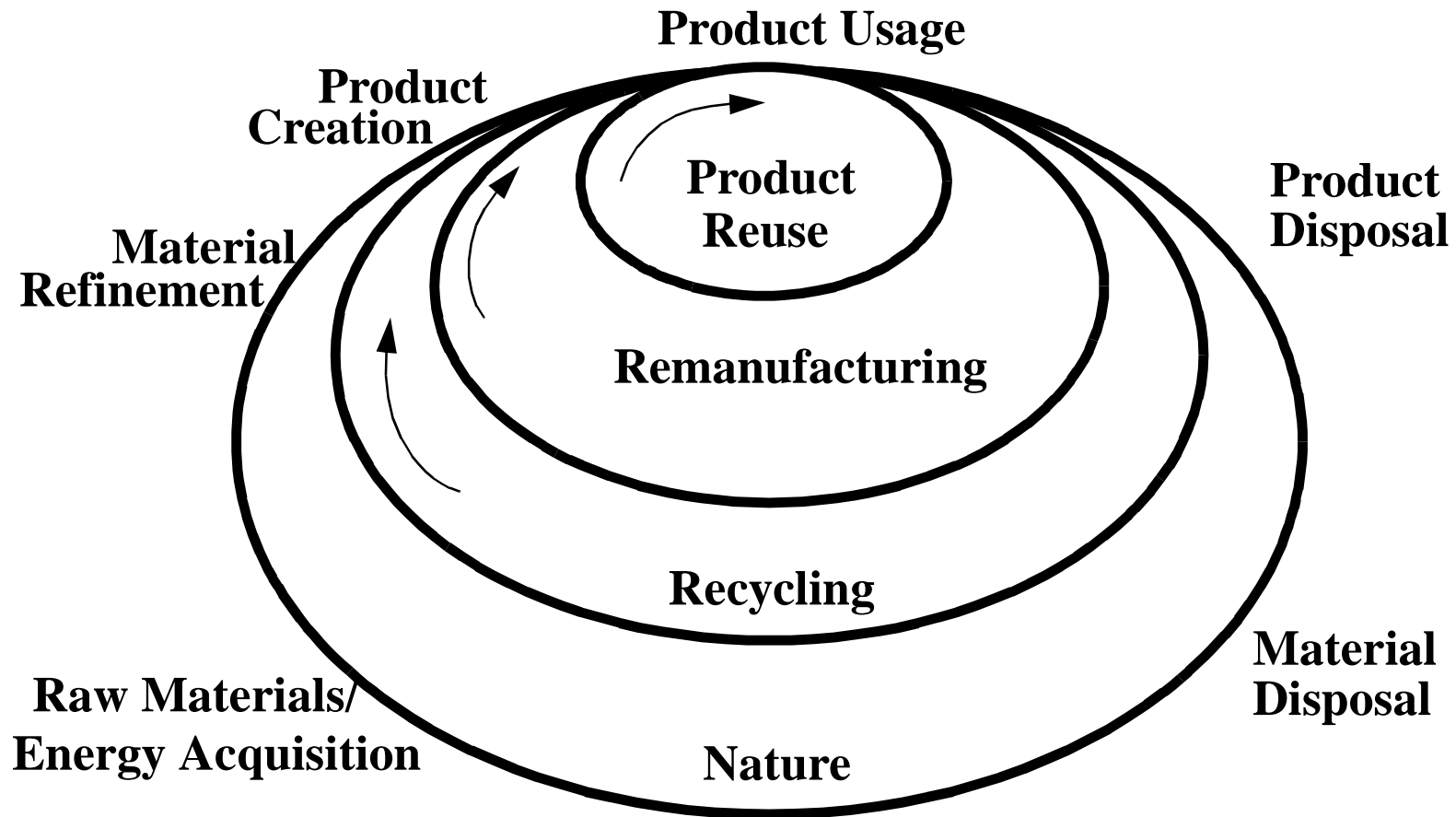
- **Concept Design - System Design**
- **Module definition - Assemblies**
- **Detailed Product Design - Material Type & Features**
- **Detailed Product Design - Dimensions & Tolerances**
- **Prototyping and Testing**

So far....

- **Want to understand how the characteristics of a product design impact the environment**
 - **Material selection issues**
Mining & Metals processing, Plastics
 - **Concept design**
QFD proposed as one way to “hear the voices”:
customer and environment

Next: How does product design geometry influence recycling?

Product Life Cycle



Reuse?

- What promotes it?
- What discourages it?

Remanufacturing?

- What promotes it?
- What discourages it?

Recycling?

- What promotes it?
- What discourages it?

