GROUP TECHNOLOGY

THE GROUPING TOGETHER OF PARTS OR PRODUCTS INTO FAMILIES BY PROCESSING OPERATIONS SO THAT ALL MEMBERS OF A FAMILY ARE PROCESSED IN A MINIATURE FACTORY CALLED A CELL.

GROUP TECHNOLOGY REFERENCES

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10. “Production Flow Analysis For Planning Group Technology," by John L. Burbidge, Clarendon Press, Oxford, 1989.

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GROUP TECHNOLOGY

THE LOGICAL ARRANGEMENT AND SEQUENCE OF ALL FACETS OF COMPANY OPERATION IN ORDER TO BRING THE BENEFITS OF MASS PRODUCTION TO HIGH VARIETY, MIXED QUANTITY PRODUCTION

from Ranson (1972)

KEY CHARACTERISTICS OF A GROUP TECHNOLOGY SYSTEM

1. COMPONENTS CLASSIFIED INTO FAMILIES

2. WORK LOADS ARE BALANCED BETWEEN PRODUCTION GROUPS

3. PRODUCTION GROUPS ARE CLEARLY IDENTIFIABLE ON THE SHOP FLOOR

4. EACH GROUP WORKS WITH A SIGNIFICANT DEGREE OF AUTONOMY

CELLS FACILITATE RAPID FLOW AND EFFICIENT PROCESSING OF MATERIAL AND INFORMATION

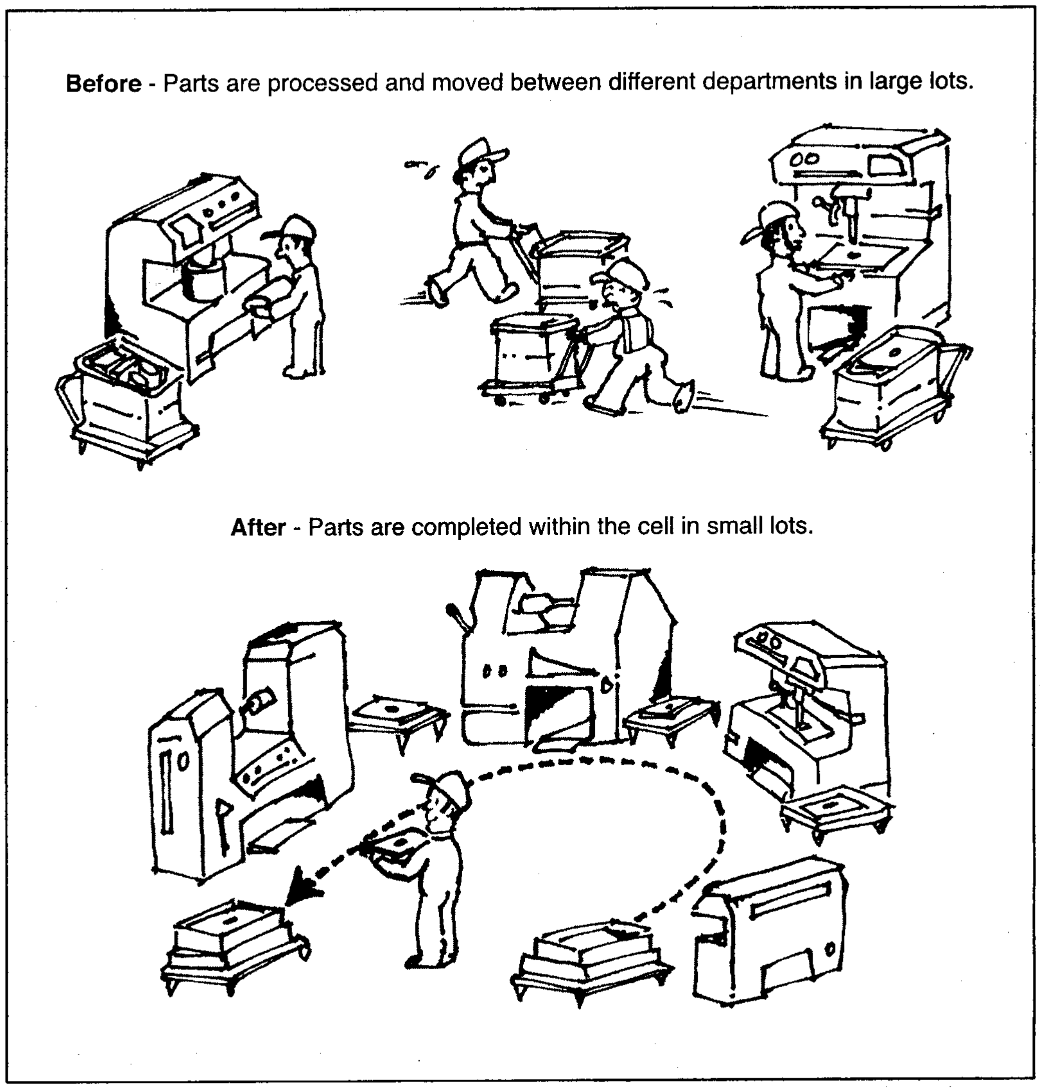


Figure 1-1. Before and after cellular manufacturing

from Hyer and Wemmerlov (2002)

REPORTED PERFORMANCE RESULTS FROM CELLULAR MANUFACTURING IMPLEMENTATIONS

Table 1-1. Reported performance results from cellular manufacturing implementations

	Wemmerlöv and Johnson (1997)—46 Firms			Wemmerlöv and Hyer (1989)—32 Firms		
Performance measure	Average Improvement	Minimum Improvement	Maximum Improvement	Average Improvement	Minimum Improvement	Maximum Improvement
Reduction of move distances/move times	61.3%	15.0%	99.0%	39.3%	10.0%	83.0%
Reduction in throughput time	61.2	12.5	99.5	45.6	5.0	90.0
Reduction in response time to customer orders	50.1	0.0	93.2	–	–	–
Reduction in WIP inventory	48.2	10.0	99.7	41.4	8.0	80.0
Reduction in setup times	44.2	0.0	96.6	32.0	2.0	95.0
Reduction in finished goods inventory	39.3	0.0	100.0	29.2	10.0	75.0
Improvement in part/product quality	28.4	0.0	62.5	29.6	5.0	90.0
Reduction in unit costs	16.0	0.0	60.0	–	–	–

Note: missing entries in the Wemmerlöv and Hyer (1989) data indicate that responses are not available.

from Hyer and Wemmerlov (2002)

GROUP TECHNOLOGY

A TECHNIQUE FOR MANUFACTURING (1) SMALL TO MEDIUM LOT SIZE BATCHES (2) OF PARTS OF SIMILAR PROCESS,
(3) OF SOMEWHAT DISSIMILAR MATERIALS, GEOMETRY, AND SIZE,
(4) WHICH ARE PRODUCED IN A COMMITTED SMALL CELL OF MACHINES WHICH HAVE BEEN GROUPED TOGETHER PHYSICALLY,
(5) SPECIFICALLY TOOLED, AND (6) SCHEDULED AS A UNIT.

from Hyde (1981)

WAYS TO GROUP PRODUCTS

Table 5-2. Nine different ways to group products

Criteria for Identifying Product Families	Examples
1. **Product type.** Group products of the same type or function into families.	Motors and generators.
2. **Market.** Group all products sold in a certain geographical market in one family.	North America, Europe; market segmentation can also be based on type of user, e.g., commercial vs. residential user.
3. **Customers.** Group all products sold to one or more customers in the same family.	The products for two dominant customers make up two families, the rest of the products a third family; this segmentation does not work if several customers purchase the same products.
4. **Degree of customer contact.** Group products according to the degree of influence the customer has on the final product.	Group all stocked items in one family, all made to order in another, etc.
5. **Volume range.** Group products with similar volume ranges into the same families.	High-volume vs. low-volume products.
6. **Order stream.** Group products with similar customer order patterns in same families.	Large and repetitive orders in one family, small and irregularly placed order in another.
7. **Competitive basis.** Allocate all products that compete on the same basis to the same family.	Those competing on cost and speed to one family, those competing on customized design to another.
8. **Process type.** Group products or parts requiring similar processes in the same families.	All assembled products in one family, all non-assembled products in another, etc.; within each group, products with similar routings form a family.
9. **Product characteristics.** Group products with same physical features or raw material into families.	Large vs. small, light vs. heavy, etc.

