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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

MTC Marketing Trading Consulting GmbH

UNIDO-WORKSHOP ON COMPUTER APPLICATION IN ENGINEERING IN NANJING 23 TO 27 AUGUST 1985

PARTICIPATING COUNTRIES:

Bangladesh, China, Indonesia, Pakistan, Malaysia and Thailand

PRESENTED BY:

Dr.-Ing. M. Soerensen

Telefon 0 71 50 / 20 29 Telex 7 22 253 mtc d Bank Deutsche Bank Stuttgart (BLZ 600 700 70) 1 324 029
Geschäftsführer / General Manager Dr.-Ing. Michael Sörensen Amtsgericht Stuttgart HRB 9803

OPERATING SYSTEM SOFTWARE

1. Performs basic tasks in the computer and queues the tasks according to established priorities.

2. Communicates with all input and output devices (peripherals, mass storage devices, discs, etc.) as well as any external networking capabilities.

3. Provides fail-safe features, such as preventing loss of data during a breakdown.

4. Provides error checking.

5. Provides data security through access coding.

6. Determines order of execution of programs.

RATINGS OF LIVE DEMONSTRATIONS

Item or Feature	Feature Weights	VENDOR A Rating	VENDOR A Total Points	VENDOR B Rating	VENDOR B Total Points
1. Documentation					
a. On-line Operations	10	0	0	0	0
b. Manuals	10	6	60	8	80
c. Ease of Learning	10	3	30	7	70
2. Display					
a. Speed of Response	10	8	80	6	60
b. Graphics Presentation	10	4	40	6	60
3. Database Management	10	7	70	8	80
4. Text Handling	10	4	40	4	40
5. Mechanical Drafting - 2D	10	7	70	0	0
- 3D	5	0	0	0	0
6. Printed Circuit Board					
a. Ground Plane Handling	10	6	60	4	40
b. Trace Mani-pulation	10	6	60	8	80
c. Component Placement	10	7	70	5	50
7. Schematic Drafting	10	7	70	6	60
8. Net List Generation	10	4	40	7	70
9. Design Rule Checking	10	4	40	2	20
10. Hardware-Overall Desirability	7	7	49	5	35
11. File Control	8	5	40	5	40
TOTALS		85	819	81	785

MECHANICAL CAD/CAM SYSTEMS

MAJOR CAPABILITIES

Vendor	2-D	3-D Wireframe	3-D Solids	Solid Shaded Image	Struct. Analy.	2-D NC	Multiaxis NC
AM Bruning	X	--	--	--	--	--	--
Applicon	X	X	X	X	X	X	X
Arigonni	X	--	--	--	--	--	--
Aristo	X	X	X	--	X	X	X
Auto-trol	X	X	--	--	--	X	X
Aydin	X	--	--	--	--	--	--
Bausch & Lomb	X	--	--	--	--	--	--
Cadam	X	X	--	--	--	X	X
Cadcal	X	--	--	--	--	--	--
CADLINC	--	X	--	--	--	X	X
Calma	X	X	X	X	X	X	X
Com-Code	X	--	--	--	--	--	--
Computer-vision	X	X	X	X	X	X	X
Computool	--	X	--	--	--	X	X
Contraves	X	X	X	--	X	X	X
Control Data	X	X	X	X	X	X	X
Evans & Sutherland	X	X	X	--	X	X	X
Ferranti Cetec	X	X	X	--	X	X	X
Gerber Systems T.	X	X	--	--	--	X	X
Graftek	X	X	--	--	--	X	X
Harris	X	X	--	--	--	X	X
HPackard	X	--	--	--	--	X	--
Holguin	X	--	--	--	--	X	--
IBM	X	X	X	--	X	X	X
ICS	X	X	--	--	--	--	--
Intergraph	X	X	X	X	X	X	X
J.S. Staedtler	X	--	--	--	--	--	--

MECHANICAL
CAD/CAM SYSTEMS
MAJOR CAPABILITIES
(Continued)

Vendor	2-D	3-D Wireframe	3-D Solids	Solid Shaded Image	Struct. Analy.	2-D NC	Multiaxis NC
K & E	X	--	--	--	--	--	--
Kongsberg	X	X	--	--	--	X	X
MCAuto	X	X	X	X	X	X	X
Matra	X	X	X	X	X	X	X
MCS	X	X	--	--	--	X	X
Micro Control	X	X	--	--	--	--	--
Omni CADD	X	--	--	--	--	--	--
Omni Tech	X	X	--	--	--	--	--
Perkin Elmer	X	X	--	--	--	X	X
Prime	X	X	X	--	X	X	X
Racal-Redac	X	--	--	--	--	--	--
Sigma Design	X	--	--	--	--	--	--
Sperry	X	X	X	--	X	X	X
Summagraphics	X	--	--	--	--	X	--
Tektronix	X	--	--	--	--	--	--
Terak	X	--	--	--	--	--	--
T & W	X	--	--	--	--	--	--
Vector Automation	X	--	--	--	--	--	--
Versatec	X	--	--	--	--	X	--
Zuken	X	--	--	--	--	--	--

SUMMARY OF SOME VENDOR ADVERTISED CAPABILITIES FOR PRINTED CIRCUIT BOARDS

	PC											
	ROUTING		OUTPUTS									
Vendor	Manual	Auto	Check Plots	Photo Plots	Parts Lists	Solder Masks	NC Drill	Comp. Place	Logic Tester	Hybrids	Schematics	Automatic Net List Generation
Applicon		X	X	X	X	X	X	X	X	X	X	X
Automated Systems		X	X	X	X	X	X	X	X	X	X	X
CADMatics											X	X
CALay		X	X	X	X	X	X	X				
Calma		X	X	X	X	X	X	X	X	X	X	X
Calos											X	X
Computer-vision		X	X	X	X	X	X	X	X	X	X	X
Dasoft	X		X	X	X						X	
Design Aids											X	X
Design Automation		X	X	X	X	X	X	X	X		X	X
Future Net					X						X	X
GSI	X		X	X	X	X	X	X				
GST		X	X	X	X	X	X	X			X	X
IBM		X	X	X	X	X	X	X	X		X	X
Intergraph		X	X	X	X	X	X				X	X
Racal-Redac		X	X	X	X	X	X	X	X	X	X	X
Scientific Calculations		X	X	X	X	X	X	X	X		X	X
Summagraphics	X		X	X	X	X	X				X	
Telesis		X	X	X	X	X	X				X	X
Versatec		X	X	X	X	X	X				X	X

QUALITY CIRCLES

INCREASING PRODUCTIVITY WITH PEOPLE POWER

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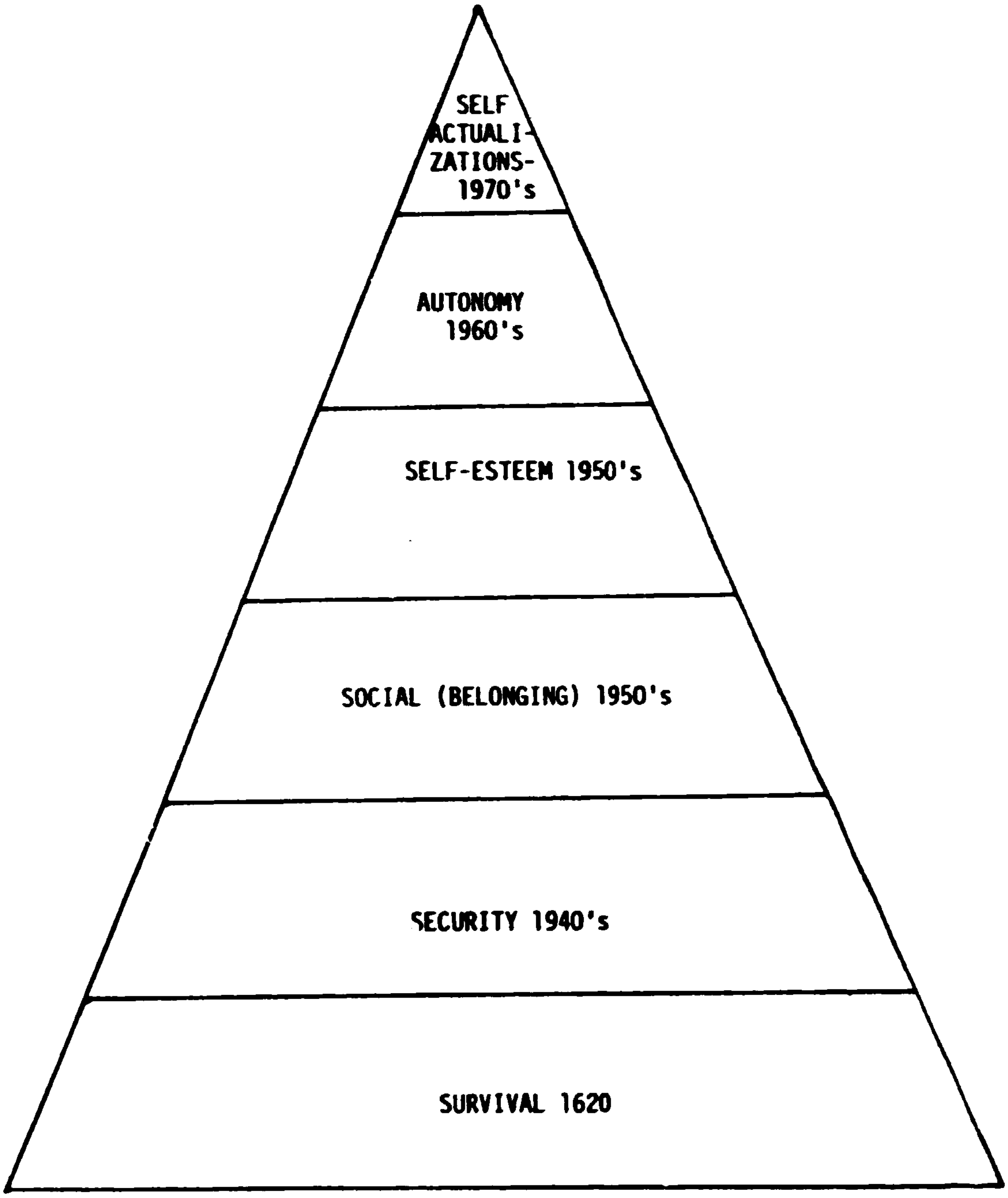
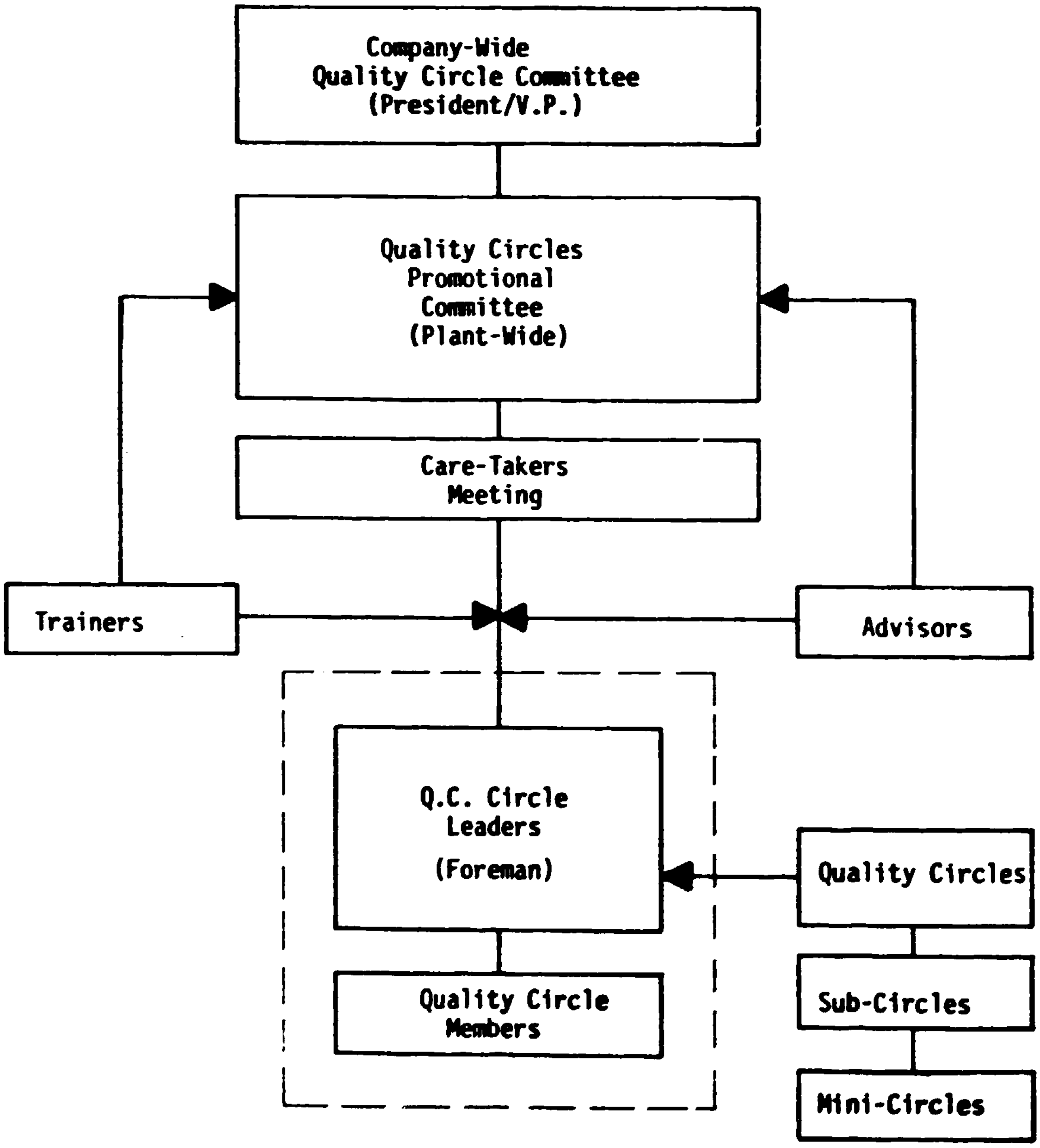
CAE-Workshop Nanjing, August 1985

WHAT DO WORKERS WANT ?



QUALITY CIRCLE MODEL IN JAPAN



MAJOR FUNCTIONS

COMPANY-WIDE QUALITY CIRCLE COMMITTEE

1. Establishment of company policy
2. Promotion of executive committee
3. Overall planning of activities (instruction and training)

PROMOTION COMMITTEE

1. Promotion of group leader meeting, and study of problems
2. Promotion of presentations (twice a year)

CARETAKERS MEETING

1. Promotion of group meetings and study of problems
2. Work with leaders

TRAINERS

Develop and implement the Quality Circle training materials and techniques.

ADVISORS

Help to promote program. Help in case of difficulties. Help in facility arrangements, interdepartmental communications.

LEADERS

Leader of the Circle

MEMBERS

Backbone of the Quality Circle program. Voluntarily work to solve problems in the company.

KEY FEATURES OF THE QUALITY CIRCLE MODEL

1. Well organized system
2. Systematic education and training programs
3. Circle leader's conferences
4. Plant-wide meetings
5. Company-wide meeting (annual)
6. Outside visits
7. Annual awards for best projects
8. Good publicity through pictures and posters
9. Clean, nice meeting areas on the floor
10. Well organized recognition program throughout the plants

ADVANTAGES OF ESTABLISHING A QUALITY CIRCLE

1. Quality improvement
2. Waste reduction
3. Attitude change
4. Cost reduction
5. Safety improvement
6. Improved communications
7. Higher productivity
8. Increased job satisfaction
9. Team building
10. Improvement in skills

A QUALITY CIRCLE PROGRAMM IS NOT

SOMETHING MANAGEMENT NEED FEAR

ONLY A MANAGEMENT PROGRAM

A "CURE-ALL"

GUARANTEED TO SUCCEED

ALWAYS GOING TO SURFACE WHAT WE WANT TO HEAR ....