Geometric Features

Focus on a single part (element of a larger product)

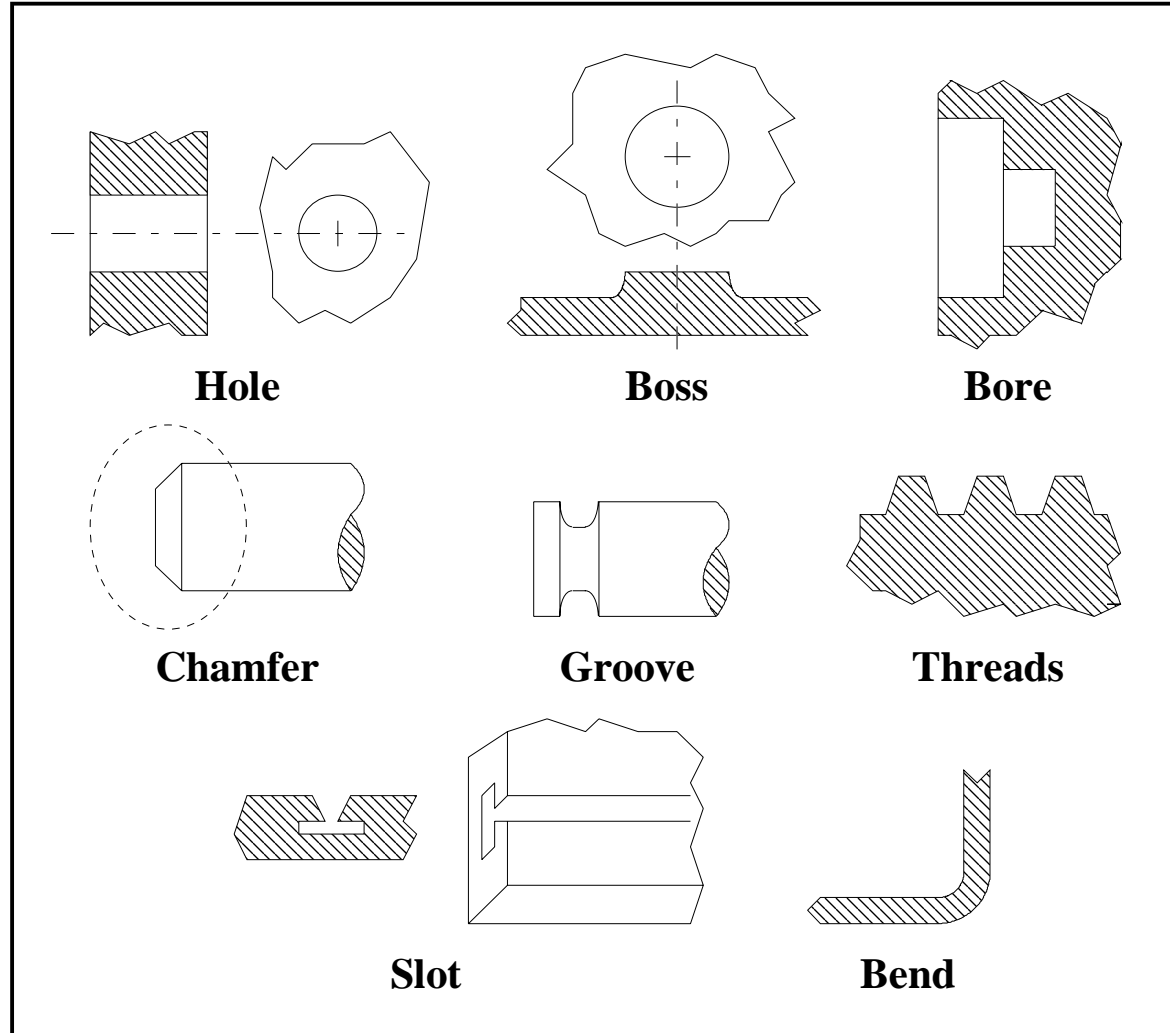
- **Holes**
- **Slots**
- **Threads**
- **Contours**