from Hyer and Wemmerlov (2002)

SIMILAR PARTS BASED ON MANUFACTURING PROCESS

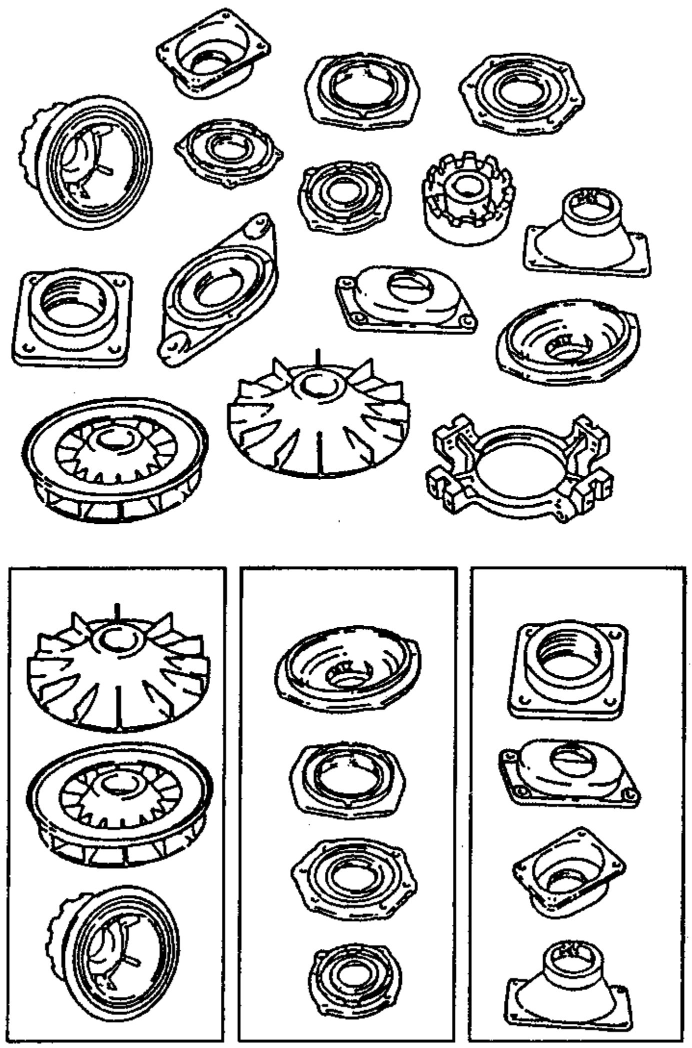
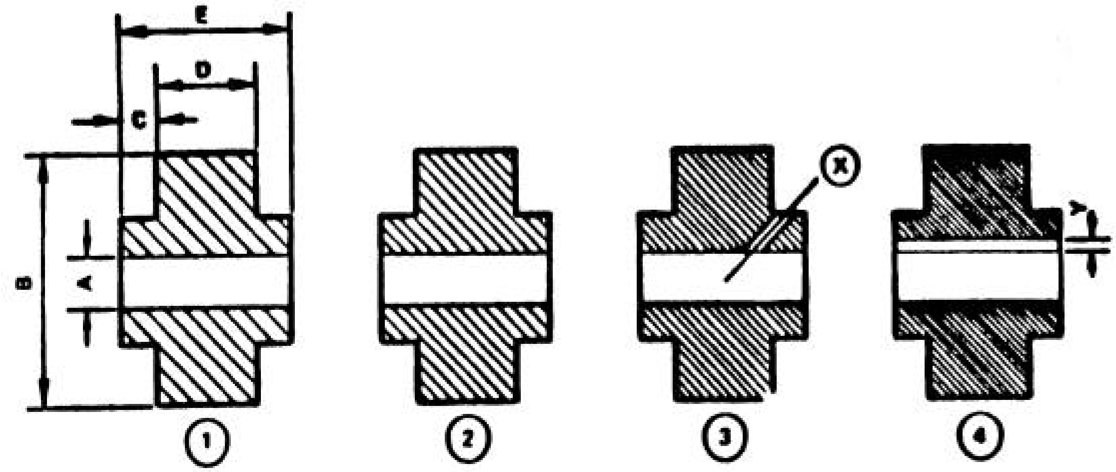


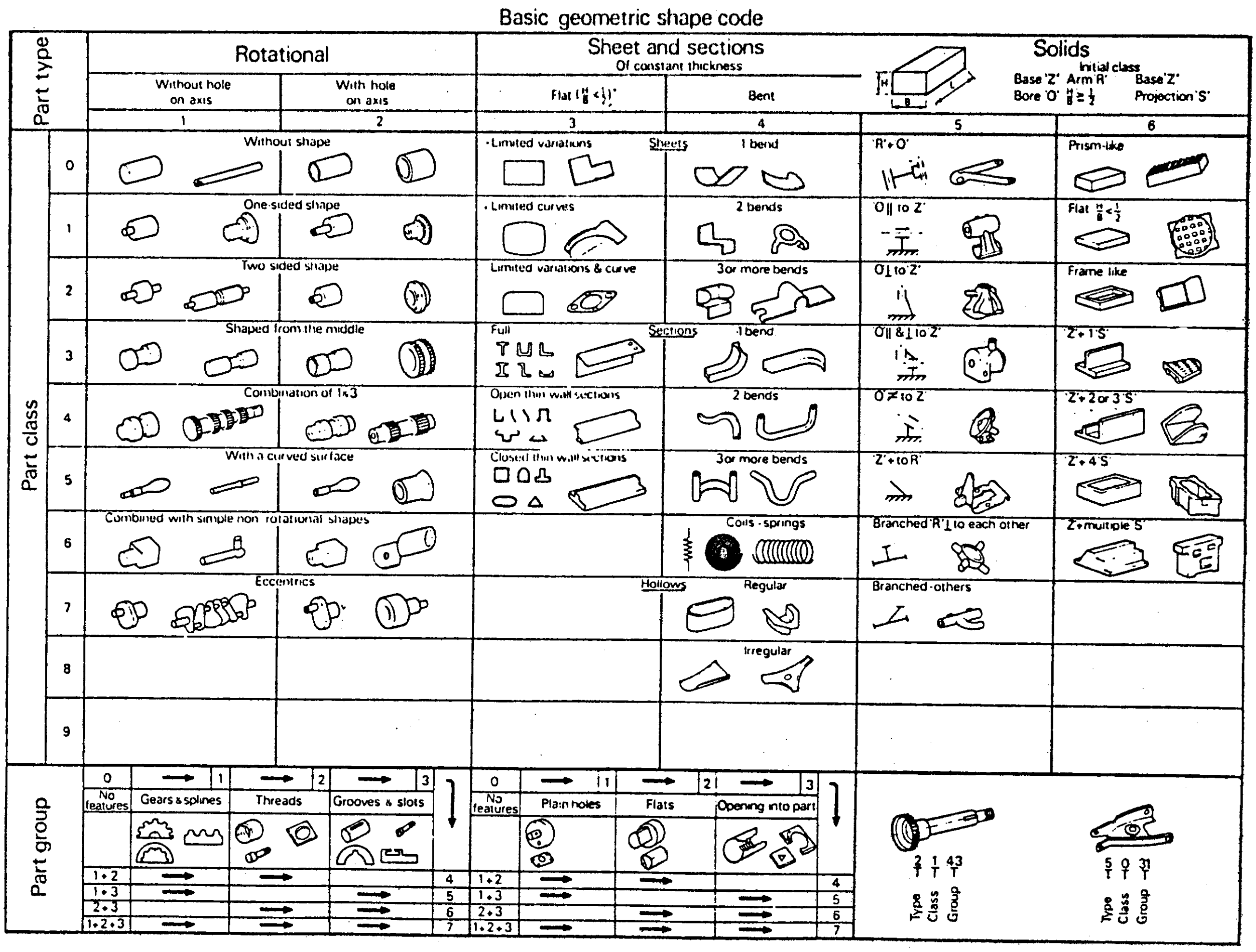
Figure 6-3. A product family and subfamilies with greater internal similarities

from Hyer and Wemmerlov (2002)