A QUALITY CIRCLE PROGRAM IS

ONE EFFECTIVE METHOD FOR INVOLVING AN ORGANIZATION'S EMPLOYEES IN ASSUMING RESPONSIBILITY FOR "QUALITY"

.......THE "QUALITY" OF THEIR WORK, THEIR WORK ENVIRONMENT, THEIR PROFESSIONAL GROWTH, AND THEIR PERSONAL DEVELOPMENT.

QUALITY CIRCLE LEADER'S FUNCTIONS

1. Generate enthusiasm for Circle activities
2. Take care of operation of Circle
3. Meet with the Circle once a week
4. Use facilitator for assistance
5. Be responsible for Circle records
6. Create coordination and harmony in the Circle
7. Be key link between members and management
8. Attend leadership training
9. Work closely with the foreman
10. Seek advice and help if required
11. Keep the meeting on track
12. Enforce code of conduct
13. Maintain a good attitude above Circles
14. Give assignments
15. Start and end meetings on time
16. Help get new members for the Circle
17. Promote Quality Circle program
18. Visit other companies
19. Attend quality programs
20. Teach others useful material to better the society and surroundings

DUTIES OF THE FACILIATOR

1. Sits as an active member of the steering committee
2. Serves as Quality Circle program coordinator
3. Trains members, leaders, management
4. Coordinates Circles
5. Maintains Circle records
6. Arranges meetings with outsiders
7. Attends in-Circle meetings
8. Solves personal problems
9. Searches for new members
10. Works in the shop daily
11. Searches for new ideas
12. Publicizes the program
13. Spreads a good word about the program
14. Links all people in the organization
15. Prepares for presentation-invitations, papers, visual aids
16. Prepares new training material
17. Follows up on completed projects
18. Attends conferences
19. Reads outside materials
20. Organizes informal gatherings-invites outside speakers

PROBLEMS IN MANAGING QUALITY CIRCLES

1. Poor training
2. History of previous programs
3. Existing suggestion system
4. Union relationships
5. Insufficient support from top management
6. Insufficient cooperation from middle management
7. Inadequate publicity
8. Difficult or unrelated problems
9. Unrealistic expectations
10. Poor or slow response from management

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CAE-Workshop Nanjing, August 1985

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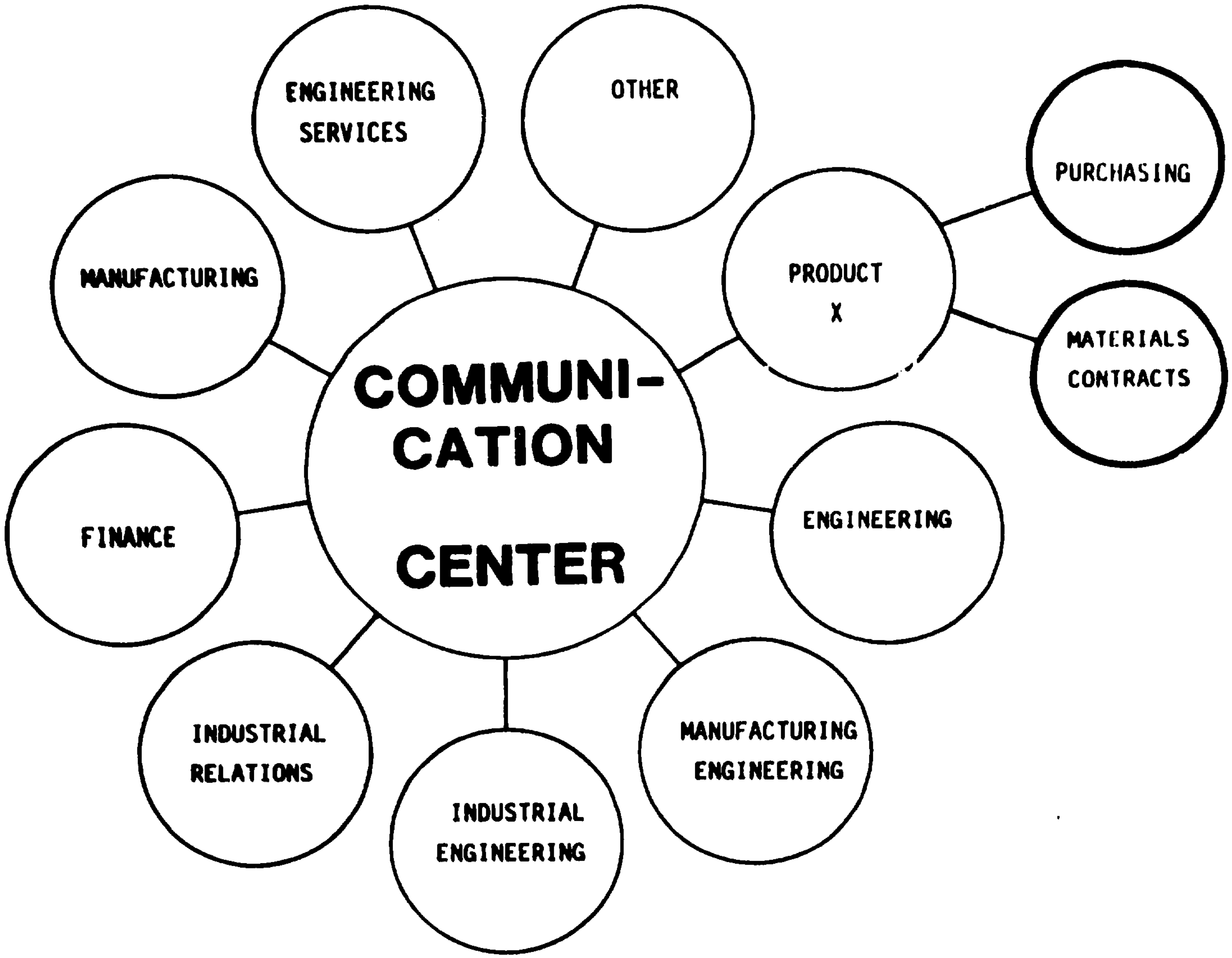
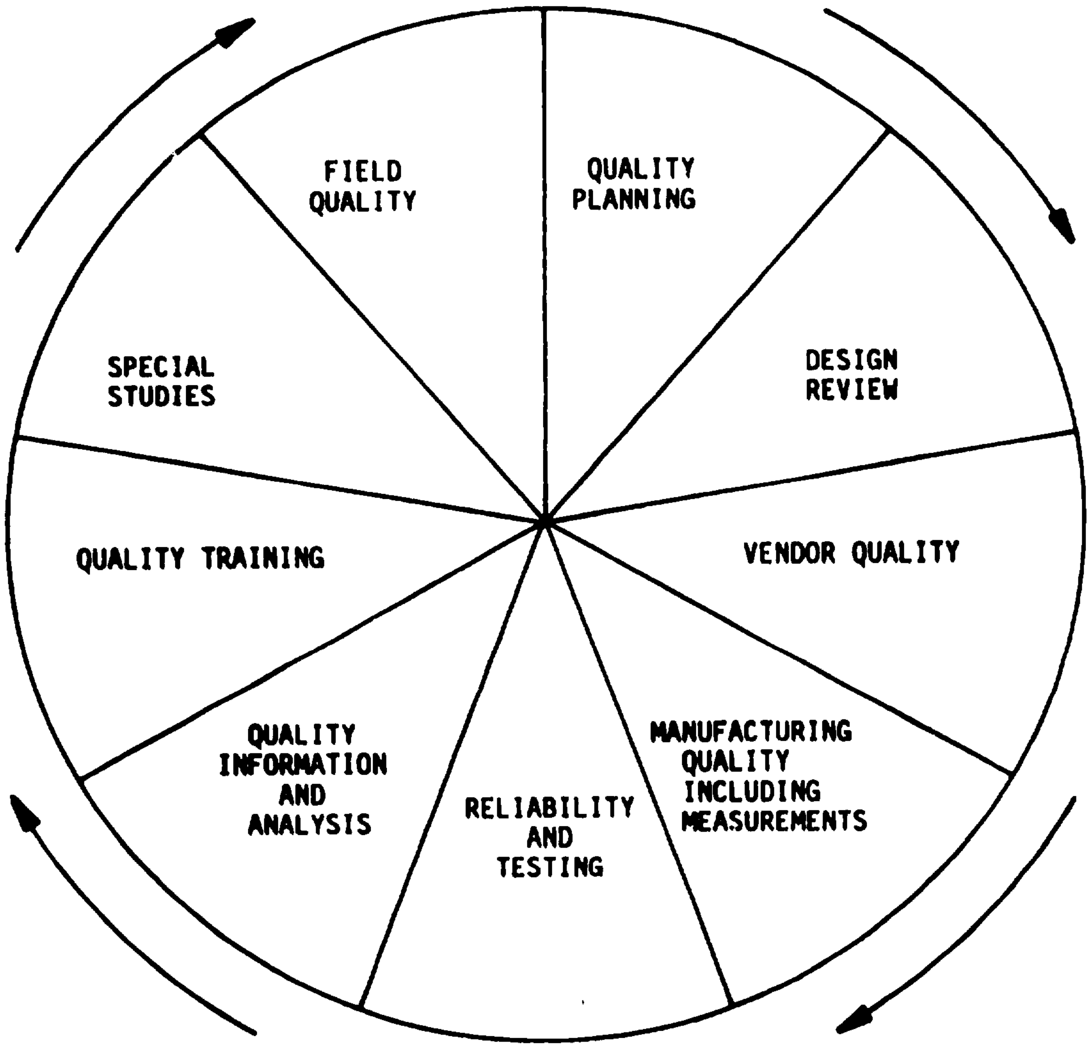
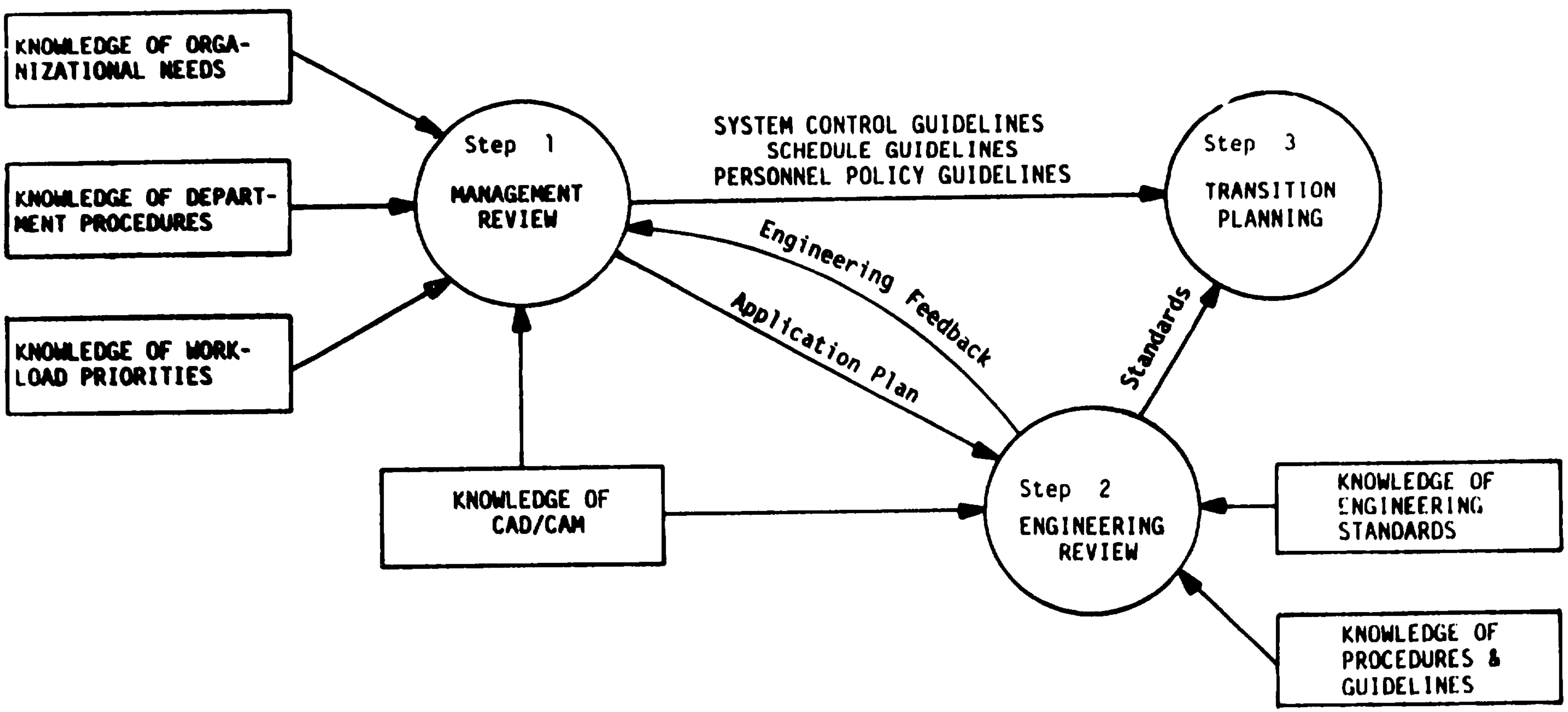

COMMUNICATION CENTER
ENGINEERING SERVICES
OTHER
PURCHASING
PRODUCT X
MATERIALS CONTRACTS
MANUFACTURING
FINANCE
ENGINEERING
INDUSTRIAL RELATIONS
INDUSTRIAL ENGINEERING
MANUFACTURING ENGINEERING

TOTAL QUALITY SYSTEM



CAD/CAM TRANSITION PLANNING MODEL



PRODUCT PERFORMANCE PARAMETERS

Cost

As influenced by:
Design
Producibility
Technology
Materials
Suppliers
Production
Fabrication
Labor cost
Facilities
Quantities
Experience
Scrap
Inventory
Growth trends
Installation
Financing
Selling cost
Overheads
Automation
Simplicity
Shipping
Distribution

Packaging

Form both implies and permits function.
Mechanismus
Layout
Surfaces
Size, quantity
Modularity
Styling
Geometry
Interferences
Fit and finish
Color, texture
Framework
Identity
Inside, outside

Ease of Use

Users include buyers, managers, operators.
User friendliness
Controls, displays
Graphics
Ergonomics
Training
Manuals, documentation
User-machine interface
Operating conditions
Noise, vibration
Handling
Feedback
Simplicity
Sensory input and output
Anthropometry
Illumination
Effort
Environment
Timing
Human factors
Cognition

Life Cycle

Foresight and quality often mean lower life-cycle costs.
Lifetime
Uptime, downtime
Fatigue, wear, corrosion
Deterioration
Maintainability
Parts, supplies availability
Service
Component interchangeability
Backups
Monitoring
Upward compatibility
Futures
Obsolescence
Standardization
Depreciation, appreciation
Energy costs
Operating costs
Installation costs
Disposal costs
Life-cycle costs

Availability

Providing what customers want, why, when, where, and how they want it.
Marketing
Sales
Distribution method
Stock
Lead times
Advertising
Ordering
Locations
Configuration
Sizes
Quantities
Options
Pricing
Demonstrability
Awareness
Positioning

Performance

The primary functions may be tangible or intangible.
Function
Appeal
Specifications
Speed
Capacity
Power
Payload
Size
Accuracy
Repeatability
Productivity
Versatility
Performance VS constraint (power vs weight, capacity vs cost, miles vs gallon)

Assurances

Assured performance.
Reliability
Quality
Safety
Margin for error
Structural integrity
Safety factor
Stability
Redundancy
Error detection, correction
Failproofing
Foolproofing
Diagnostics
Certification
Testing
Guarantees

Social Acceptance

Often, there ar hidden costs for builders, buyers, operators and bystanders.
Indirect influencers
Status
Effect on bystanders
Effect on environment
Social approval
Legal concerns
Government regulation
Deregulation
Tax incentives
Restrictions
Safety
Product liability
Pollutants
Health effects
Insurance
Resource consumption
Security
Side effects
Toxicity
Customs, taboos
Special interests
Workers, work place
Political impact

THE ADVANTAGES OF FMS ARE:

- Increased labor productivity with less skilled people needed.
- Increased quality with less scrap and rework.
- Increased production flexibility either by product design or by production volume.
- Reduced operating costs.
- Much higher machinery utilization.