**In general, the size and shape of a product.
How do these features influence the three R's??**

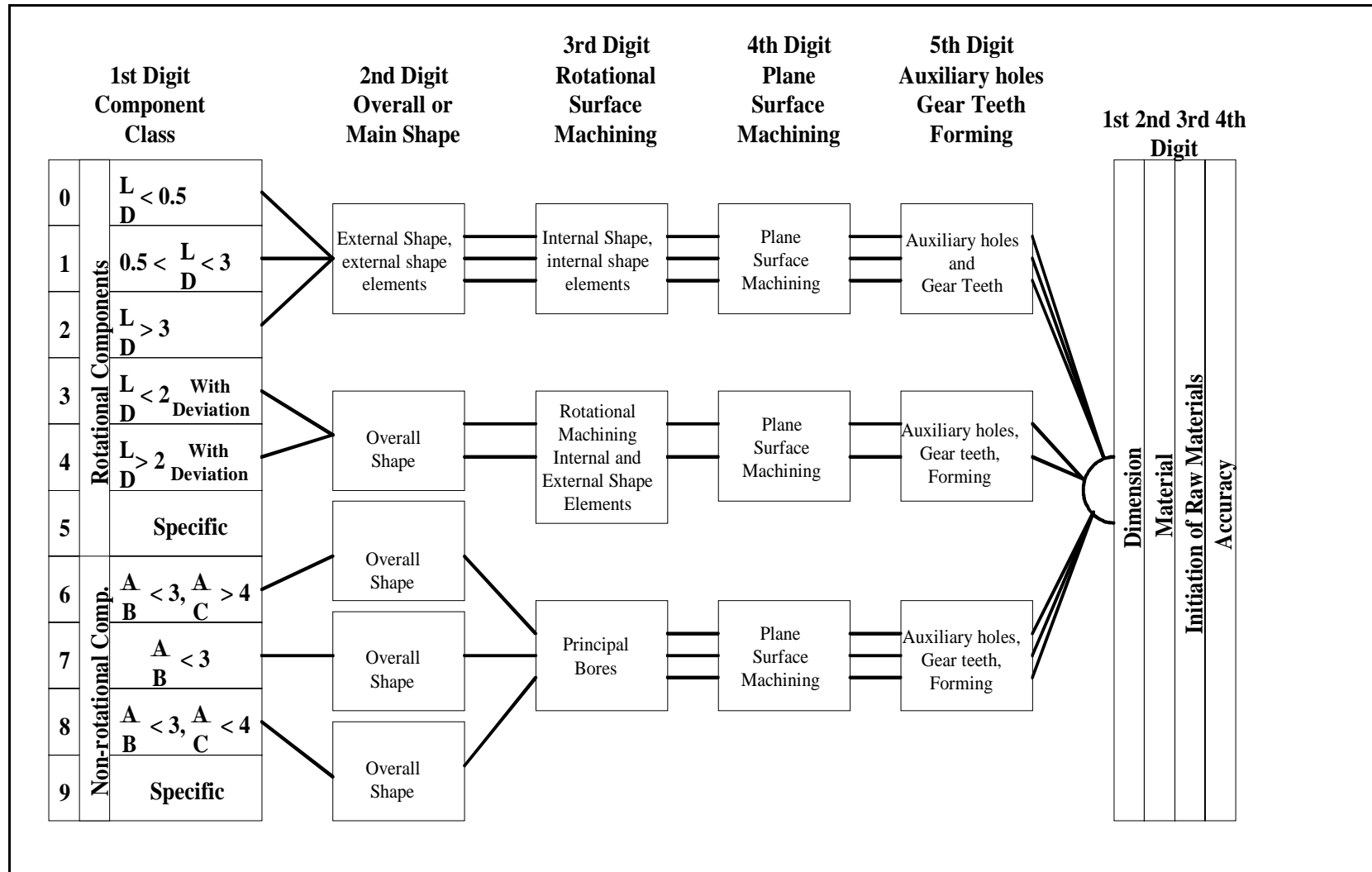
Role of Geometric Features

- Large parts vs. small parts
- Large surface area vs. small
- Complex vs. simple
- Presence of mating / sliding surfaces
- Sections / features that experience high stress

Product Features



Opitz Classification Code



MDSI Code (Manf. Data Sys., Inc.)