Similar Parts Based on Shape

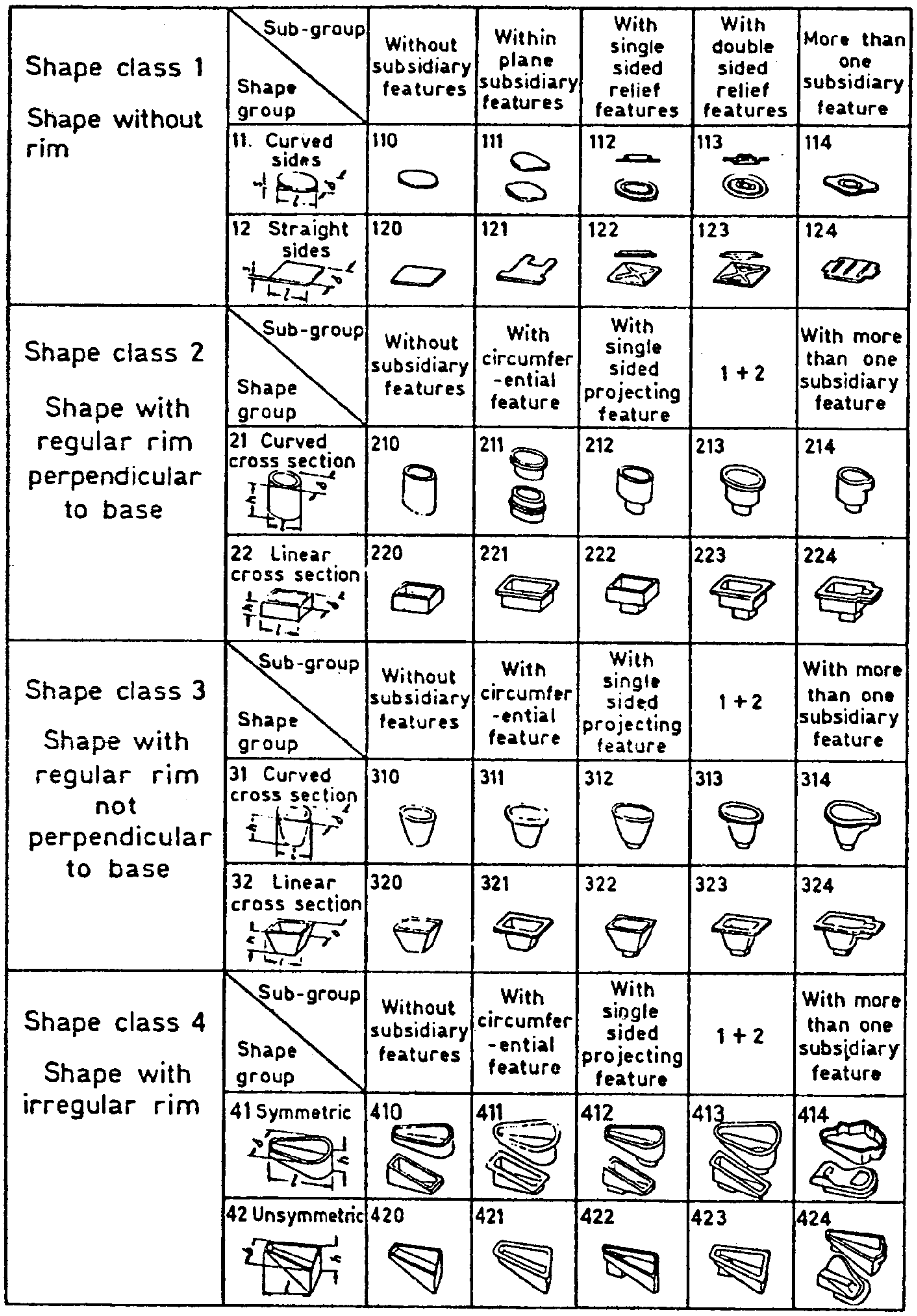


PART CLASSIFICATION BY SHAPE



VUSTE System

PART CLASSIFICATION BY SHAPE



Shape class	Sub-group / Shape group					
Shape class 1 Shape without rim	Sub-group / Shape group	Without subsidiary features	Within plane subsidiary features	With single sided relief features	With double sided relief features	More than one subsidiary feature
	11. Curved sides	110	111	112	113	114
	12 Straight sides	120	121	122	123	124
Shape class 2 Shape with regular rim perpendicular to base	Sub-group / Shape group	Without subsidiary features	With circumfer-ential feature	With single sided projecting feature	1 + 2	With more than one subsidiary feature
	21 Curved cross section	210	211	212	213	214
	22 Linear cross section	220	221	222	223	224
Shape class 3 Shape with regular rim not perpendicular to base	Sub-group / Shape group	Without subsidiary features	With circumfer-ential feature	With single sided projecting feature	1 + 2	With more than one subsidiary feature
	31 Curved cross section	310	311	312	313	314
	32 Linear cross section	320	321	322	323	324
Shape class 4 Shape with irregular rim	Sub-group / Shape group	Without subsidiary features	With circumfer-ential feature	With single sided projecting feature	1 + 2	With more than one subsidiary feature
	41 Symmetric	410	411	412	413	414
	42 Unsymmetric	420	421	422	423	424

Puchmann Sheet Metal Part Classification

CLASSIFICATION BY SHAPE AND PROCESS

PPFM NO.	PIPE PIECE FAMILY		SKETCH
01	Straight	≦ 50mm	
04	Straight	65∿200mm	
07	Straight	≧ 250mm	
11	Bent After Fabrication	≦ 50mm	
14	Bent After Fabrication	65∿200mm	
21	Radiographic tested		
24	Hydrostatic tested	≧ 40 kg/cm^2	
27	Hydrostatic tested	< 40 kg/cm^2	
31	Plastic		
34	Bent by heating		
41	Bent Before Fabrication	≦ 50mm	
44	Bent Before Fabrication	65∿200mm	
51	Assembled	≦ 50mm	
54	Assembled	65∿200mm	
57	Assembled	≧ 250mm	