BENEFITS
AND
ADVANTAGES
OF
GROUP TECHNOLOGY

- Reduced number of parts in the database.
- Reduced part introduction cost through re-use of modified or similar parts.
- Reduced new product design lead time.
- Increased capability utilization by as much as 10-15%.
- Reduced set-up time from fewer set-ups (40% reductions are possible).
- Reduced scrap costs.
- Reduced design costs by 5-10%.

ANALYSIS OF MECHANICAL DESIGN, DRAFTING, AND TOOLING DESIGN

Description	Manual	CAD
1. Frame Engineering Packages		
Type A	12,500 hours	3,800 hours
Type B	2,700 hours	700 hours
Type C	1,000 hours	300 hours
Subtotals Design and Drafting	16,200 hours	4,800 hours
2. Tooling Design	3,500 hours	1,200 hours
Totals	19,700 hours	6,000 hours

ANALYSIS OF ELECTRONICS DESIGN AND DRAFTING

Description	Manual	CAD
1. Schematics	3,800 hours	900 hours
2. Printed Circuit Boards	1,800 hours	400 hours
3. Cable Layouts	300 hours	30 hours
4. Mechanical Packaging	1,000 hours	300 hours
TOTALS	6,900 hours	1,630 hours

FMS GAINS
YAMAZAKI MACHINERY

$ 18 MILLION
INVESTMENT COST

(1984)

	Conventional	FMF [FMS]
Number of machines	68	18
Number of employees	215	12
Square feet occupied	103,000	30,000
Average processing Time/Work Piece		
Line A	35 days	1.5 days
Line B	60 days	3.0 days
First two year's savings:		
Inventory costs	$ 3.9 million	
Labor costs	$ 3.0 million	

COMPARISON OF FMS AND CONVENTIONAL PRODUCTION METHODS

	4 FMS in Yamazaki Minokamo	Conventional production with identical capacity
No. of machin tools	43	90
No. of employees, in	39	195
__production	36	170
__managing/ control	3	25
Machining time	3 days	35 days
Assembly of modules	7 days	14 days
Final assembly	20 days	42 days
Total elapsed time	30 days	91 days
Needed area	6600 m2	16 500m2

source: Yamazaki

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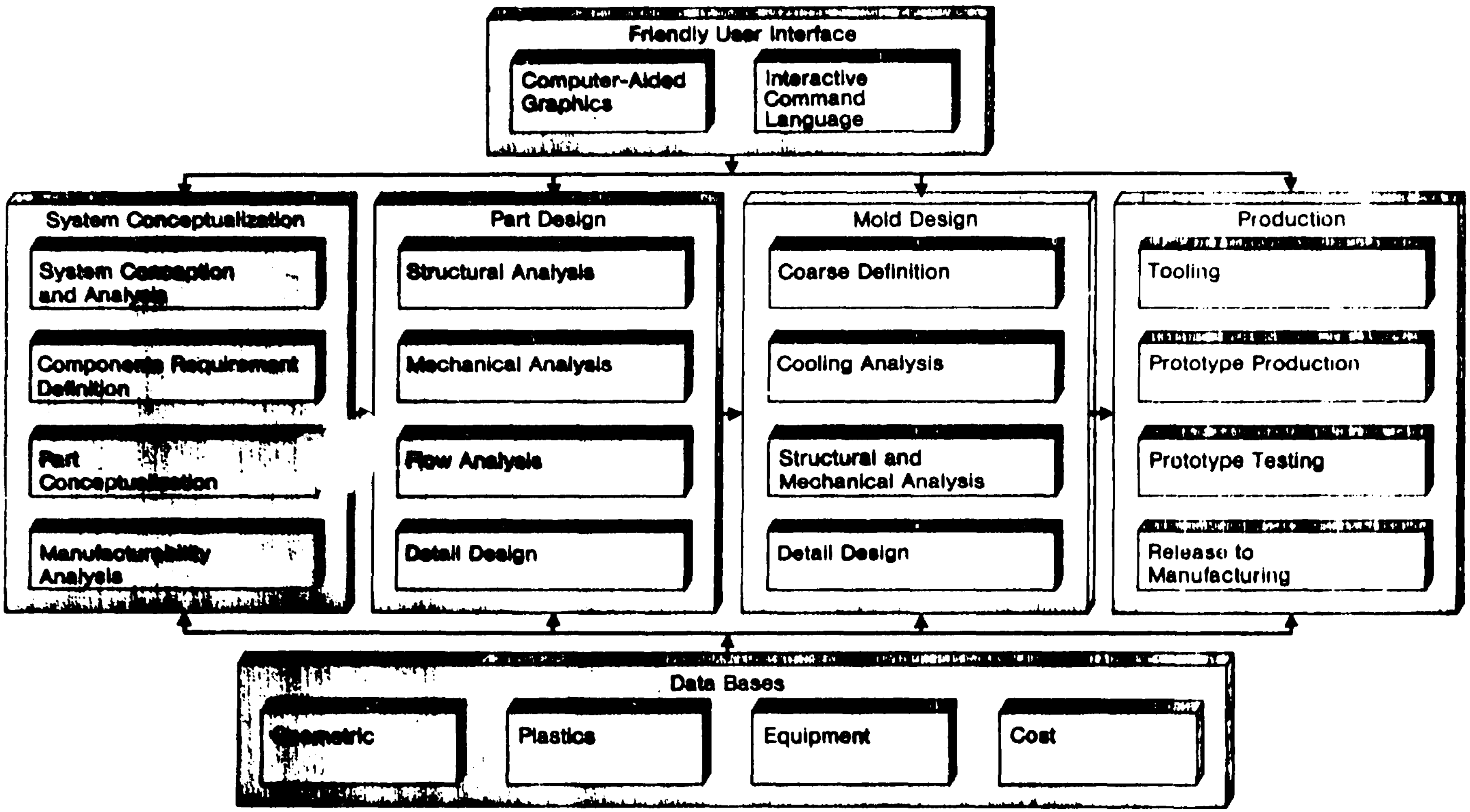
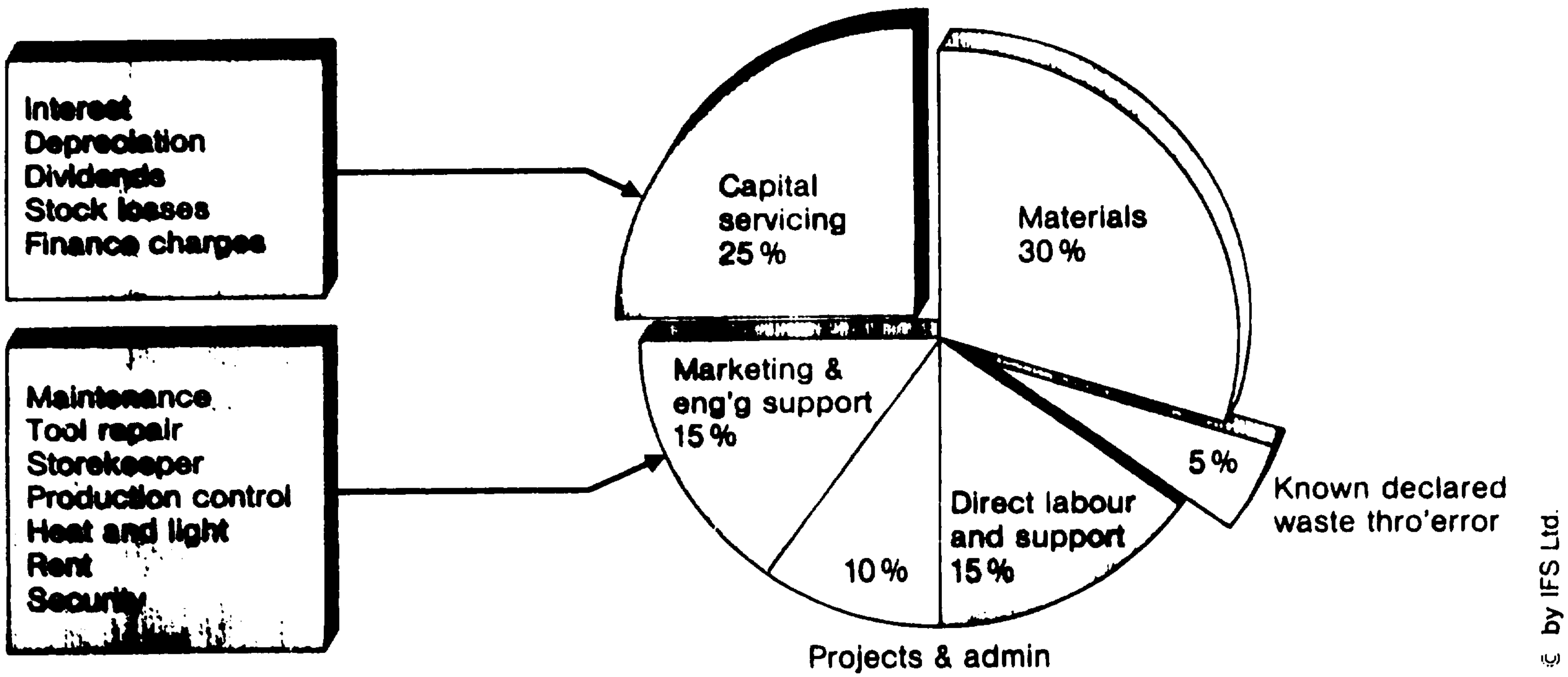
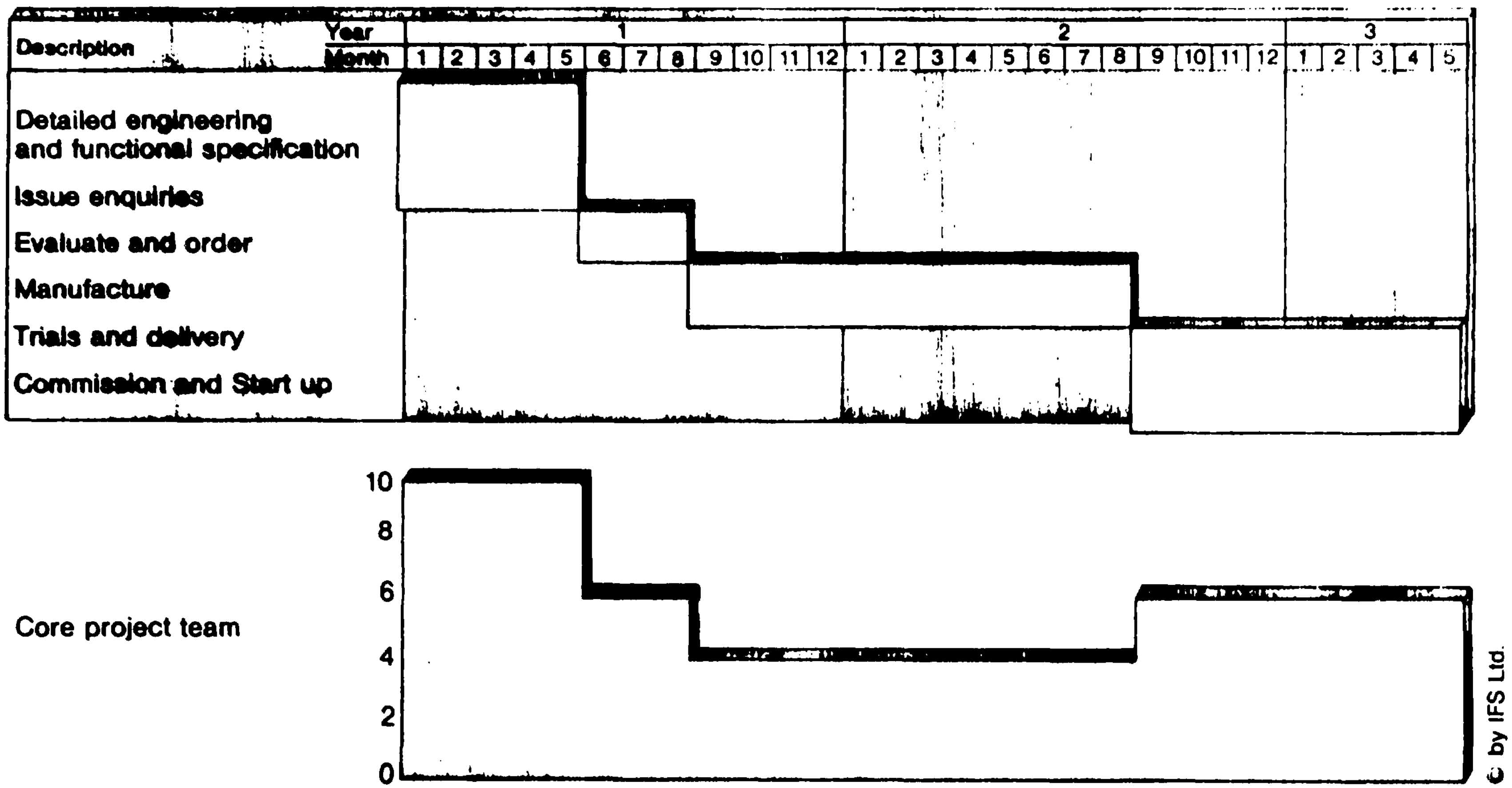
The Major Components of CAE-in-Plastics as Defined by CAE International Division of GE and SDRC.