MDSI MAJOR DIVISION **1** BASIC CHART CONCENTRICS OTHER THAN PROFILED **1**

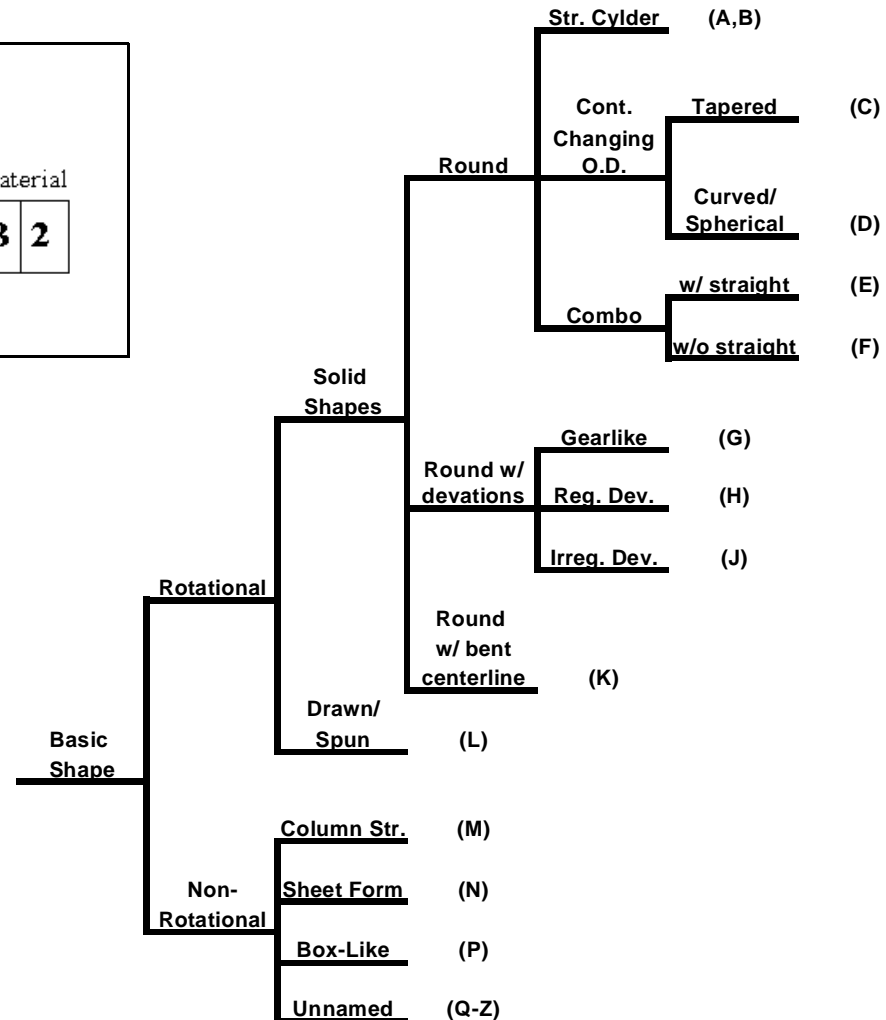
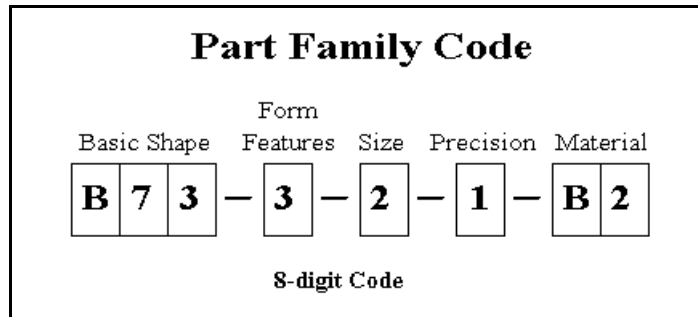
DESCRIPTOR	SECOND	THIRD	FOURTH	FIFTH	SIXTH	SEVENTH		EIGHTH	
	O.D. OR SECTION	CENTER HOLE	HOLES (other than center hole)	GROOVES THREADS	MISCELLANEOUS	MAX O.D. (8) or section across flats		MAX. OVERALL LENGTH	
0	OTHER THAN	OTHER THAN	OTHER THAN OR NONE	OTHER THAN OR NONE	OTHER THAN OR NONE	NONE		NONE	
1	CYLINDER single	NONE	LONGITUDINAL other than bolt circle	GROOVE (S) external	CONCENTRIC VARIATIONS	1	.10	1	1.00
2	CYLINDER multi concave	SINGLE I.D. thru going	RADIAL round	GROOVE (S) internal	PROTRUSION (S) from main shape	2	.10	2	1.60
3	CYLINDER multi convex	SINGLE I.D. blind	1 & 2	1 & 2	1 & 2	3	.16	3	1.60
4	CYLINDER multi conical	SINGLE I.D. thru going threaded	RADIAL other than round	GROOVE (S) on face (S)	SLOT (S)		.27		
5	CYLINDER multi variable	SINGLE I.D. blind threaded	1 & 4	1 & 5					
6	CONE single	MULTI I.D. thru going	2						
7	CONE multi-concave	MULTI I.D. blind							
8	DOUBLE-CONVEX	MULTI I.D. thru going threaded	BOLT CIRCLE min. two holes or slots	THREADS on O.D.	FLAT (S) hex, tri-lobe, square, D, etc.				
9	SPHERICAL PORTION	MULTI I.D. blind							
A	CYLINDER max section transverse								