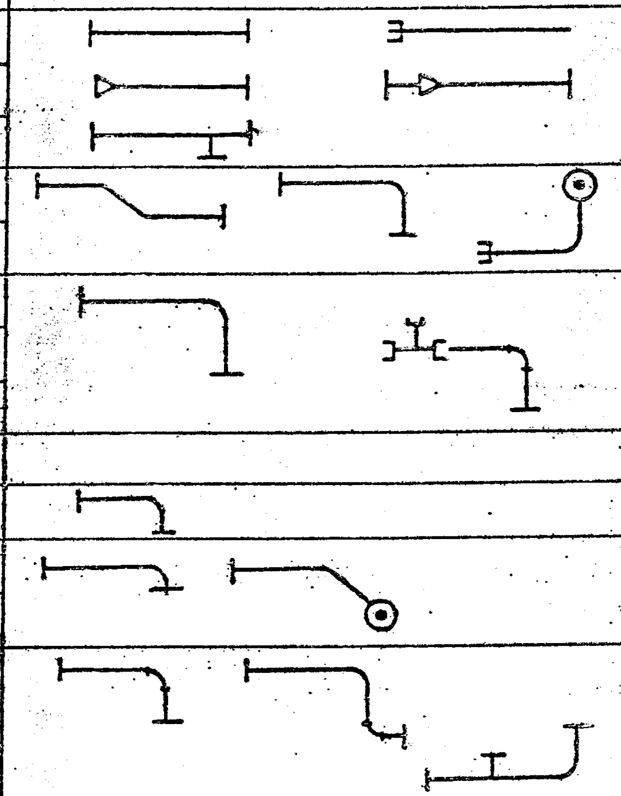


Figure 1-11: Typical Pipe Piece Families. Maximizing the relative number of straight pipe pieces ensures higher productivity. For necessary bends, the fitting man-hours for pipe pieces that are cold-bent after fabrication are one-third that required for pipe pieces with fitted ells. Pipe shop productivity depends on designers' knowledge of manufacturing methods and costs. More pipe-piece family classifications are included in Appendix A.

POLYCODE SYSTEM

	1st Digit: component class	2nd Digit: External shape, external shape elements	3rd Digit: Internal shape, internal shape elements	4th Digit: Surface machining	5th Digit: Auxiliary holes and gear teeth
0	rotational parts: L/D ≤ 0·5	smooth, no shape elements	no hole, no breakthrough	no surface machining	no auxiliary hole
1	rotational parts: 0·5 < L/D < 3	stepped to one end or smooth: no shape elements	smooth or stepped to one end: no shape elements	surface plane and/or curved in one direction, external	no gear teeth: axial, not on pitch circle diameter
2	rotational parts: L/D ≥ 3	stepped to one end or smooth: thread	smooth or stepped to one end: thread	external plane surface related by graduation around a circle	no gear teeth: axial on pitch circle diameter
3	rotational parts	stepped to one end or smooth: functional groove	smooth or stepped to one end: functional groove	external groove and/or slot	no gear teeth: radial, not on pitch circle diameter
4	rotational parts	stepped to both ends: no shape elements	stepped to both ends: no shape elements	external spline (polygon)	no gear teeth: axial and/or radial and/or other direction
5	rotational parts	stepped to both ends: thread	stepped to both ends: thread	external plane surface and/or slot, external spline	no gear teeth: axial and/or radial on PCD and/or other directions
6	non-rotational parts	stepped to both ends: functional groove	stepped to both ends: functional groove	internal plane surface and/or slot	with gear teeth: spur gear teeth
7	non-rotational parts	functional cone	functional cone	internal spline (polygon)	with gear teeth: bevel gear teeth
8	non-rotational parts	operating thread	operating thread	internal and external polygon, groove and/or slot	with gear teeth: other gear teeth
9	non-rotational parts	all others	all others	all others	all others

Main Code

	6th Digit: Diameter D or length of edge A (mm)	7th Digit: Material	8th Digit: Initial shape	9th Digit: Accuracy in coding digit
0	≤ 20	grey cast iron	round bar	no accuracy specified
1	> 20 ≤ 50	nodular graphitic cast iron and malleable cast iron	bright drawn round bar	2
2	> 50 ≤ 100	steel ≤ 42 kg/mm^2 (St-steel)	triangular, square, hexagonal or other bar	3
3	> 100 ≤ 160	steel > 42 kg/mm^2 (C and Ck steel)	tubing	4
4	> 160 ≤ 250	steel 2 + 3 heat-treated	angle, U-, T- and similar sections	5
5	> 250 ≤ 400	alloy steel	sheet	2 + 3
6	> 400 ≤ 600	alloy steel heat-treated	plates and slabs	2 + 4
7	> 600 ≤ 1000	non-ferrous metal	cast or forged component	2 + 5
8	> 1000 ≤ 2000	light alloy	welded group	3 + 4
9	> 2000	other materials	pre-machined component	(2 + 3) + 4 + 5

Supplementary code.

Opitz Code System

CELL

A CELL IS A GROUP OF CLOSELY LOCATED WORKSTATIONS WHERE MULTIPLE, SEQUENTIAL OPERATIONS ARE PERFORMED ON ONE OR MORE FAMILIES OF SIMLIAR RAW MATERIALS, PARTS, COMPONENTS, PRODUCTS, OR INFORMATION CARRIERS. THE CELL IS A DISTINCTIVE ORGANIZATIONAL UNIT WITHIN THE FIRM, STAFFED BY ONE OR MORE EMPLOYEES, ACCOUNTABLE FOR OUTPUT PERFORMANCE, AND DELEGATED THE RESPONSIBILITY OF ONE OR MORE PLANNING, CONTROL, SUPPORT, AND IMPROVEMENT TASKS.

from Hyer and Wemmerlov (2002)

APPROACHES TO CELL FORMATION

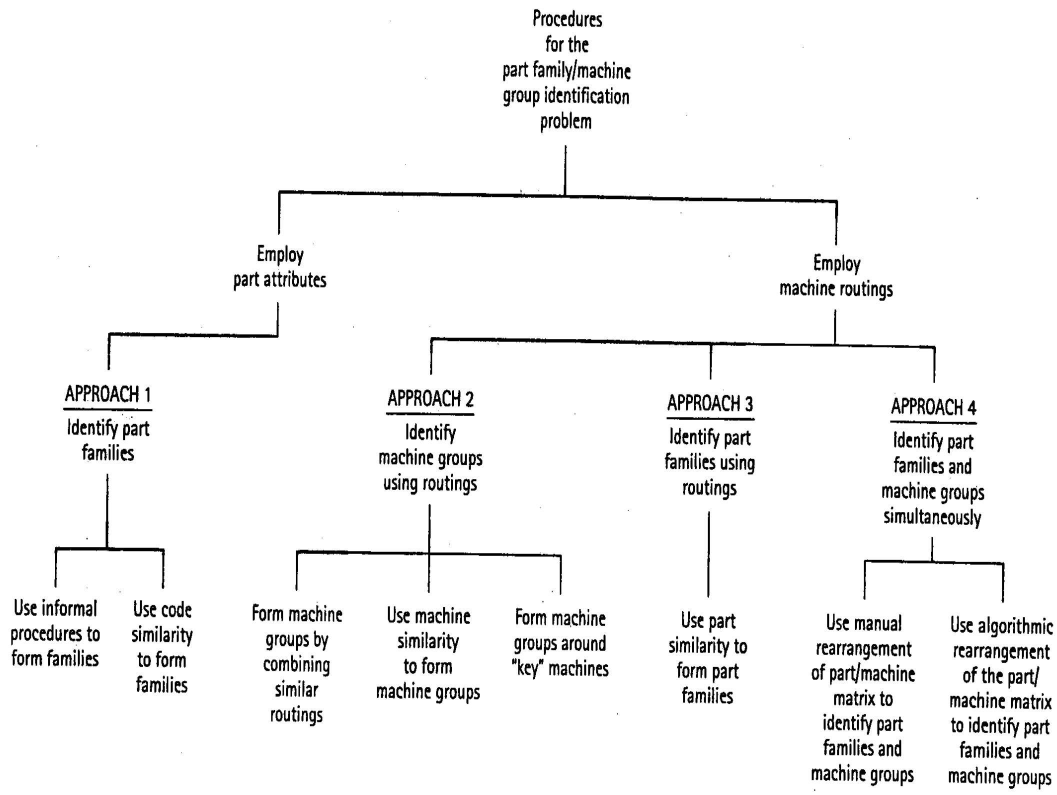


Figure 5-13. Various approaches to cell formation

from Hyer and Wemmerlov (2002)