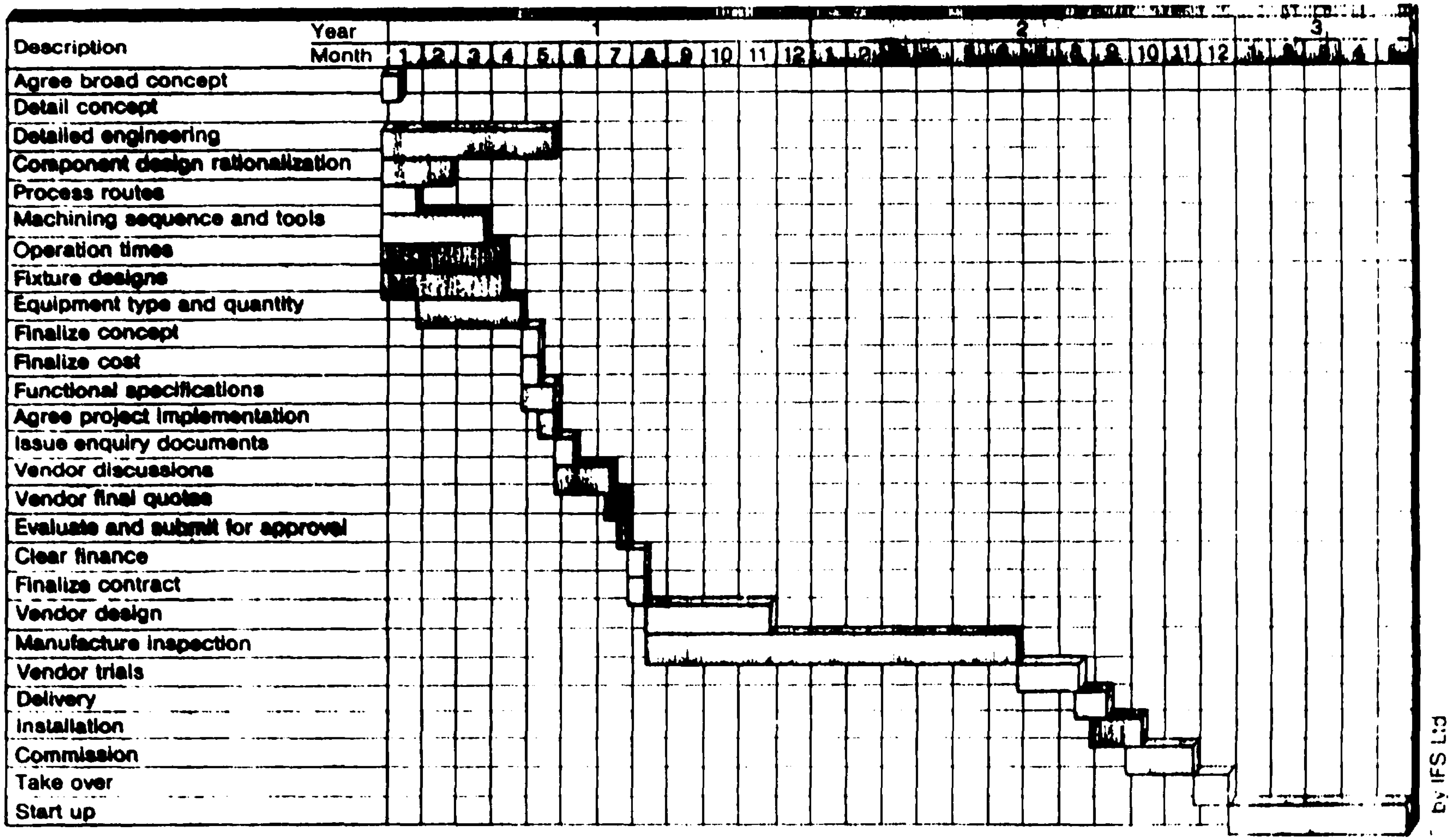
Strategic issues affecting cost in an FMS for a typical medium / heavy duty engineering company.



Project implementation and resource programme.



Implementation – machines and equipment.



Multi-station, towline materials handling system for aerospace engine cases.

DATE INSTALLED:
PHASE 1 1979
PHASE 2 FUTURE

SYSTEM COMPONENTS:
PHASE 1

7 5-AXIS MILWAUKEE-MATIC MODU-LINES

3 VERTICAL TURRET LATHES

PALLET STORAGE

TOWLINE MATERIAL HANDLING SYSTEM

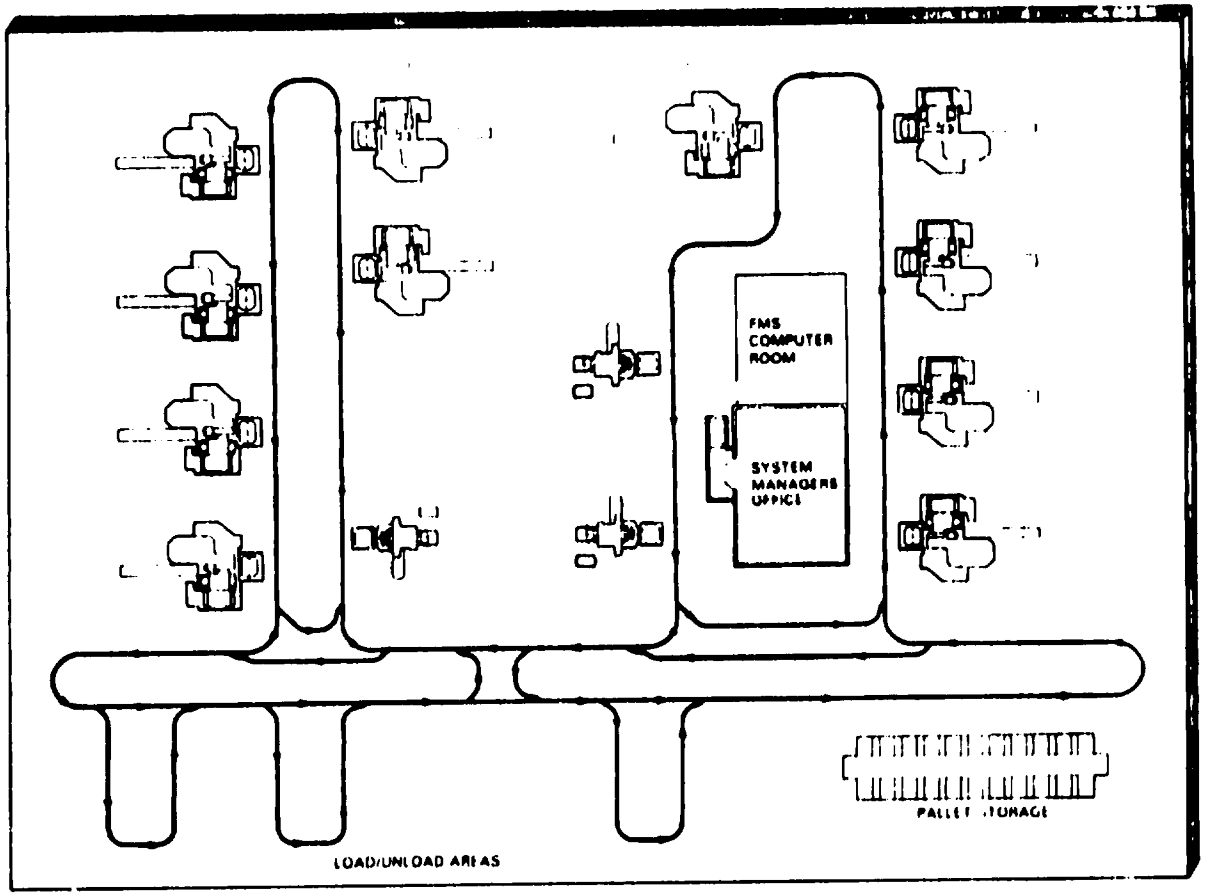
COMPUTER CONTROL

PHASE 2
4 5-AXIS MILWAUKEE-MATIC MODU-LINES

FUTURE MACHINES

OVERALL SYSTEM SIZE

200' × 152'



System E – Gas Turbine Components

INDUSTRY	Aerospace
TYPE	Gas turbine components
TASK	Engine cases
SUPPLIER	Kearney and Trecker
WORKSTATIONS	10 workstations comprising seven machining centres and three vertical lathes
MATERIALS HANDLING	Towline material handling system
TOOLING	
MANAGEMENT AND CONTROL	Interdata – computer control
STATUS	Implemented D.N.C. link only. Total system to follow
INST. DATE	Mid 1980
COSTS	$20 million
BENEFITS	Reduced lead time; improved machine utilisation
COMMENTS	

Reasons for installing system

WHY WAS THE SYSTEM INSTALLED?	
EXTRA MACHINING CAPACITY NEEDED	Yes
NEW COMPONENTS REQUIRING NEW MACHINING FACILITIES	Yes
NEED TO MOVE TO A NEW SITE	No
SHORTAGE OF SKILL LABOUR	No
INVESTMENT DECISION – INCREASED PROFIT SEEN	Yes
DESIRE TO EXPERIMENT	No
BETTER CONTROL OF WORKFLOW	Yes
NEED FOR IMPROVED AND CONSISTENT QUALITY	Yes
OTHERS	
WHAT ARE THE MAIN BENEFITS OBTAINED OR EXPECTED?	
INCREASED UTILISATION OF MACHINE TOOLS	50% improvement in machine tool utilisation
REDUCED LEAD TIME	35% reduction realised
INCREASED FLEXIBILITY	Yes
IMPROVED PRODUCT QUALITY	Yes Improved part location
REDUCED W.I.P.	
BETTER LABOUR UTILISATION	No
REDUCED TOOLING COST AND IMPROVED RATIONALISATION	Data not available
DURATION OF RUN-TIME BEFORE MANUAL INTERVENTION	System fully manned at this stage
COST BENEFIT DATA	Not collated yet They feel they will need another year before the cost benefit data will be meaningful
OTHERS	

Nature of production

MATERIALS MACHINED	Iron	Steel	Aluminium	Titanium	Ni-based	Others
	x	x				

SHAPE OF COMPONENTS	Cylindrical	Prismoid
	A mixture of both cylindrical and prismoid	

MAXIMUM DIMENSION OF COMPONENTS	Up to 300mm %	300-600mm %	Over 600mm %
	-	Approx 50% of parts	Approx 50% of parts

NUMBER OF DIFFERENT COMPONENTS IN THE SYSTEM	Three at the moment
PERCENTAGE OF ALL COMPONENTS IN THE PLANT THAT GO OVER THE SYSTEM	1% of parts of a similar size envelope

BATCH SIZE	Average	Range
	One	

MANNING LEVEL	In total: 31 operators inclusive of four tool loaders; one computer operator; one supervisor
SHIFT PATTERN	Three shifts
TYPE OF 'PEOPLE' SKILLS	NC machinists preferred at the moment. Skill level may change when system fully operational.
HOW LONG WILL 'SYSTEM' OPERATE WITHOUT MANUAL INTERVENTION	At this stage the 'system' is fully manned at each machine and therefore will not operate without manual intervention
THROUGHPUT	Longest cycle time – 10 hours Shortest cycle time – six minutes Two per day on long cycle, large parts Six per day on small range of parts
COMPONENTS OF ALL TYPES IN HOURS	

DISTRIBUTION OF MACHINE CYCLE TIME BY %	Turning	Milling	Drilling	Grinding
	40%	60% across milling and drilling		
				In process inspection
				All manual

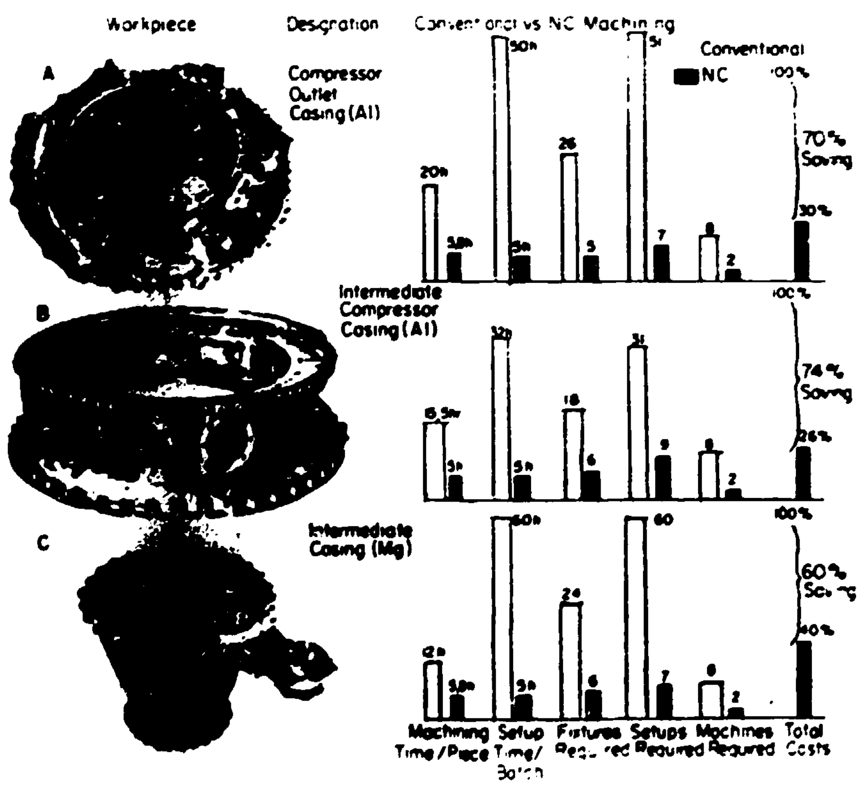
NUMBER OF OPERATIONS	Approximately 13 operations for large long cycle parts
HOW LONG INSTALLED	Approximately 12 months
WHAT ARE/HAVE BEEN THE PROBLEMS	Software development and tooling problems

Nature of machining system

WILL SYSTEM ACCEPT MORE THAN ONE COMPONENT WITHOUT MANUAL RE-SETTING	Yes but restricted by tooling capacity		
WILL IT HANDLE COMPONENTS REQUIRING MORE THAN ONE OF THE MACHINE TOOLS TO COMPLETE MACHINING	Yes		
WORKPIECE HANDLING	Completely automatic	Automatic after initial manual load	Largely manual
		x	
PART-PROGRAMME SELECTION	Manual	Mechanical	Computer
			x
PART IDENTIFICATION	Coded pallet	Individual part identification	Others
	x		
COMPUTER CONTROL EVERYTHING	Computer controlled for all functions, not fully operational		
PROGRAM SELECTION ONLY			
PROGRAM SELECTION PLUS LOAD/UNLOAD			
LOAD/UNLOAD ONLY			
OTHERS			
PROVISION OF CUTTING TOOLS	Automatic	Semi-automatic	Manual
	Automatic at spindle		Manual load of tool changer
GAUGING AND INSPECTION	In process	Post process	
	Manual in process		
TYPE OF MACHINES STANDARD	Seven five-axis Milwaukee Matic Modu-Lines and three vertical turret lathes		
SPECIAL			
MIXTURE OF TWO			
MACHINE CONDITION MONITORING	None		
SWARF MANAGEMENT	Central underfloor system		

NC Justification: Initial Estimate

Decis on Factors	Yes / No	Example
(A) Machining Requirements		
Low machining/idle time ratio due to:		
1. Workpiece complexity	( ) ( )	– Complex drilling pattern
2. Type of machining	( ) ( )	– Low drilling length/diameter ratio
3. High cutting speed	( ) ( )	– Al alloy machining
4. Long setup, loading & chucking times	( ) ( )	– Comparable to machining time
5. Numerous operations with same tool	( ) ( )	– Several holes of same diameter
6. High-accuracy operations otherwise checked and gauged by operator	( ) ( )	– Exact depth for stepped bores
(B) Production Requirements		
7. Repetition of small batches	( ) ( )	– 5 to 10 times a year
8. Small batch size	( ) ( )	– less than 300
9. Several suitable workpieces, adequate to load NC machine fully	( ) ( )	– Sufficient suitable workpieces for 2-shift operation
10. Frequent workpiece modifications and/or dimensional variations in a family of components	( ) ( )	– Slight dimensional changes in drilling pattern
11. Replacements required after completing production	( ) ( )	– Spare parts needed for fast delivery to customer
12. Cost of jigs & fixtures considerable	( ) ( )	– Drilling jigs
13. Storage of jigs & fixtures a problem	( ) ( )	– Large or heavy jigs
14. Time-consuming, expensive inspection, gauging after machining	( ) ( )	– Several tight-tolerance dimensions
(C) Plant Requirements		
15. NC machine solves production bottle-neck	( ) ( )	– New machines have to be purchased
16. Work can be transferred from expensive machine tools to NC machine	( ) ( )	– Conventional machining on expensive machine tool setups
17. Skilled machine tool operator shortage	( ) ( )	– High-accuracy machining of expensive workpieces
18. Shorter product lead time of importance to company operations	( ) ( )	– Product frequently redesigned to adapt to changing market conditions
19. Substantial workpiece transport costs and investment in workpiece storage & work in progress	( ) ( )	– Large, heavy and/or expensive workpieces
20. Tool presetting & tape preparation facilities available	( ) ( )	– NC machines already installed



Cost comparison for conventional machining vs. NC machining center.