4.40 5 7.20
 111.76 182.88

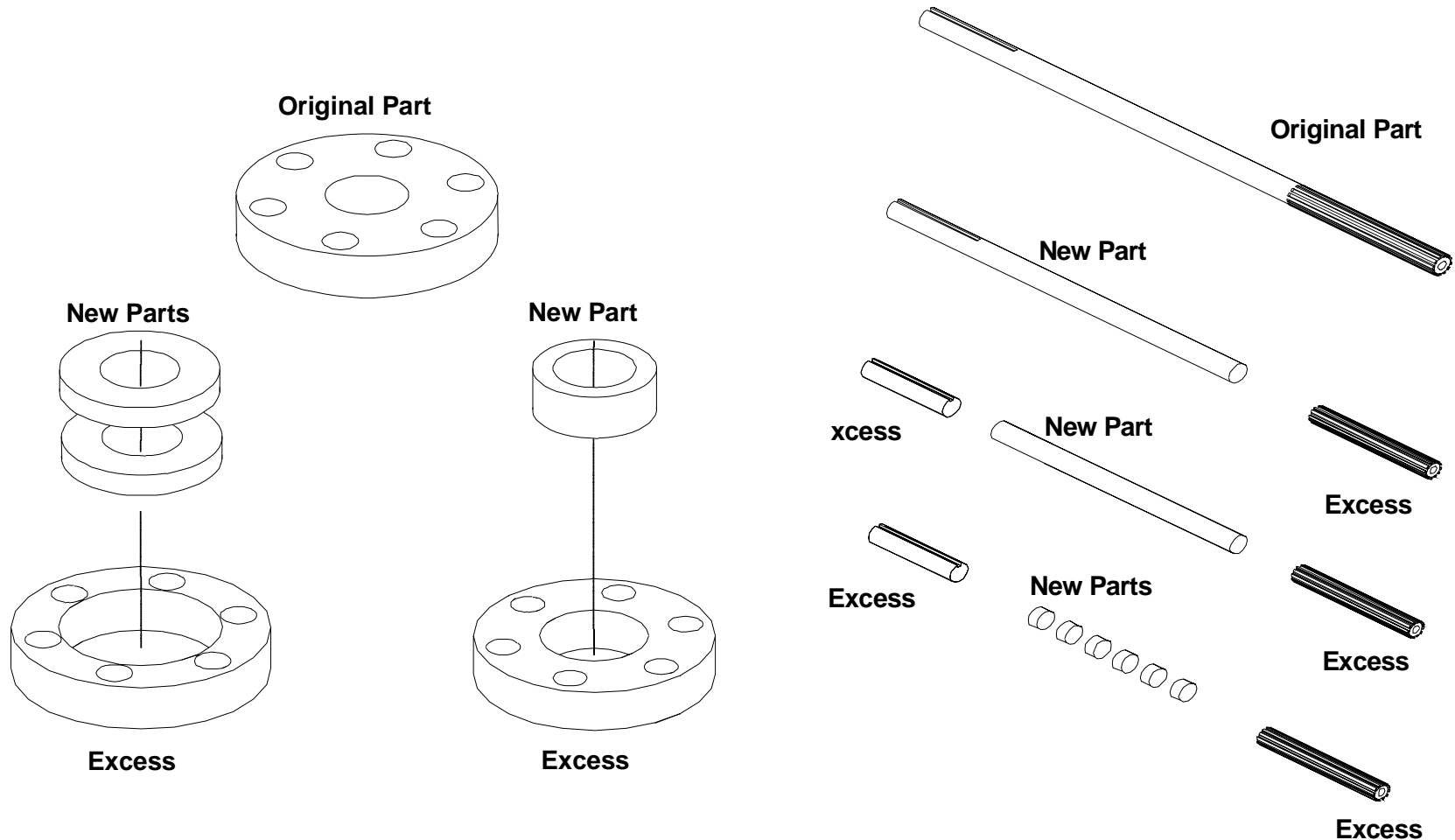
1.20 2.00
 30.48 50.80

13188D75

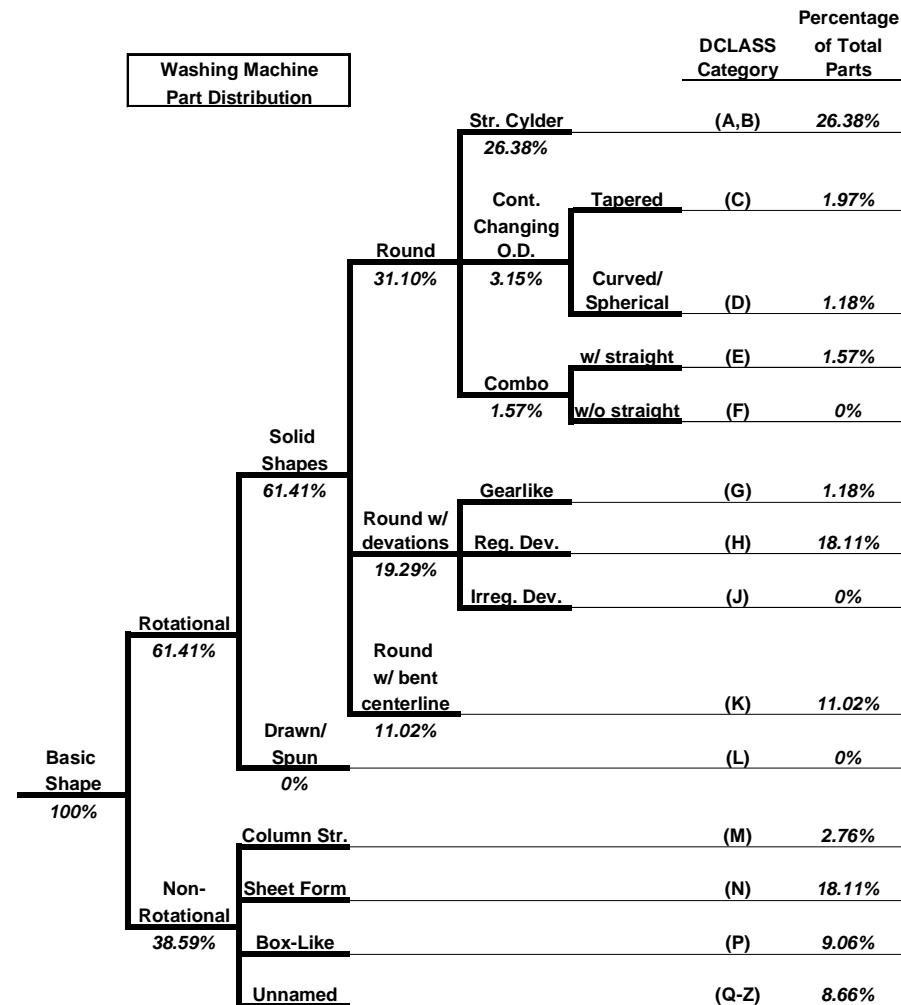
D-Class Code



Post-use Alternatives



Washing Machine



RPI - Reprocessability Index System (Wentland)

Focus on Rotational Parts

Product	Number of Parts	Rotational Parts %
Washing Mach.	254	61%
Cordless Drill	53	60%
Automotive Jack	122	80%
Electric Drill	79	68%