COMPARISON OF STRAIGHT LINE AND U-SHAPED CELLULAR LAYOUTS

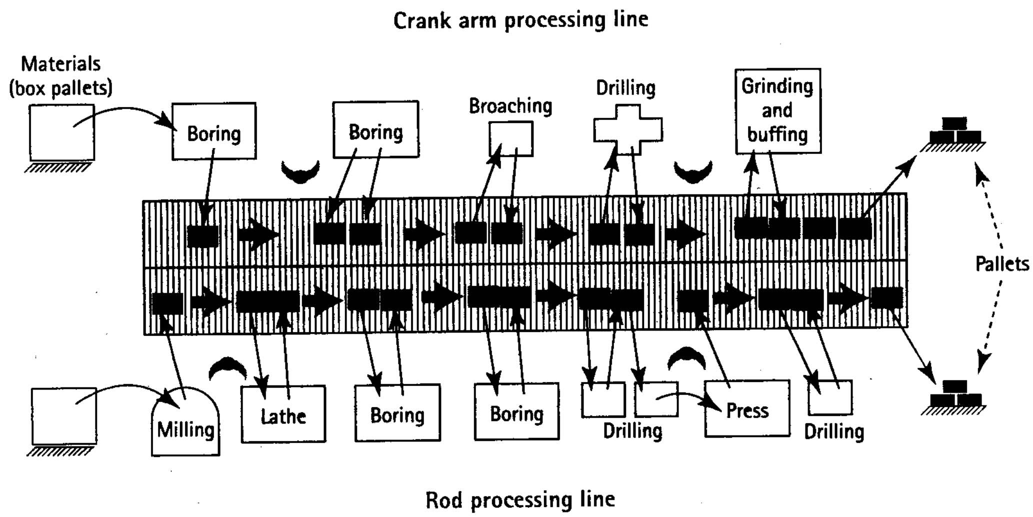


Figure 6-6. Straight station layout

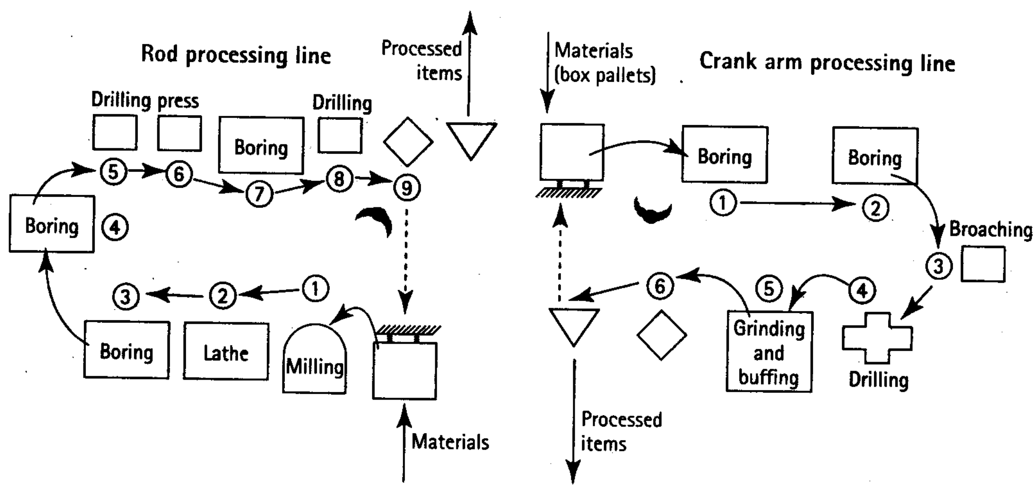


Figure 6-9. U-cells formed from the straight station layout in Figure 6-6

from Hyer and Wemmerlov (2002)

PROBLEMS WITH FUNCTIONAL ORGANIZATION

Table 3–1. Typical problems in functionally organized manufacturing systems

- Material moved long distances
- Material handled many times (in and out of storage)
- Long setups
- Large lot sizes
- High defect rates
- High rates of equipment breakdowns
- Unavailable tooling
- Long manufacturing lead times
- Parts shortages in assembly
- Large inventories
- Divisiveness between operators, supervisors, and support
- Problems with communication, coordination, and scheduling
- Flow of material, and work content, are difficult to simplify and standardize
- Difficulties in identifying cause of defects
- Constant mode of reaction leads to emphasis on control (vs. planning)

In short, functionalized plants often demonstrate long lead times, poor manufacturing quality, high manufacturing costs, fractionalized product responsibilities, and low improvement opportunities.

from Hyer and Wemmerlov (2002)

DESIGNING U-SHAPED CELLS

Table 6-3. Guidelines for designing U-shaped cells

1. Place the workstations as closely as possible to minimize walking distances.
2. Avoid operator walking patterns that cross paths.
3. Position operators so they face outwards.
4. Operators should stand, not sit.
5. Position the workstations so the material moves counterclockwise in the cell.
6. Assign the entry and exit operations to the same operator.
7. Avoid or minimize the use of conveyors in low volume/high variety cells.
8. Rely on one-piece production, one-piece inspection, and one-piece conveyance.

from Hyer and Wemmerlov (2002)