Kostenvergleich für konventionelles und NC-Bearbeiten auf einem Bearbeitungszentrum.

Coût de l'usinage conventionnel par rapport à la CN sur un centre d'usinage.

COMPARISON OF RASTER REFRESHED DISPLAYS, DIRECT VIEW STORAGE TUBES, AND VECTOR REFRESHED DISPLAYS

TECHNOLOGY	ADVANTAGES	DISADVANTAGES
RASTER REFRESH Cathode gun writes and refreshes horizontal lines of data directly from digital memory, filling entire CRT screen.	1. Competitive cost with decreasing cost trend for future. 2. Digital accuracy. 3. Digital reliability. 4. Good brightness. 5. Good contrast between data and background. 6. Excellent gray scale. 7. Multitude of colours. 8. Readback of data by host CPU. 9. Selective update/erase. 10. Low maintenance cost.	Resolution currently limited to 1280 x 1024 addressable points.
DIRECT VIEW STORAGE TUBES Cathode gun writes vectors on energized CRT screen, which then maintains image without refreshing.	1. Very high resolution (4096 x 4096 addressable points).	1. Higher maintenance cost. 2. Analog circuits require adjustment. 3. No gray scale. 4. No color. 5. No readback of data by host CPU. 6. Low contrast between data and background. 7. Limited to low ambient light working environments. 8. No selective updating or erasing.
VECTOR REFRESH Cathode gun writes vectors on standard CRT screen, with phosphor persistence maintaining data until vectors can be refreshed by redrawing.	1. High-resolution (4096 x 4096) addressable points.	1. Analog circuits require adjustment. 2. Flickers when too many vectors displayed.

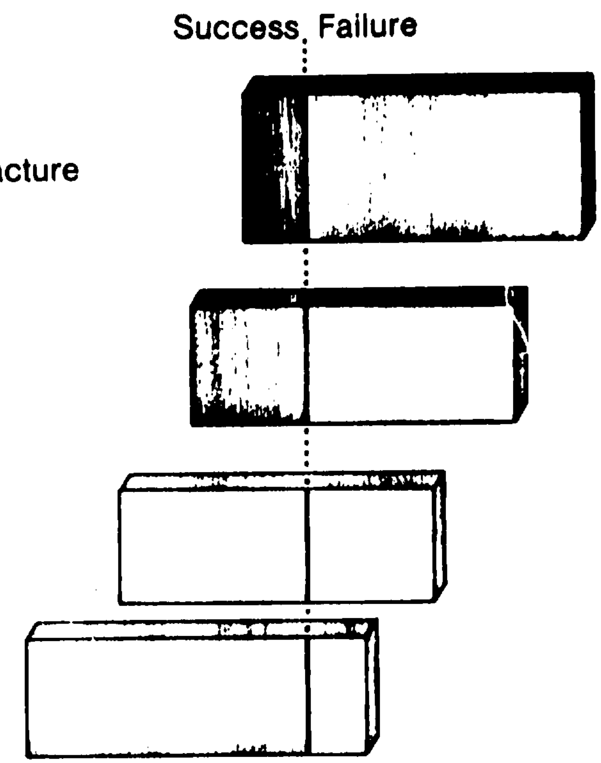
Industry's Risks

HIGH TECHNOLOGY:
Computer-integrated manufacture
Computer-aided design and manufacture
Manufacturing resource planning
Flexible manufacturing systems
Integrated data bases

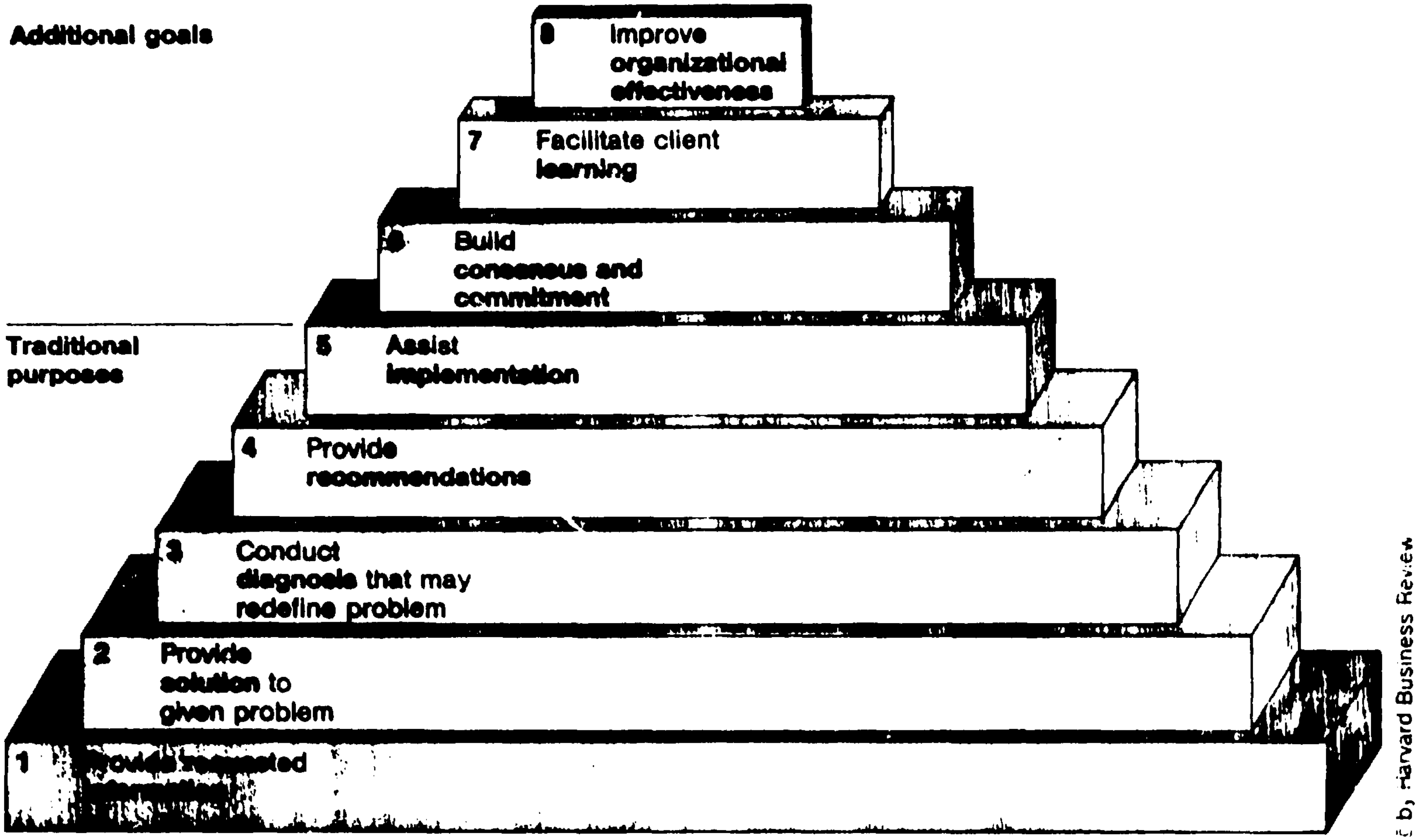
MEDIUM TECHNOLOGY:
Computer-aided design
Materials requirements planning
Direct numerical control
Robots

LOW TECHNOLOGY:
Just-in-time
Cells
Computer numerical control

NO TECHNOLOGY:
Simplicity
Layout
Numerical control



A hierarchy of consulting purposes



MTC

CAD/CAM Justification and Implementation Methodology

[illegible]

- Activity 1: Preliminary Project Investigation
- Activity 2: Current System Inventory/Audit
- Activity 3: CAD/CAM Project Proposal
- Activity 4: Project Cost-Benefit Analysis

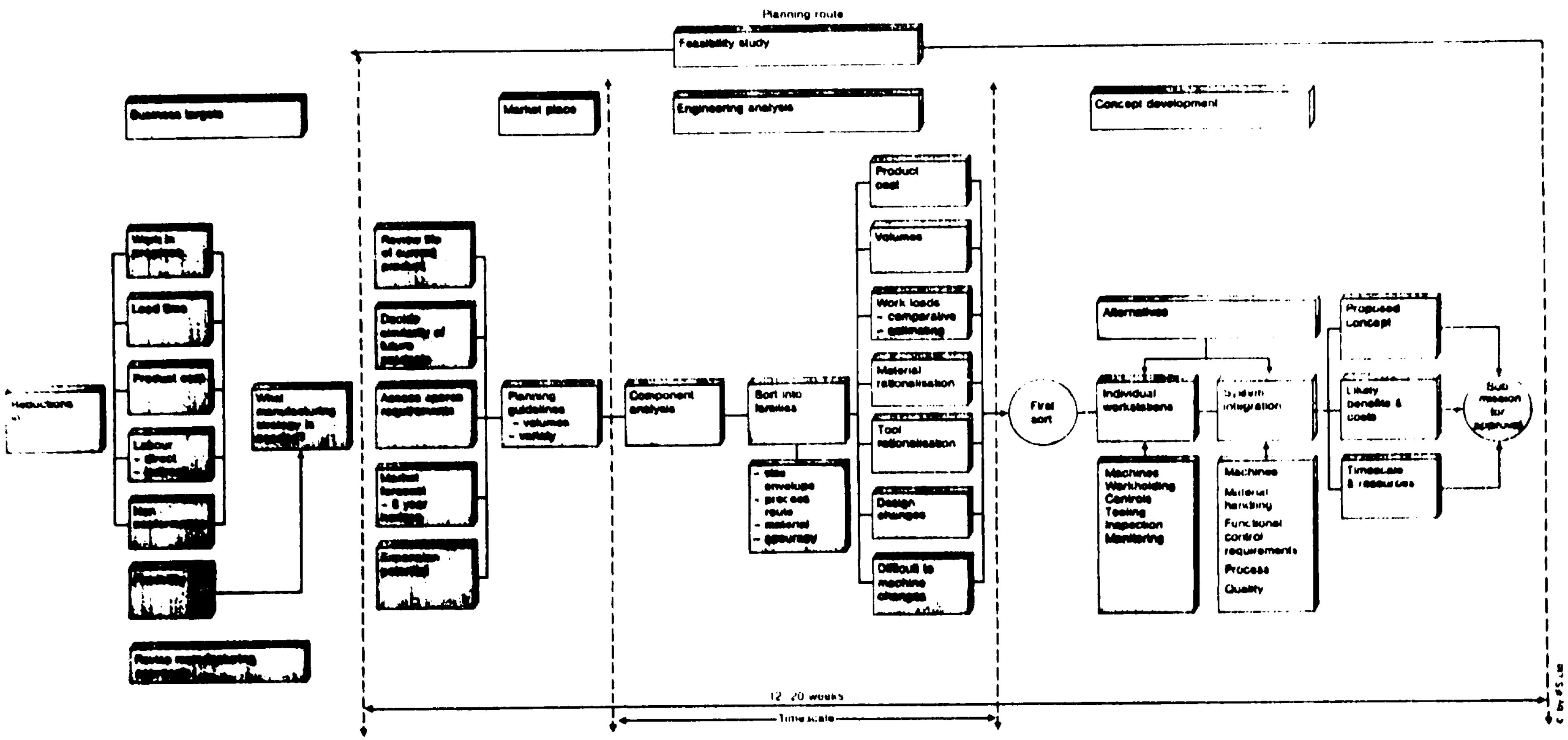
Phase Two – Project Planning and System Acquisition

- Activity 5: Project Implementation Plan
- Activity 6: Project Definition
- Activity 7: Project Specifications
- Activity 8: System Selection

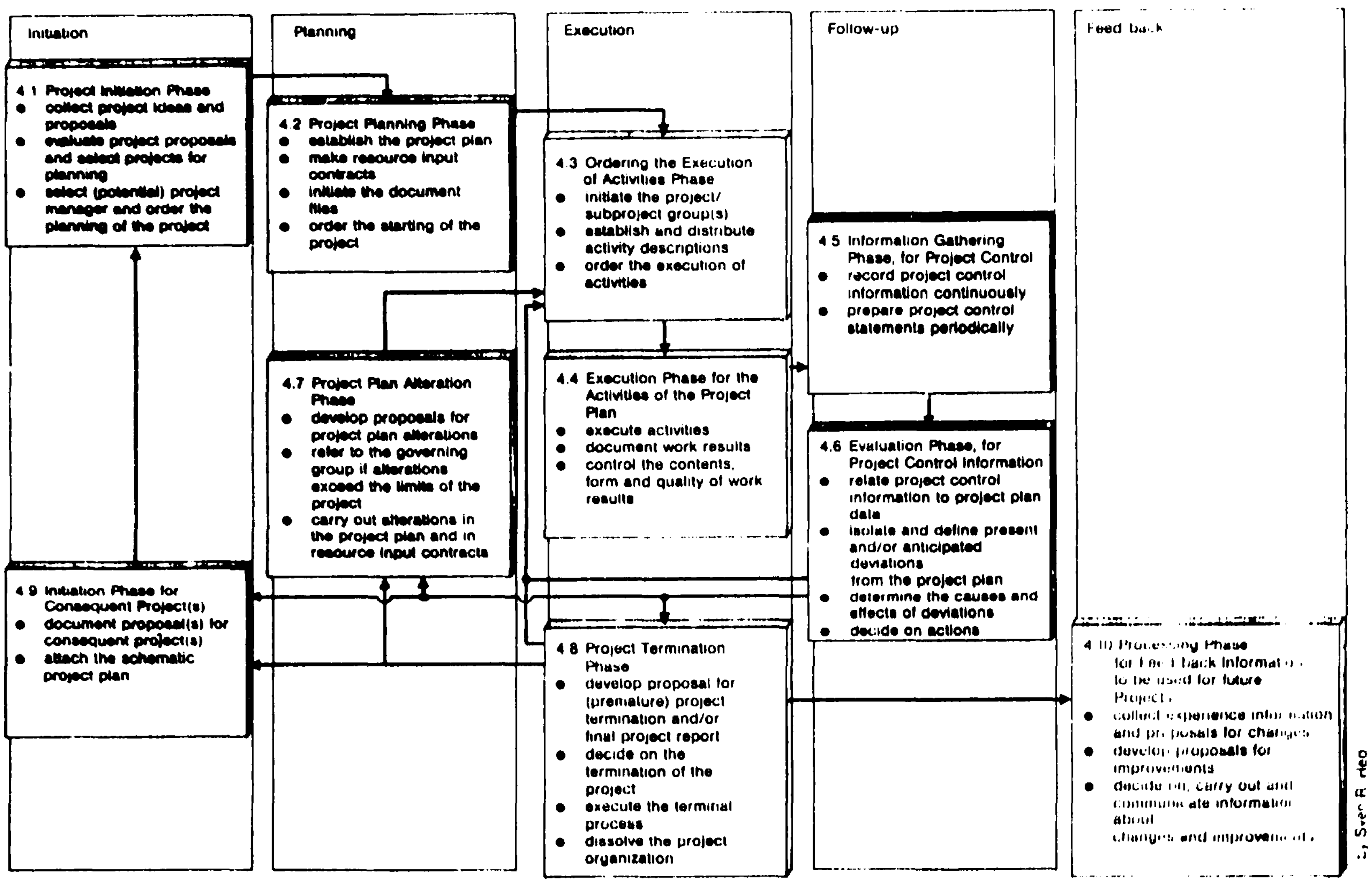
[illegible] Considerations

- Activity 9: Pilot/Test Project
- Activity 10: System Implementation
- Activity 11: Project/System Operations