Utility Engine	188	68%

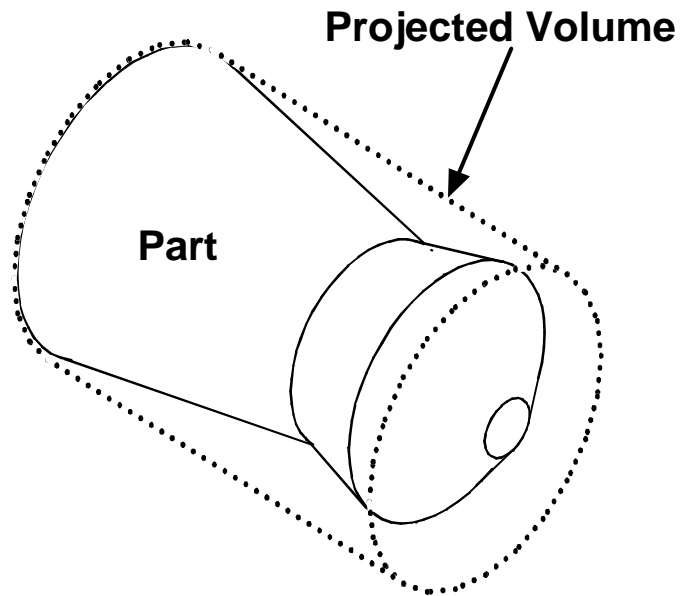
RPI Philosophy

Define metrics that, when small, are more likely result in product post-use. Metrics for the following

- **Part complexity (more complex is bad)**
- **Part size (smaller parts are bad)**
- **Removable features (preferred)**
- **Relative stress level (low stress -- less damage?)**
- **Amount of mating (moving) contact areas (minimize)**