U-SHAPED CELL EXAMPLE

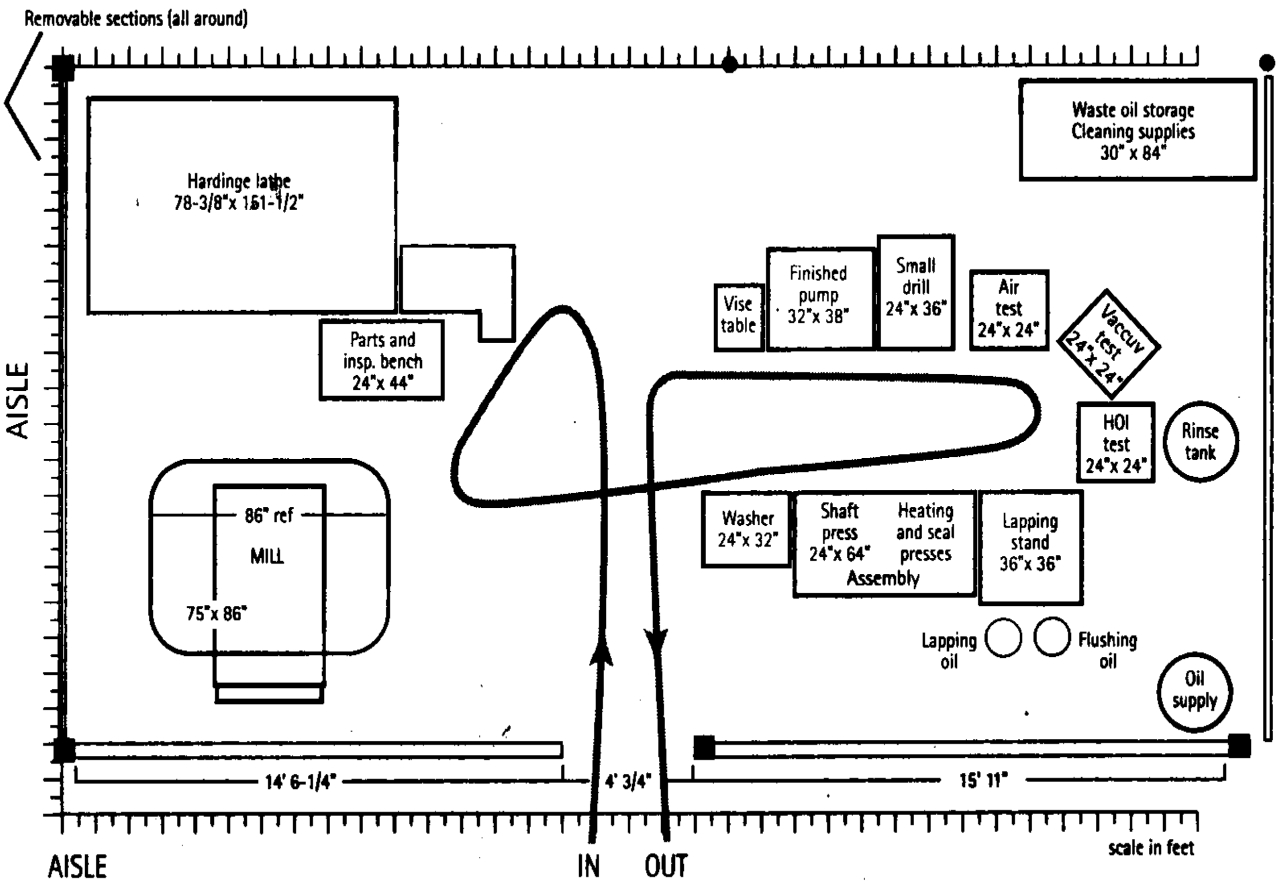


Figure 6-7. U-shaped pump cell at Baker Manufacturing

from Hyer and Wemmerlov (2002)

CELLS DESIGNED FOR FOCUSED FACTORY

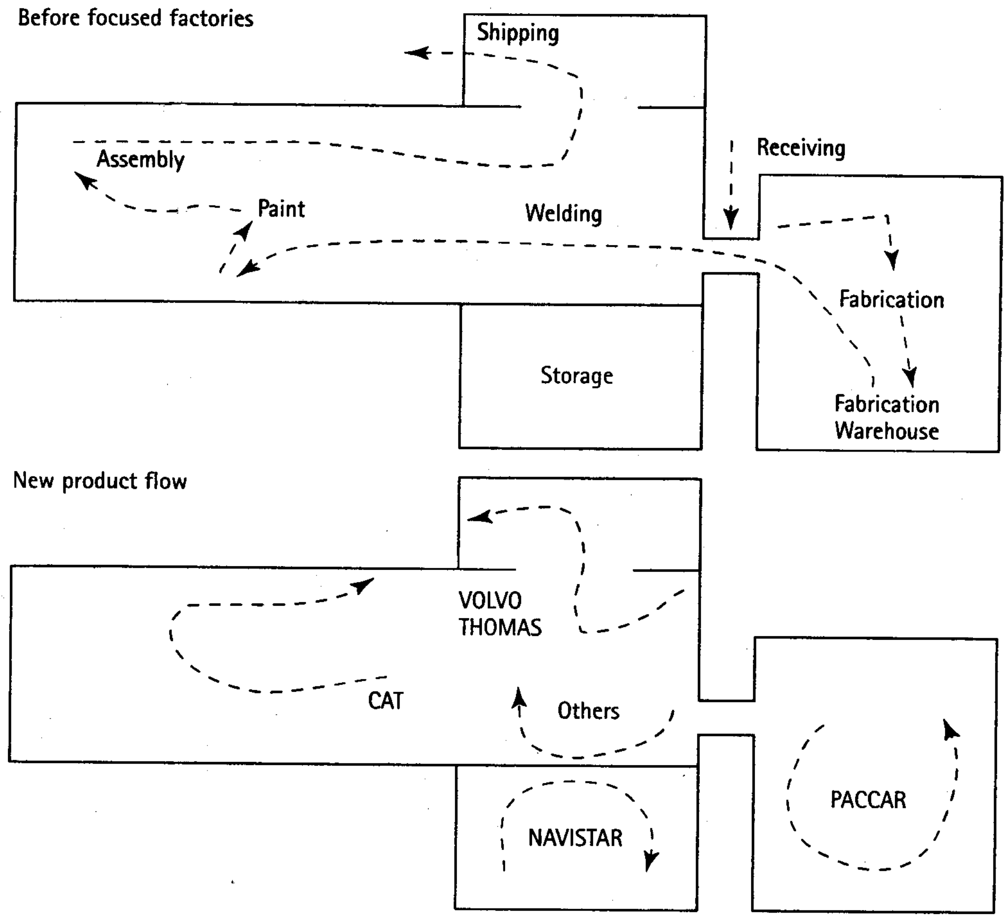


Figure 2-4. Bergstrom Manufacturing's factory organization

from Hyer and Wemmerlov (2002)

IMPROVING FLOW IN CELLS

Table 6-2. Ways to improve flows in cells by modifying the routings

- Group items with identical or highly similar routings
- Standardize raw materials
- Change the sequence between operations
- Reroute the parts or products to different types of equipment
- Eliminate unnecessary operations
- Redesign the parts or products to remove process steps
- Remove parts/products with deviating processes (outliers) from the family

from Hyer and Wemmerlov (2002)

DEVELOPING ASSEMBLY CELLS

1 Does unit complete products, or a major stage in assembly?
NB. Assembly groups normally make their own subassemblies

2 Does team of workers normally stay together?
NB. Redeployment is normally restricted to emergencies and major changes in load

3 Does unit have its own territory?
NB. Preferably the whole area inside one perimeter

4 Is the team small enough to be socially cohesive?

5 Is material flow in the unit continuous?
NB. Not intermittent, or completing one stage on all products, before going on to the next

6 Does the unit regulate its own operations?
NB. At the least its own dispatching

7 Is the unit responsible for its own quality?
NB. May be subject to central quality control

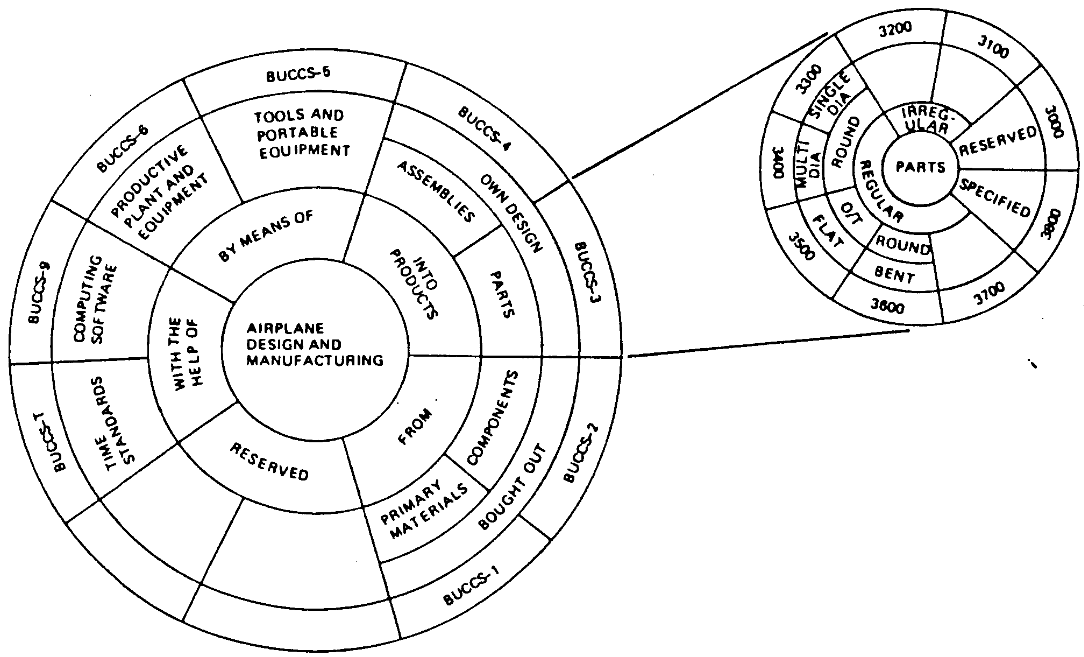
8 Does the unit directly control all the machines and other facilities it uses?