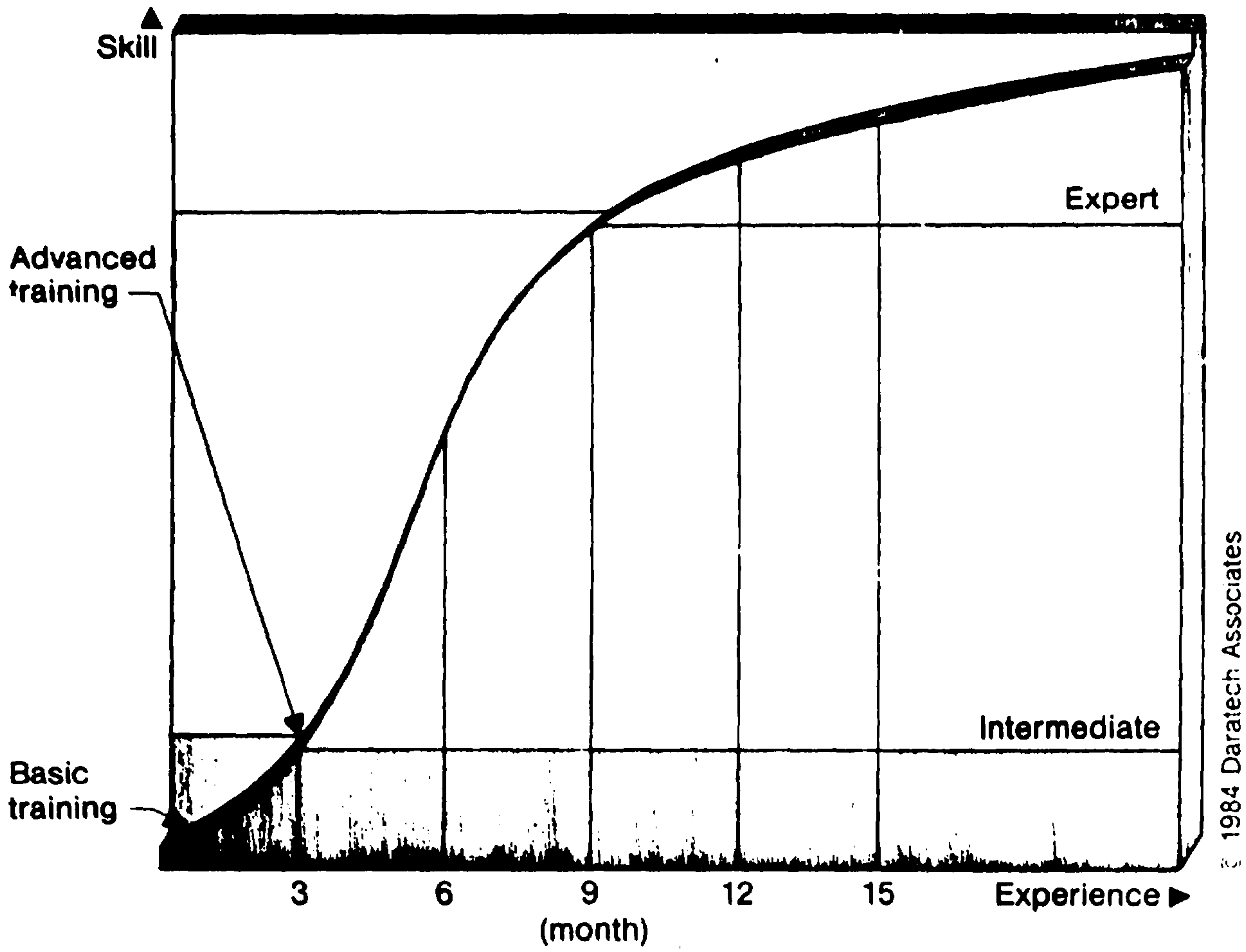
Typical planning route for a feasibility study.



The Project Control Process: Project Control Phases (master chart)



Typical operator's learning curve



STEPS IN DEVELOPING A LONG-RANGE TRAINING PLAN

1. Identify potential users.
2. Establish user requirements.
3. Prepare a basic operator course and customized class material to complement vendor training manuals.
4. Establish prerequisites for students.
5. Start basic training oriented toward users' discipline when practical.
6. Prepare application-specific courses (e.g., finite-element modeling, and NC programming) and training materials.
7. Prepare familiarization course for supervisors and managers.
8. Prepare new software release courses as required.
9. Prepare refresher course for operators who have not used the system for a long time.

CAD/CAM INVESTIGATION-PLANNING CHECKLIST

__ 1. Define CAD/CAM feasibility assessment objectives

__ 2. Develop questionnaires and interview formats, including:
   __Creator and user questionnaires
   __Engineering documentation questionnaire
   __Cost questionnaire
   __Information flow process questionnaire
   __System interface requirements questionnaire

__ 3. Develop schedules and assign responsibility for interviews and questionnaires

__ 4. Complete data-gathering activities

__ 5. Prepare data reduction formats to aid analysis

__ 6. Analyze collected data according to performance and cost objectives

__ 7. Complete the current system inventory/audit report

__ 8. Define CAD/CAM functional requirements

__ 9. Develop the CAD/CAM macro strategic plan, including:
   __Schedule
   __Pilot study
   __Conversion plan
   __Implementation team
   __Personnel costs
   __Data base design
   __System operation design
   __Consultant costs
   __Hardware configuration and costs
   __System implementation costs
   __System interface costs
   __Applications software costs
   __Ongoing operations; performance and cost factors

__10. Complete the needs/wants/risks decision analysis

__11. Complete the cost analysis of the CAD/CAM system

__12. Complete the CAD/CAM cost/benefit analysis

__13. Decide whether to proceed

OUTLINE FOR TECHNICAL SYSTEM SPECIFICATIONS DOCUMEN

1. Introduction
2. Intended system use
3. Current methods of operation
4. Anticipated method of CAD/CAM system operation
5. System software requirements
6. System hardware requirements
7. Production system support/maintenance requirements
8. System documentation requirements
9. User training requirements
10. System environmental considerations
11. System warranty and acceptance requirements
12. System quality assurance considerations
13. Vendor objective statement.

CAD/CAM SYSTEM FEATURES LIST

Mechanical Drafting/Design

Essential Features
- 3D drawing
- Text scaling
- Line weighting
- Line typing (chain, dot, etc.)
- Dimensioning (metric, imperial)
- Cross-hatching
- User library of standard parts
- Generation of cross-sectional views
- Tolerance and error checking
- Calculation of moment, mensuration, etc.
- Assembly checking for separately drawn parts
- Developable surface layout
- Access to geometric database via software (vendor-supplied language or FORTRAN)
- Output of 3D geometry in IGES format

Desired Features
- Automatic dimensioning
- Grid generation for finite element work
- Kinematics
- Structural stress analysis
- Architectural drawing capability
- Gear tooth generation
- Vendor-supplied finite element analysis package that is linked to CAD/CAM geometry

Numerical Control

Essential Features
- Production of NC tool paths for up to 5-axis contouring machines
- Cutter path generation for milling machines with pocket and boundary routines, planers, flame cutters
- Cutter path generation with drill, tap, threading, profiling and boring tools
- Fixture avoidance
- Inclusion of tool change and auxiliary functions in cutter path file
- Capability to drive machines using controllers with parabolic and circular interpolation
- Tolerance setting
- Regulation of cusp height between cuts
- Validation of cutter path
- Boundary recognition
- Availability of post-processors for a wide variety of modern automatic machine tools

Desired Features
- Output from APT including extended surface geometry
- Output of cutter location file

General CAD/CAM System Features

Desired Features
- Task accounting
- Secure filing system
- Archive management
- Ability to set process priorities and virtual memory management characteristics for the system
- Data storage on magnetic tape
- Output of paper tape at user stations
- Flexible user station hardware
- Use of current computing machines
- Data communication protocol via RS232

CAD/CAM SURVEY

Page -1-

1. Rank your interest in the following areas. ("1" is most important, "2" is next in importance etc.)

   ______ CAD generally
   ______ CAM generally
   ______ Engineering Analysis
   ______ Automated Drafting
   ______ Piping/Flow
   ______ Other (specify) ______
   ______ Other (specify) ______
   ______ Computer graphics
   ______ PC/IC layoutcheckout
   ______ Electrical
   ______ Mechanical/Architectural
   ______ Graphic arts

   Comment ____

2. Indicate the extent of your current involvement in CAD/CAM.

   ______ None ______ Some ______ Fair ______ Heavy

   Comment ____

3. Estimate the growth rate of CAD/CAM in your laboratory for the next five years.

   ______ None ______ Some ______ Fair ______ Heavy

   Comment ____

4. In your opinion, what are the major benefits of CAD/CAM. ("1" is most important, etc.)

   ______ Productivity increases
   ______ Ease of modification
   ______ Information integration/ byproducts
   ______ Other (specify) ______
   ______ Quality/accuracy improved
   ______ New capabilities available
   ______ Dollar savings

   Comment ____

5. What do you feel are major problems in current CAD/CAM systems and packages? (Use "1" for the most important, etc.)

_____ Inadequate user interface
_____ Shortage of trained personnel
_____ Unproven for "one-off" work
_____ Other (specify) _____
_____ Other (specify) _____
_____ Inadequate capabilities
_____ Economic justification

Comment ____

6. Which of the following would you require in the CAD/CAM area?

Input

_____ Graphic CRT
_____ Keyboard
_____ Digitizing tablet
_____ Other (specify) _____

Processing/analysis

_____ 3D capability
_____ Structural analysis codes
_____ Parts-list generators
_____ Pressure/flow analysis
_____ Other (specify) _____
_____ Other (specify) _____
_____ 2D plus depth
_____ Circuit analysis
_____ Heat/cooling analysis

Output

_____ Large flatbed plotter
_____ NC/CNC-compatible output
_____ Graphic 16/35 mm film output
_____ Other (specify) _____
_____ Other (specify) _____
_____ Automated drafting
_____ NC tools
_____ Optical-head plotter

Comment ____

7. In your areas of CAD/CAM interest, do you know of ...

_____ reports of successful CAD/CAM entry?

_____ products available meeting your requirements?

_____ CAD/CAM trends in outside research labs?

_____ available processing/analysis codes?

Comment ____

8. Please provide general comments on CAD/CAM which you think might be of interest:

____

____

____

____

____

RFP

CONTENTS

A recommended RFP includes the following sections:

1. Invitation to bid
2. Bidder/vendor list
3. Instructions to bidders/vendors
4. Terms and conditions
5. Special considerations
6. System benchmark considerations
7. System technical specifications

(Organization of the system technical specifications section is detailed later in this article).

CONCLUDING COMMENTS :

TECHNICAL SPECIFICATIONS REVIEW LIST

When writing the technical specifications, the investigative team should focus on the following objectives:

* Language should be simple and clear. The team should not try to develop a document that is overly legal or technical.

* User needs should be thoroughly discussed with several vendors before finalizing the technical specifications.

* The vendor should be told what the organization wants and needs, not how to build each system component.

* Document everything. System capabilities should not be presumed, and vendor assurances should not be taken on faith.

* The purchasing and legal members of the team should review matters that may have financial consequences.

* The vendors must respond according to the format specified, to ensure that proposals can be compared effectively.

* The RFP and technical specifications should be presented to all vendors simultaneously with sufficient time allowed for vendor review.

SAMPLE VENDOR SUPPORT QUESTIONS

- How long has the company been in business?
- How many employees does the company have?
- Did the company design or is it only marketing the hardware? Software?
- What are the business, technical, and applications backgrounds of key members of the firm?
- Is the company profitable? Please supply annual report.
- Will the company support the installation of the package?
- What warranty and future support will the company guarantee?
- What nonwarranty support will the company supply?
- Is there a regular program of revisions and enhancements?
- Is training of user/technical personnel included in the package price?
- How many systems has the vendor delivered?

CHECKLIST OF QUESTIONS TO ASK ABOUT CAD/CAM SERVICE ORGANIZATIONS

1. Where is the service office located?
2. Are there district and regional offices? Where are they located?
3. How many representatives work from the service office?
4. How many customers and systems are supported from the service office?
5. Is technical support available from the district office? From the regional office?
6. How many representatives work from the district office? From the regional office?
7. How many customers and systems are supported from the district office? From the regional office?
8. What level of training and experience do the service representatives have?
9. What range of spares is carried by the service representatives?
10. What range of spares is kept at the district office? At the regional office?
11. What method is used to dispatch service representatives?
12. Is the service organization's management able to monitor the time of each dispatch? Does it?
13. Is there an established problem escalation procedure? What is it?
14. How is problem escalation procedure communicated? Is it documented?
15. What authority does the service office have? District office? Regional office?
16. Which individual has the authority to decide when system equipment is replaced? Does the service organization report to that individual?
17. Are technical manuals and current drawings of system configuration supplied with the equipment?

SAMPLE SITE VISIT QUESTIONS

System Features and Design Characteristics

- Describe your organization's major CAD/CAM system use and key applications.
- Describe system configuration and cost. Is the system turnkey or unbundled?
- From a general perspective, describe the system's intelligence and flexibility in handling design and manufacturing control information.
- Does the system support high-level languages (e.g., FORTRAN, C, Pascal)?
- Is the CAD/CAM system required to communicate with other systems? Have any interfaces been effected?
- Does the system support remote workstations? For which applications or users?
- Is the system upgradable? Give the range.

System Performance and Operational Characteristics

- How many workstations can be operated before moderate degradation occurs? Unacceptable degradation?
- Can application program development occur concurrent with routine system operation? Does this produce any significant degradation in routine operations?
- Have you experienced data translation problems when interfaces have been implemented? What kinds of problems?
- What is the system's rate of downtime?
- Describe data input sources and forms and data output flexibility.
- What data security controls can be used between different CAD/CAM user groups?
- How often are data backups required for adequate protection against data base degradation?

Vendor Support

- Does the vendor supply good system documentation? Describe any problems in this area. Are new software releases adequately debugged before they are issued?
- Does the vendor provide hardware maintenance? Describe the overall quality and responsiveness of maintenance.
- Does your CAD/CAM vendor have an active user group?
- Describe the vendor's user training program. How long does it take to train an operator on the system to reach beginner, intermediate, and expert skill levels?
- Describe sources of applications software. Indicate satisfaction.

Organizational Impacts

- How has CAD/CAM affected information flow and business practices within your organization?
- What considerations had to be made regarding the location of equipment and workstations and the design of the surrounding environment?
- How has the system affected turnaround and error rates?
- Provide any additional insight into the CAD/CAM system's strengths and weaknesses.