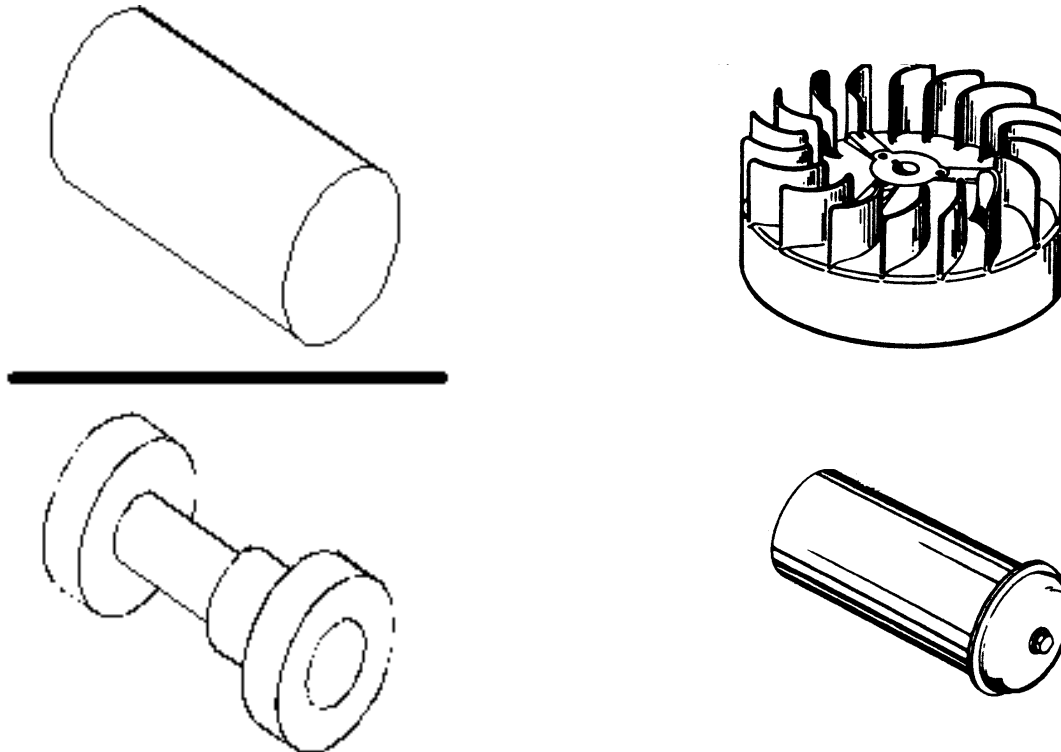
Definition of RPI Terms

$$R_1 = \frac{\text{Volume of Bounding Volume}}{\text{Part Volume}} = \frac{V_{BV}}{V}$$



RPI Terms - 2

$$R_2 = \frac{\text{Surface Area}}{\text{Surface Area of Bounding Volume}} = \frac{SA}{SA_{BV}}$$