IF THE ANSWER TO ALL QUESTIONS IS YES, THE UNIT IS AN ASSEMBLY GROUP.

FIG. 9.7 Defining an assembly group.

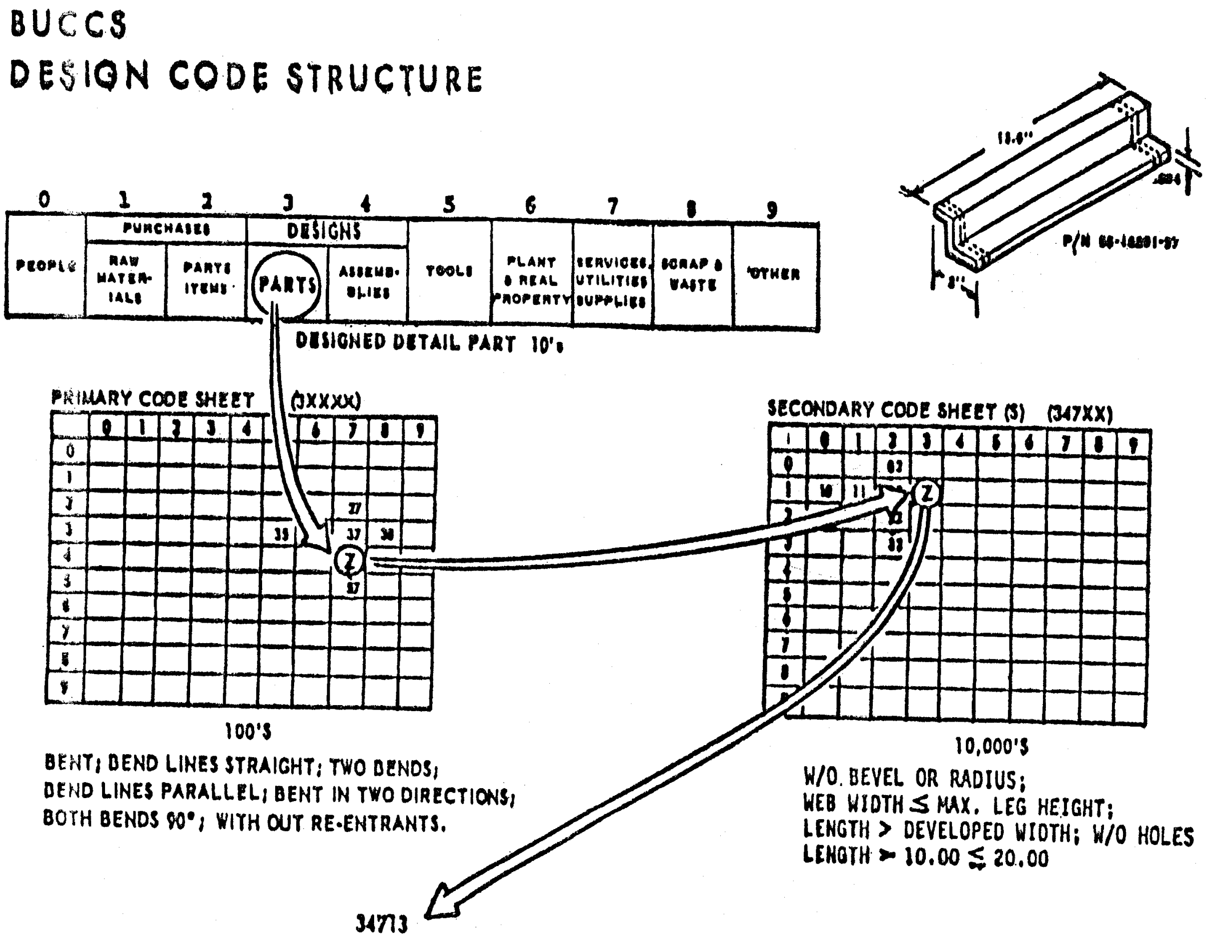
from Burbidge (1989)

COMPANY-WIDE SYSTEM



from Beeby and Thompson (1979)