CAD/CAM TECHNOLOGY INFORMATION SOURCES

Literature

Books and reference documents

- General textbooks
- Specific topics
- Directories

Conference and seminar proceedings

Periodicals

- Newsletters
- Industry magazines
- Association journals

Vendor literature (includes hardware, systems, software, and services vendors)

- General corporate/product information
- Technical specifications
- Price lists
- Customer references and project descriptions
- News releases
- Analytical reports

Conferences and Seminars (Schedules are available in trade publications)

Hardware/system oriented (also includes vendor-specific user conferences)

Application oriented

Industry oriented

Site Visits

Visits to operational CAD/CAM installations with applications similar to those desired

Three Phases

1 Audit of the total production system

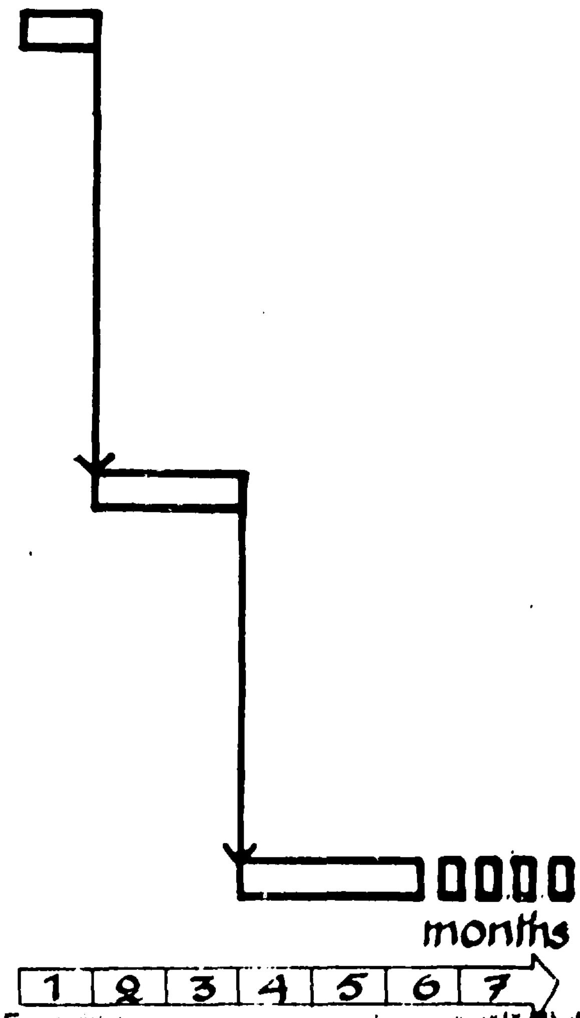
- FUTURE MANUFACTURING STRATEGY
- AUDIT OF PRESENT PRODUCTION SYSTEM INCLUDING CONTROL SYSTEMS
- POLICIES FOR FURTHER DEVELOPMENT

2 Feasibility study for robotizing

- REVIEW OF RELEVANT FACTS
  - Scope of Installations
  - Product Mix
  - Capacity
  - Type and Size of Robot/s
  - Auxiliary Equipment, Layouts
- MAINTENANCE IMPLICATIONS
- IMPLEMENTATION PLAN
- COST-BENEFIT ANALYSIS
- FEASIBILITY REPORT, RECOMMENDATIONS

3 Implementation, follow up

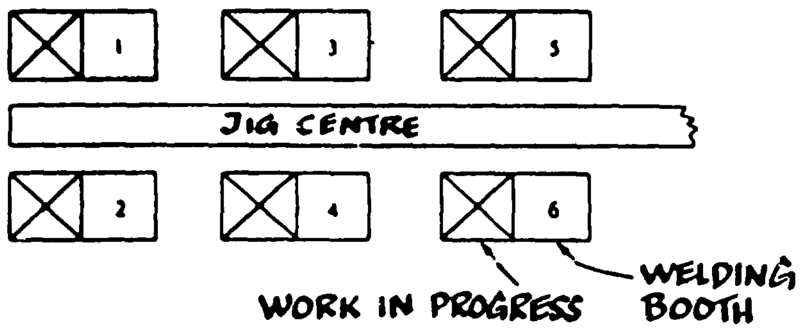
- ESTABLISHING WORKING GROUPS
- DETAILED PLANNING OF INSTALLATIONS
- PURCHASE OF ROBOTS AND AUXILIARY EQUIPMENT
- APPOINTING ORGANISATION, MANNING, CONTROL SYSTEMS
- TRAINING OF PERSONELL
- INSTALLATION, TESTS, "DEBUGGING"
- INTERMITTENT FOLLOW-UP



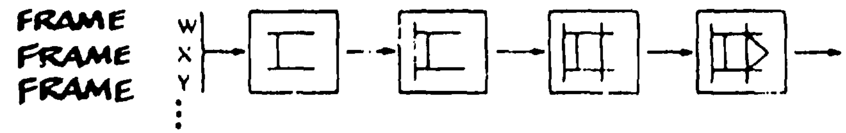
Development of layouts

EXAMPLE OF WELDING OPERATIONS

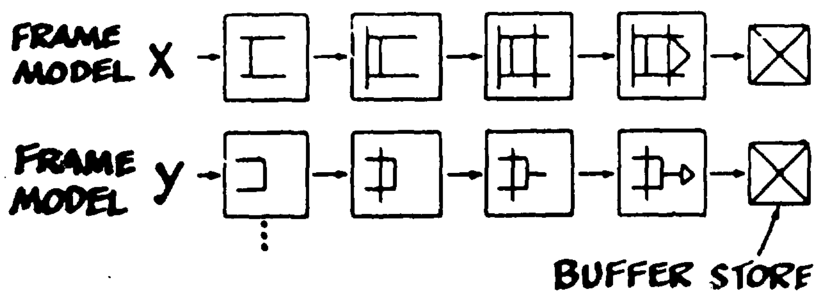
1 Functional layout with welding booths



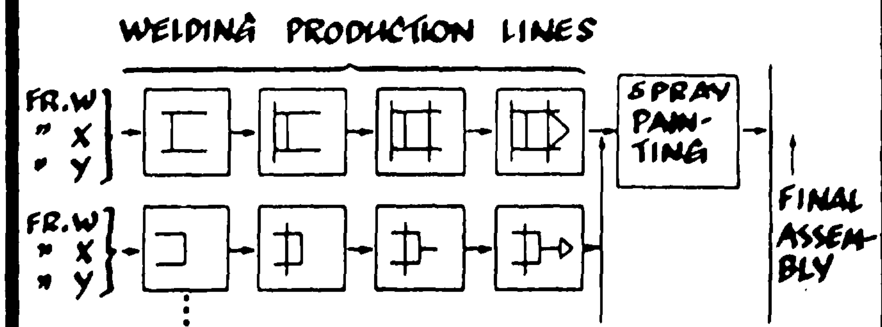
3 Mixed models on same line (group technology)



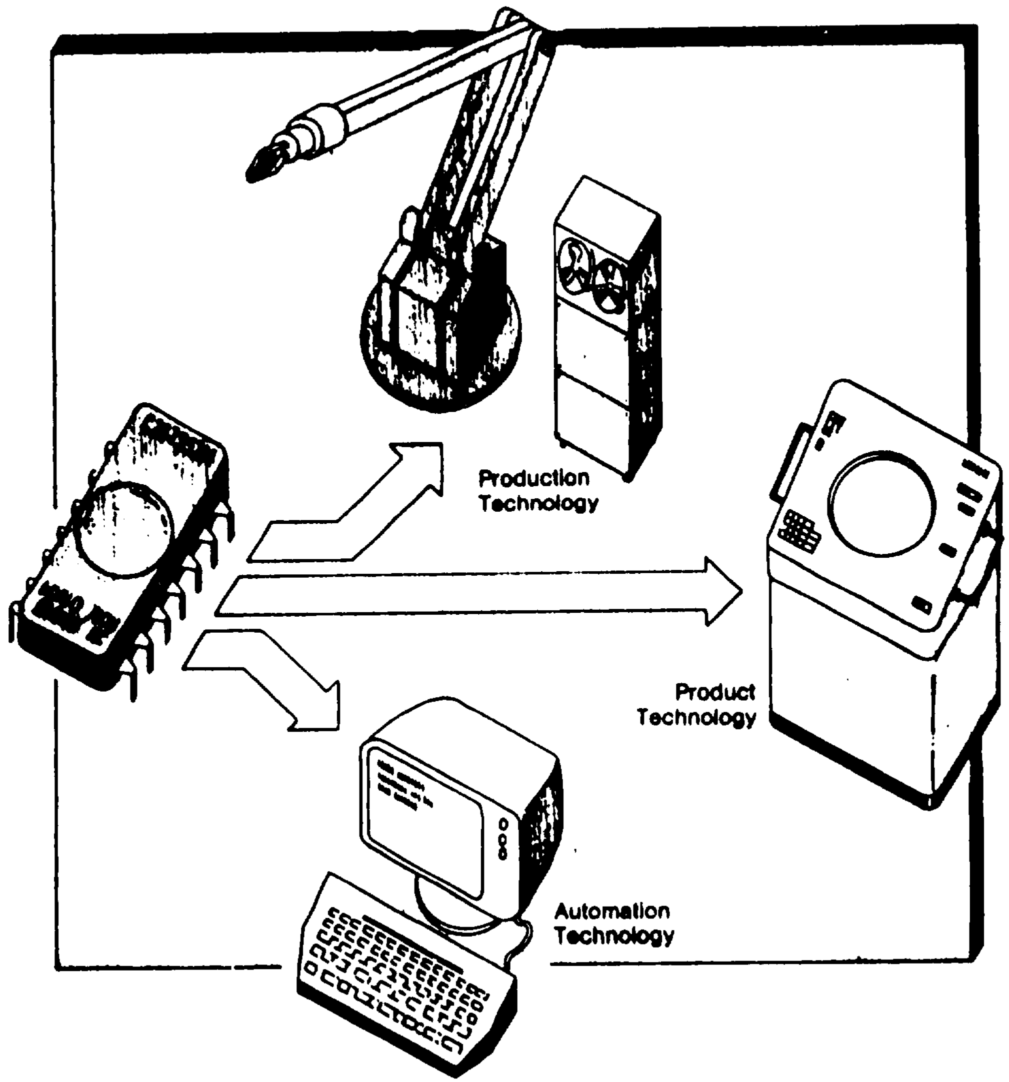
2 Special lines for welding



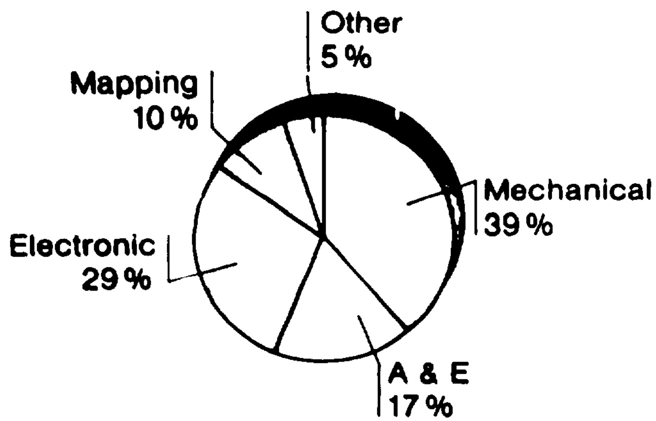
4 Lines integrated with following processes



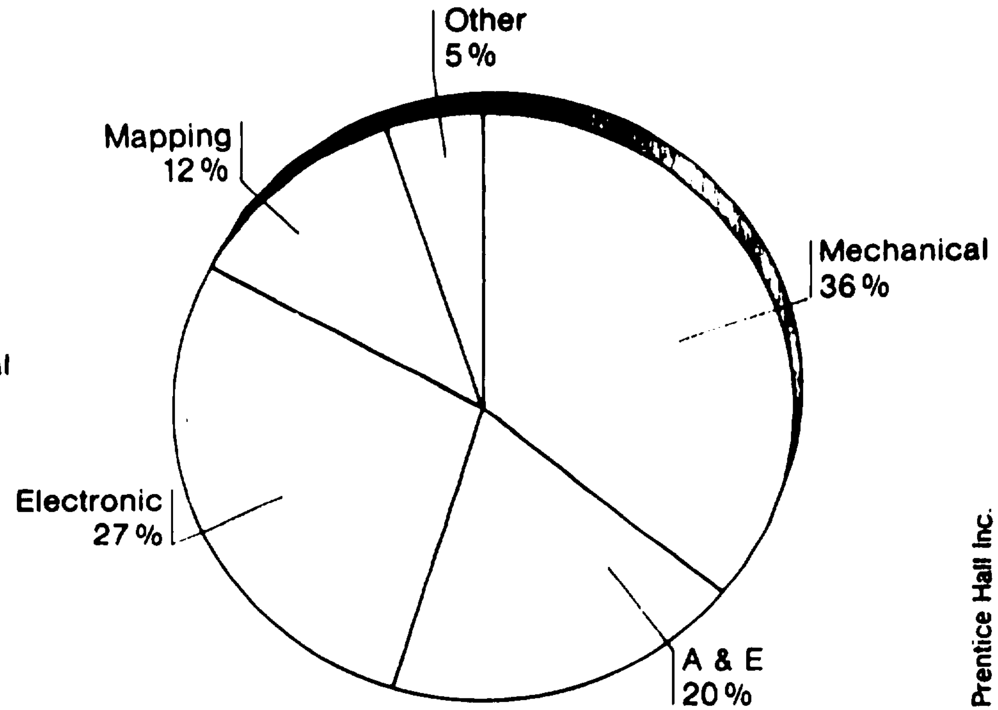
Technological Evolution



CAD/CAM Applications Growth.