RPI Terms - 3

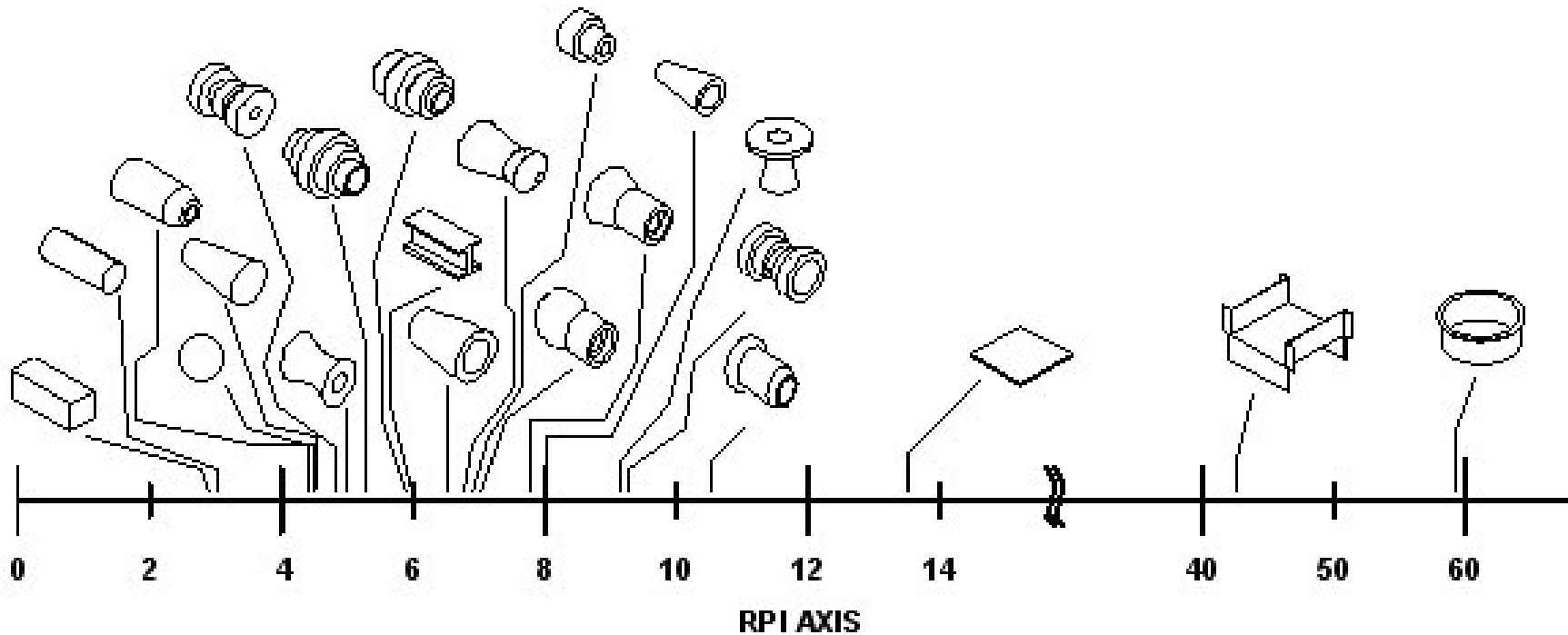
4 other terms to consider other factors

$$RPI = \sum R_i$$

Want to minimize RPI

RPI calculation linked to AutoCAD

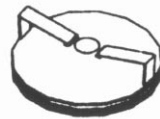
D-Class Parts



Washing Machine Parts



Washer
RPI = 10.18



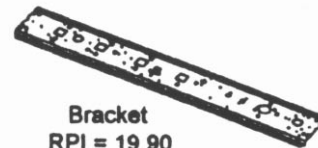
Cap
RPI = 19.92



Retaining Ring
RPI = 319.59



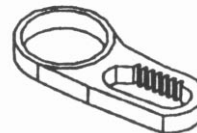
Shaft
RPI = 5.80



Bracket
RPI = 19.90



Coupling
RPI = 10.35



Rack
RPI = 9.94



Screw
RPI = 447.24

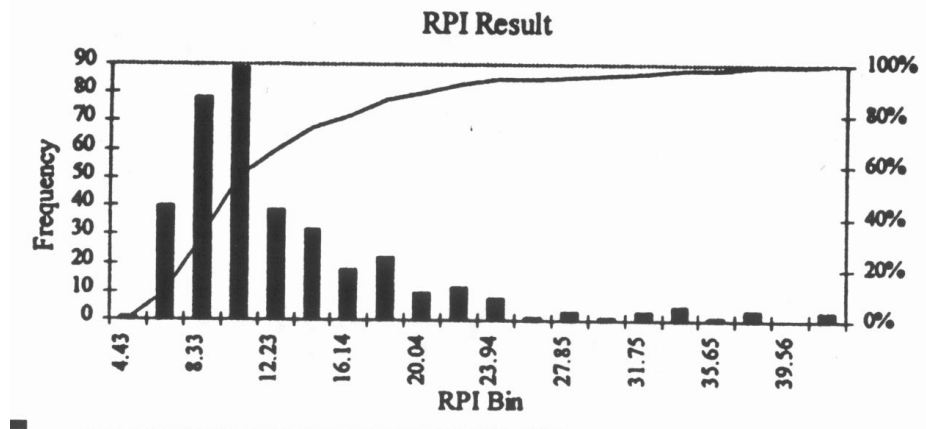
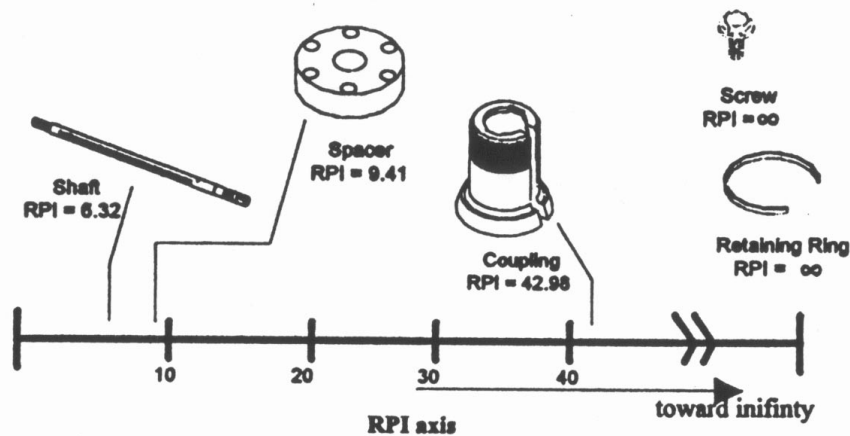


Edging Strip
RPI = 13.82



Hose
RPI = 8.24

Washing Machine Parts - 2



Another Example