DESIGN CODE STRUCTURE

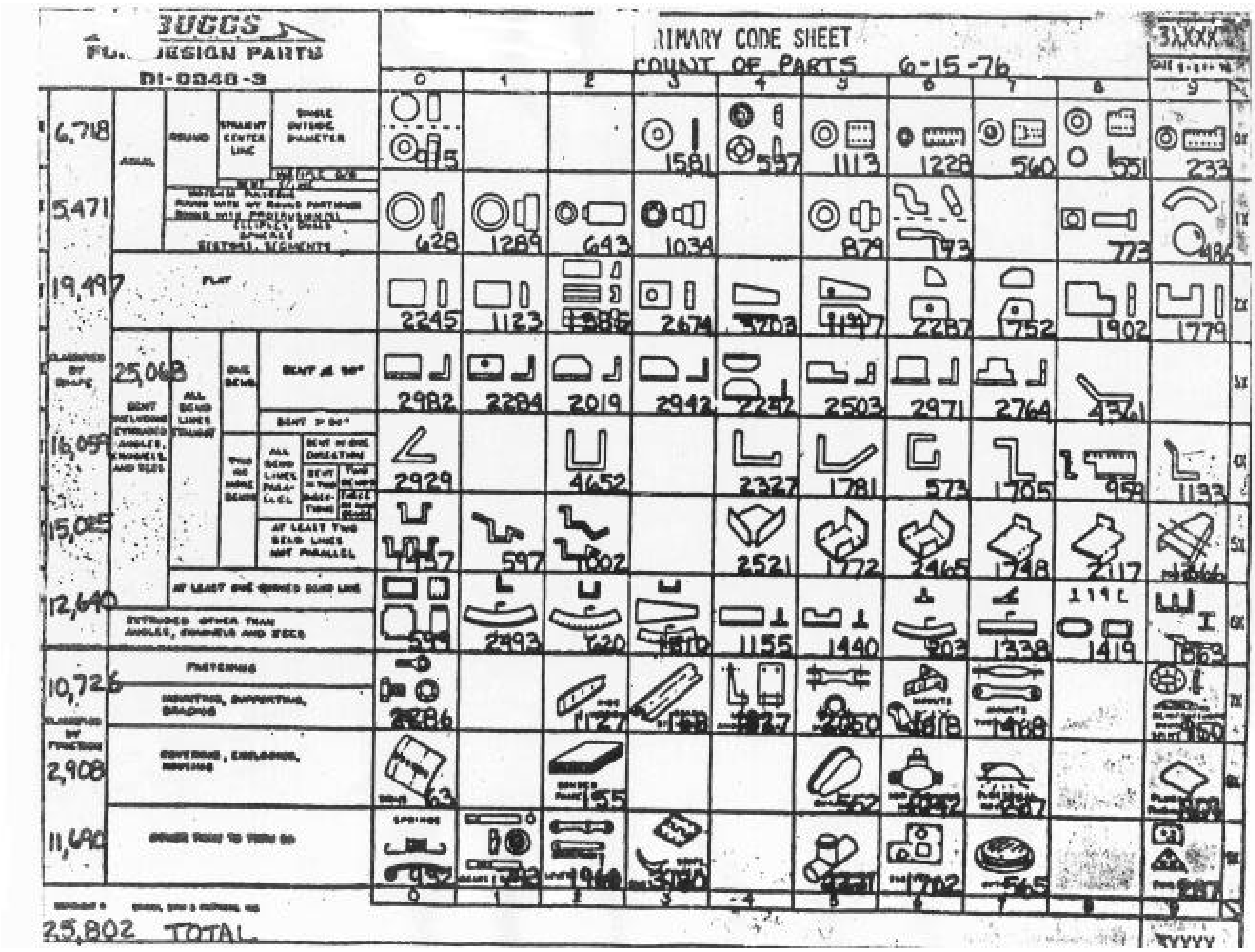


PRIMARY CODE SHEET

BUCCS — FOR RAW MATERIALS D1-8248-1		PRIMARY CODE SHEET									1XXXX OCT 25, 78
Category	**Group**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
PRODUCTION MATERIALS — SPECIFICALLY DEVELOPED	FOR/AS	00 CONTINUOUS HINGE, HINGE PIN, EXPANDED METAL, MESH, GRATING, FLOOR PLATE HONEYCOMB	01 SURFACE PREPARATION, TREATMENT, FINISHING	02 ADHESIVE TAPE, FASTENING DEVICES, COMPOUNDS, ADHESIVES, AND SEALANTS	03 HYDRAULIC FLUIDS, LUBRICANTS, COOLANTS	04 ELECTRIC CONDUCTORS, EMI/RFI SHIELDING PERMEABLE MATERIALS	05 CARPET, CARPET UNDERLAY PAD, FLOOR COVER, DRAPERY FABRICS	06 MECH CONTROL CABLES, CHAIN HYDRAULICS, HOSES AND FILTERS STOCK	07 THREAD, ROPE, CORD, TWINE	08	09 INDUSTRIAL CHEMICALS 101XX/103XX
PRODUCTION MATERIALS — NOT SPECIFICALLY DEVELOPED — METALLIC ONLY — BASE — IRON, STEEL	FLAT, ROUND, HEXAGON SECTIONS	10 IRON, CARBON STEEL, HIGH STRENGTH LOW ALLOY AND CONSTRUCTION STEEL	11 CORROSION, HEAT AND CREEP RESISTANT STEELS — SECTION: SOLID FLAT SOLID ROUND	12 CORROSION, HEAT AND CREEP RESISTANT STEELS — SECTION: OTHER THAN 111XX	13	14	15	16	17 OTHER THAN 110XX/116XX	18 CORROSION, HEAT AND CREEP RESISTANT STEELS	19 OTHER THAN 118XX
PRODUCTION MATERIALS — NOT SPECIFICALLY DEVELOPED — METALLIC ONLY — BASE — ALUMINUM	EXTRUDED SHAPES OTHER THAN 120XX (23–28); WITHOUT BULB PORTION(S) OR FULLY ENCLOSED PORTION(S) — EXTREMITIES (23–27)	20 SOLID AND TUBULAR SECTIONS: RECTANGULAR ROUND HEXAGONAL NOTE	21 FORMED SECTIONS OTHER THAN 120XX	22	23 TWO, WITH ONE MEMBER INCLUDING FILLERS	24 TWO, WITH TWO OR MORE MEMBERS INCLUDING ANGLES, CHANNELS, ZEES AND HATS	25 THREE OR FOUR INCLUDING T, J, I, AND H SECTIONS	26 FIVE OR MORE	27	28 WITH BULB PORTION(S) AND/OR FULLY ENCLOSED PORTIONS	29
PRODUCTION MATERIALS — NOT SPECIFICALLY DEVELOPED — METALLIC ONLY — OTHER THAN 11XXX/12XXX	BASE	30 TITANIUM: FLAT, ROUND HEXAGON SECTIONS	31 TITANIUM: SHAPES	32 MAGNESIUM	33 COPPER	34 NICKEL, COBALT, TUNGSTEN	35 LEAD	36	37	38	39 OTHER THAN 130XX/138XX
PRODUCTION MATERIALS — NOT SPECIFICALLY DEVELOPED — NON-METALLIC, METALLIC/NON-METALLIC COMPOSITES	FORMED FLAT ROUND SECTIONS (41–44); SHEETING, STRIPS, BLANKETS (41–43); FORMED SHAPES O/T 140XX/145XX (46–49): ELASTOMERIC (46–47), NON-ELASTOMERIC (48–49)	40 UNFORMED	41 RUBBER, SYNTHETIC RUBBER, PLASTIC FOAM	42 PLASTIC O/T 141XX INCLUDING METALLIC NON-METALLIC COMPOSITES	43 OTHER THAN 141XX/142XX	44 TUBE, ROD	45	46 WITHOUT FULLY ENCLOSED PORTION	47 WITH FULLY ENCLOSED PORTION	48 WITHOUT MALE OR FEMALE SNAP-IN FEATURE OR ENCLOSING PORTIONS	49 WITH MALE OR FEMALE SNAP-IN FEATURE OR ENCLOSING PORTIONS
TOOLING MATERIALS	NON-METALLICS AND COMPOSITES (90–93); METALLIC ONLY (94–99); STEELS (95–97)	90	91	92	93	94 ALUMINUM, ALUMINUM ALLOYS	95 CARBON ALLOY, EXCEPT TOOL	96 TOOL	97 OTHER THAN 195XX/196XX	98 COPPER, COPPER ALLOYS	99 OTHER THAN 194XX/198XX
											1XXXX

from Beeby and Thompson (1979)

COUNT OF PARTS



CELLS AND JIT FUNCTION BEST WHEN THE SAME CONDITIONS EXIST

Table 2-6. Core JIT principles

- Setup time reduction (e.g., continual emphasis on lowering setup time)
- Small lot sizes (e.g., small lots in the master schedule and elsewhere)
- JIT delivery from suppliers (e.g., daily shipments)
- Supplier involvement in quality improvement efforts (e.g., long-term supplier relations)
- Multifunctional workers (e.g., operators perform several tasks)
- Small-group problem-solving (e.g., teams are formed to solve problems)
- Training (e.g., to learn new skills)
- Daily schedule adherence (e.g., schedule allows for catch-up time)
- Repetitive master schedule (e.g., product mix is repeated on a regular basis)
- Preventive maintenance (e.g., time reserved for maintenance activities)
- Equipment layout (e.g., use of cells)
- Product design simplicity (e.g., minimization of part count in products)
- The use of kanban system (inside the plant and for suppliers)
- Pull system support (e.g., backflushing, efficient layout, authorization to stop production if quality problems occur)
- MRP adaptation to JIT (e.g., elimination of work orders)
- Accounting adaptation to JIT (e.g., a switch to process costing)

from Hyer and Wemmerlov (2002)

LEAD TIME REDUCTION FACTORS

Table 3-2. Factors with established influence on lead time

Factors that Influence Lead Time	Action Needed to Reduce Lead Time
Machine setup time	Decrease
Machine setup time variability	Decrease
Part processing time	Decrease
Part processing time variability	Decrease
Materials handling time	Decrease
Interarrival time variability	Decrease
Production batch size	Decrease (if coupled with setup time reduction)
Transfer batches	Use (if coupled with family sequencing)
Cross-trained operators	Increase
Labor constraints	Reduce
Interarrival time (time between jobs)	Increase (while keeping lot sizes fixed)
Product mix distribution	Achieve balanced work loads
Equipment capacity	Increase

from Hyer and Wemmerlov (2002)

BENEFITS OF GROUP TECHNOLOGY

	Advantage	Reasons
1	Reduces throughput time	Machines close together under one foreman
2	Reduced investment in stocks	Easy to use small batches due to short throughput time (1)
3	Reduces costs	Low stock holding (2), materials handling (1), and indirect labour costs (4)
4	Better delegation	Groups complete parts. Can be made responsible for quality, cost, and due-date performance
5	Better quality	Low throughput time (1), all under one foreman (1), delegation (4)
6	Low obsolescence	Low stocks (2), just-in-time production control
7	Flexible; able to follow changes in the market economically	Low stocks (2) and less obsolescence (6)
8	Improved morale and job satisfaction	Association with a product, a team and a territory. Effects of delegation (4)

from Burbidge (1989)