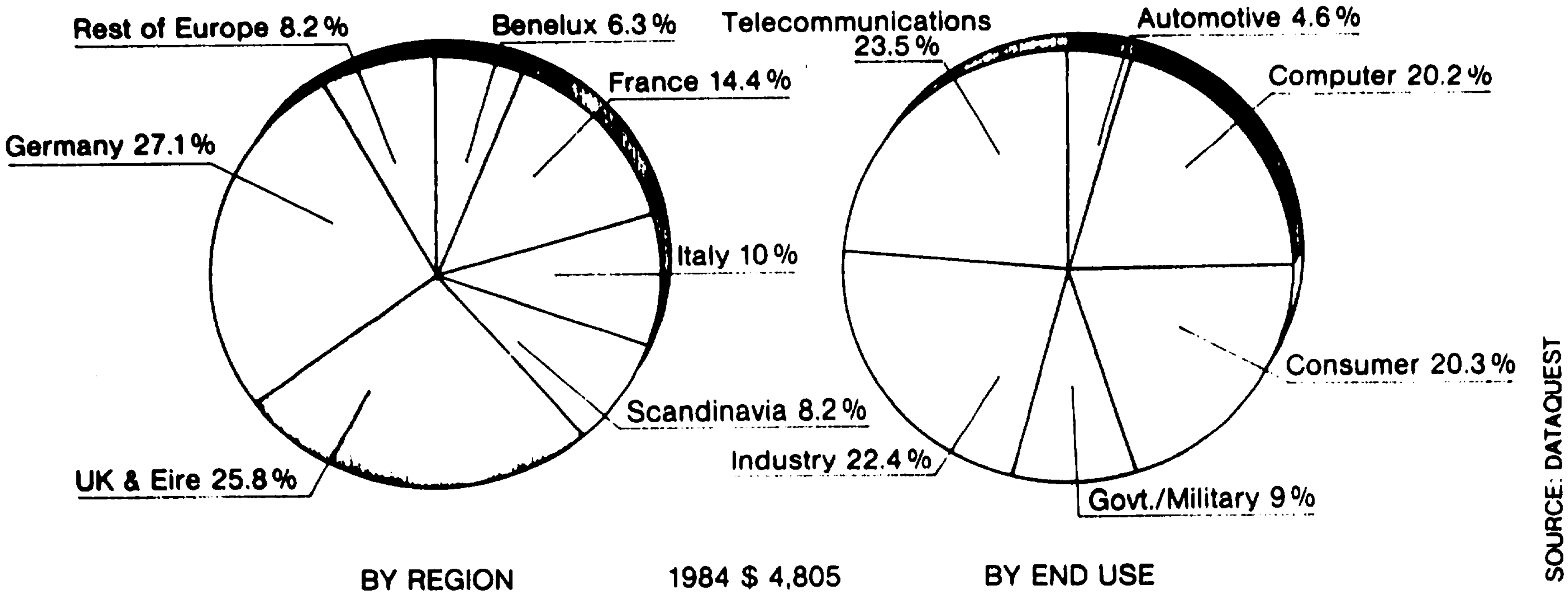


1979 total market $ 334 million

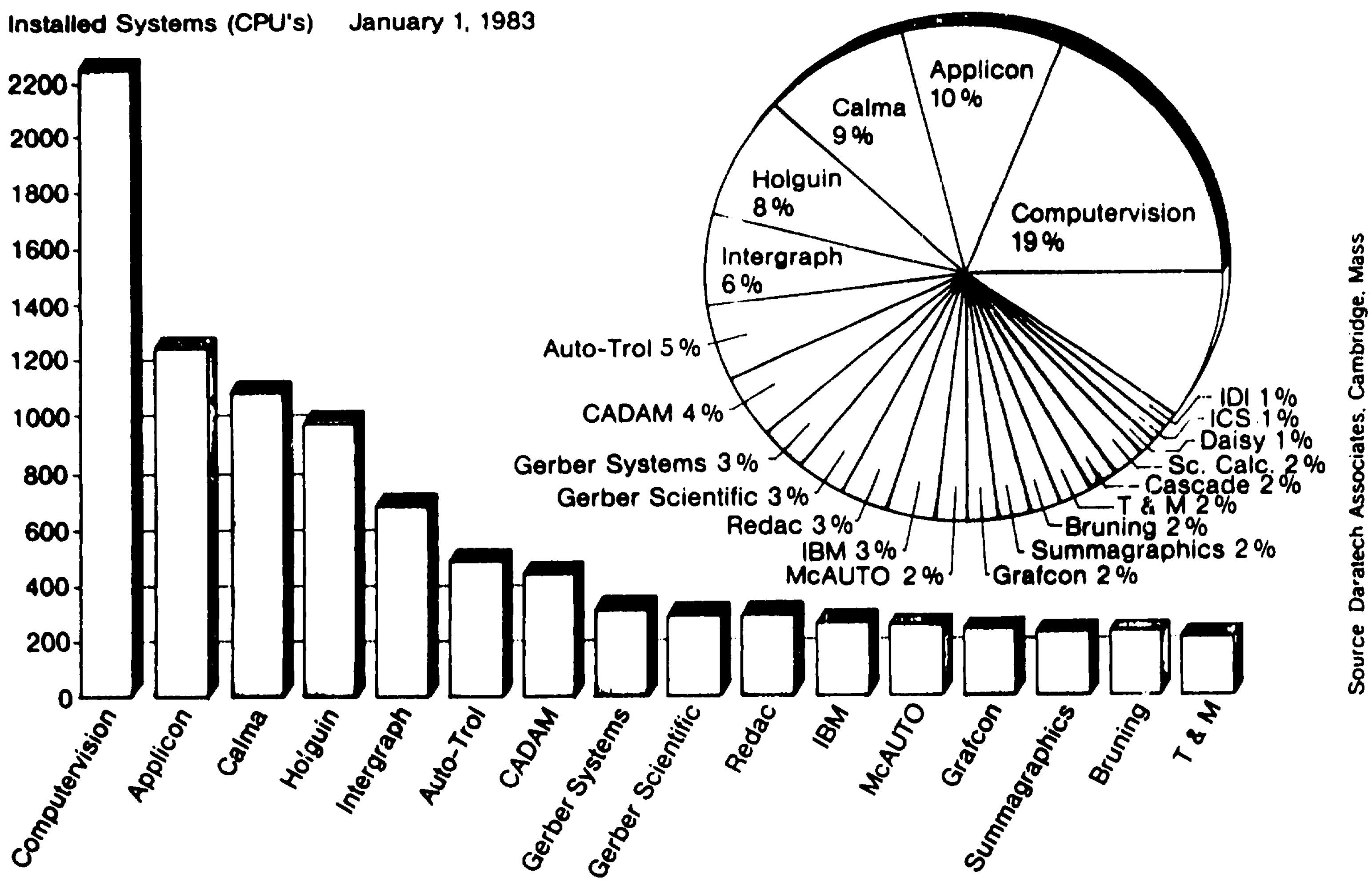


1983 total market (est.) $ 1520 million

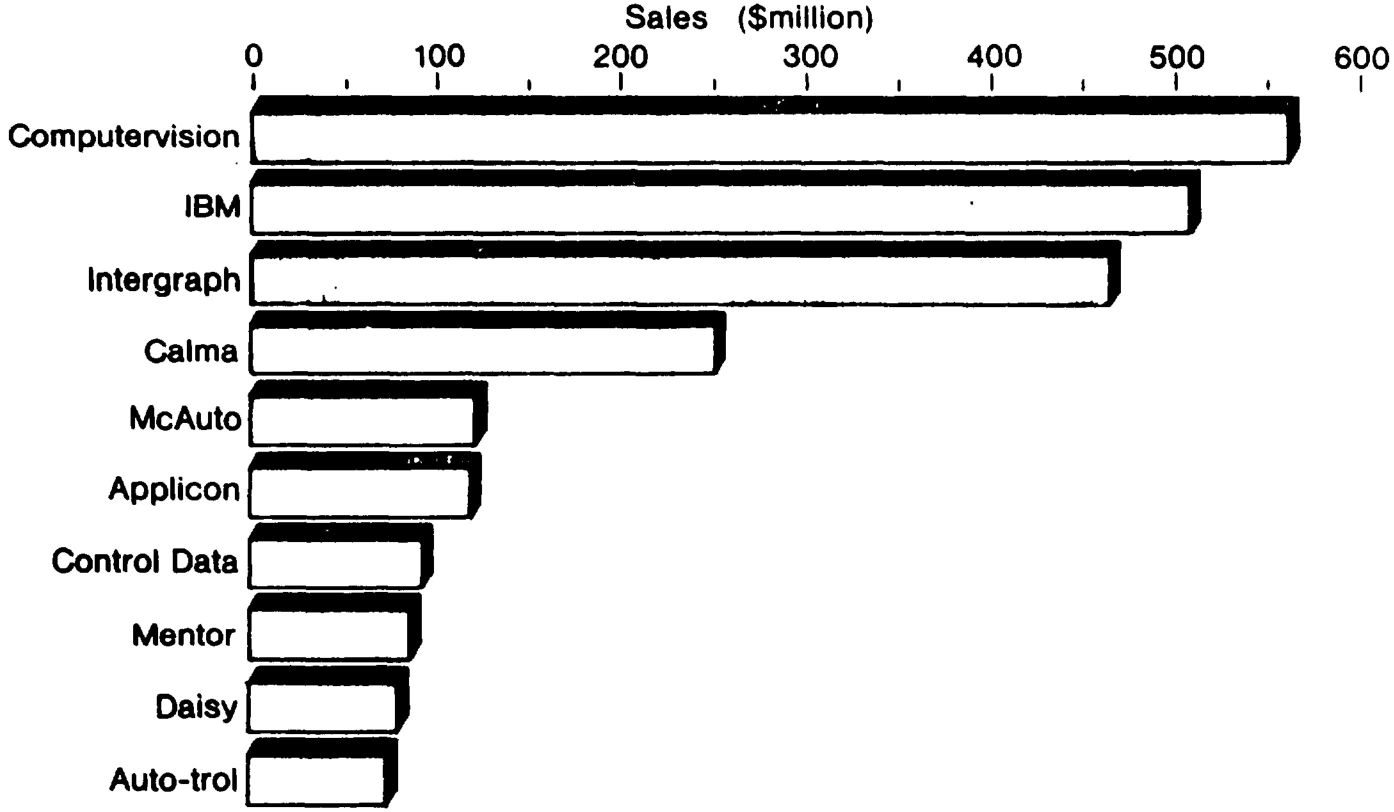
European Semiconductor Consumption



Number of Turnkey CAD/CAM Installations Worldwide – 1982



1984 U.S. CAD/CAM Industry Estimated Revenues

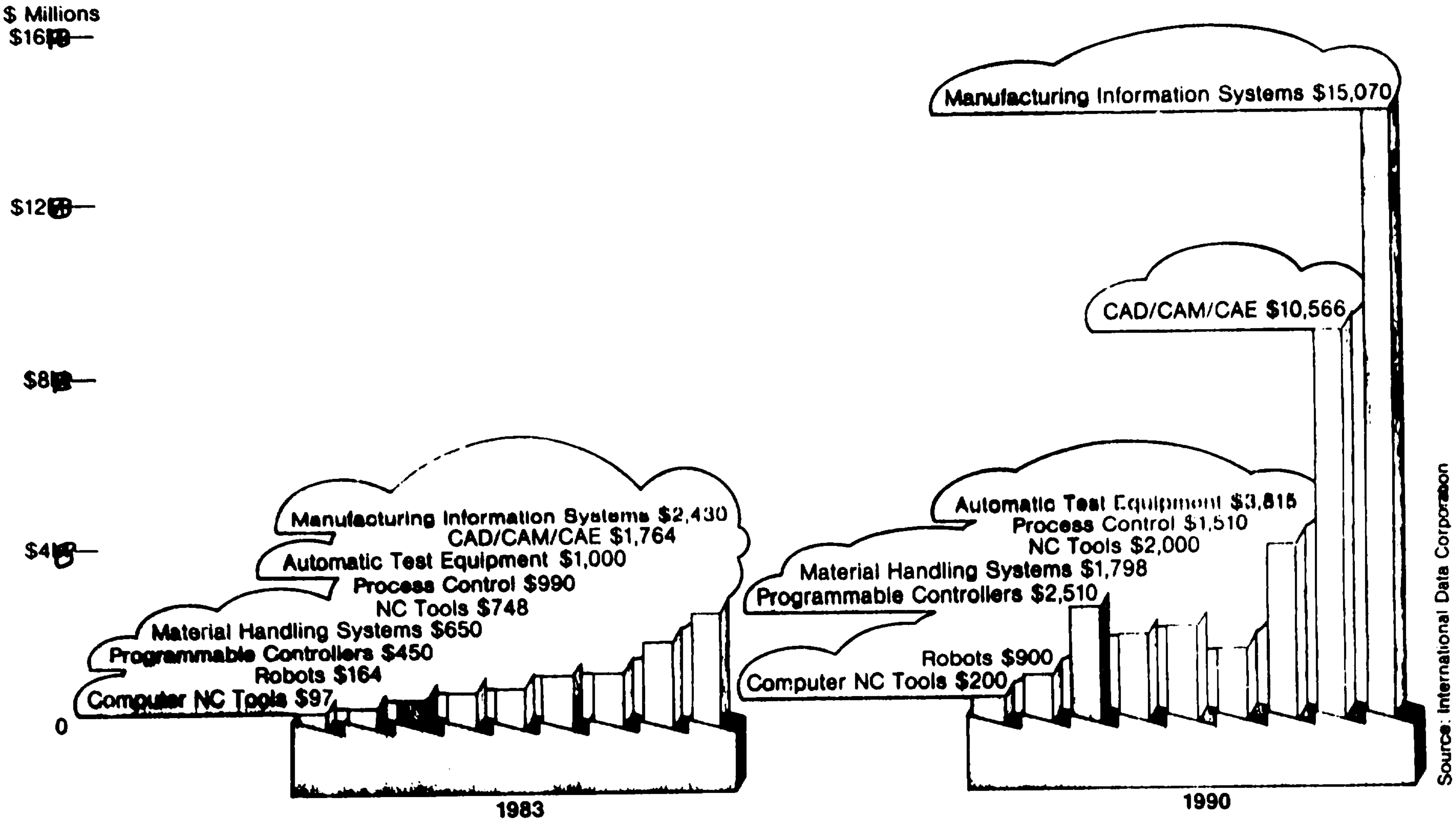


Source: DARATECH. Inc Cambridge Mass.

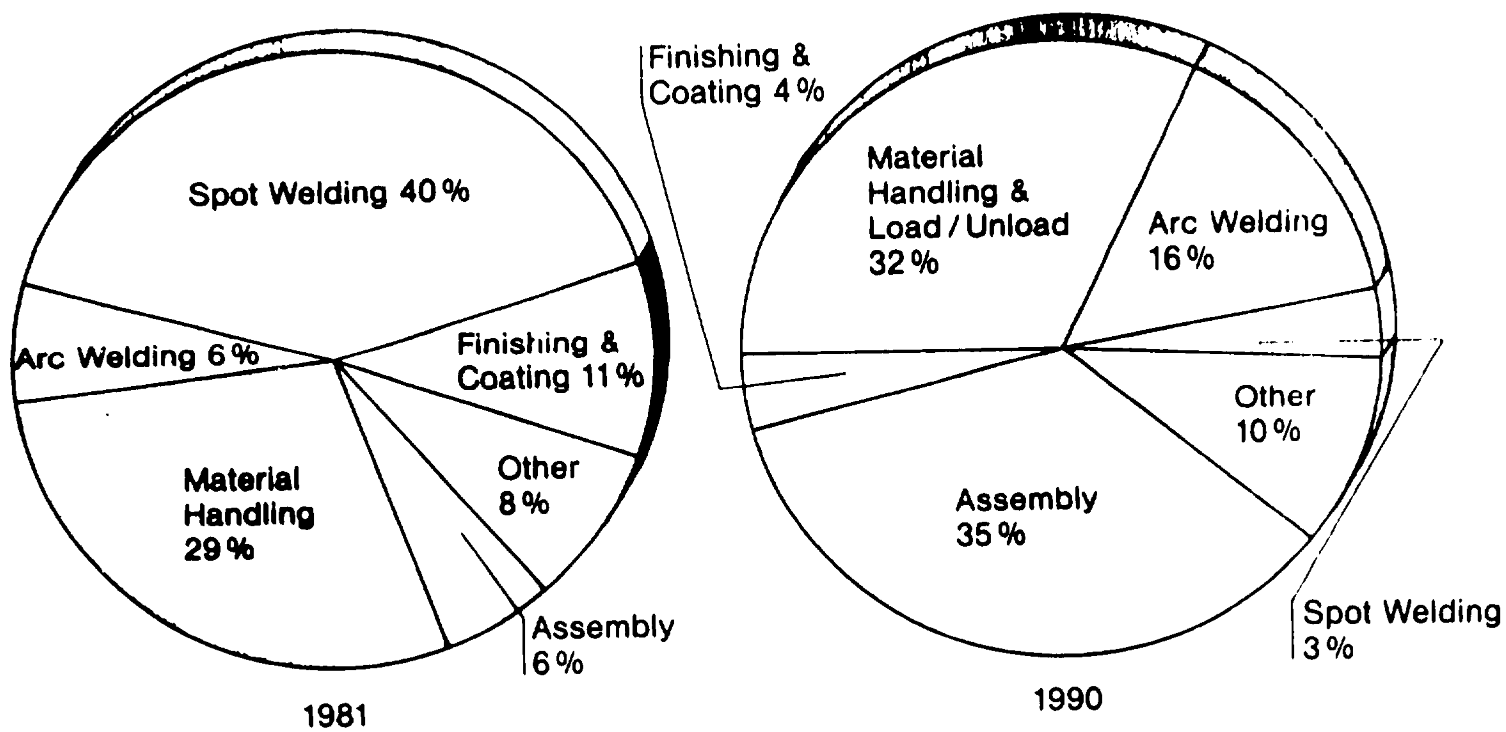
MTC

Smokestack America Embraces Automation

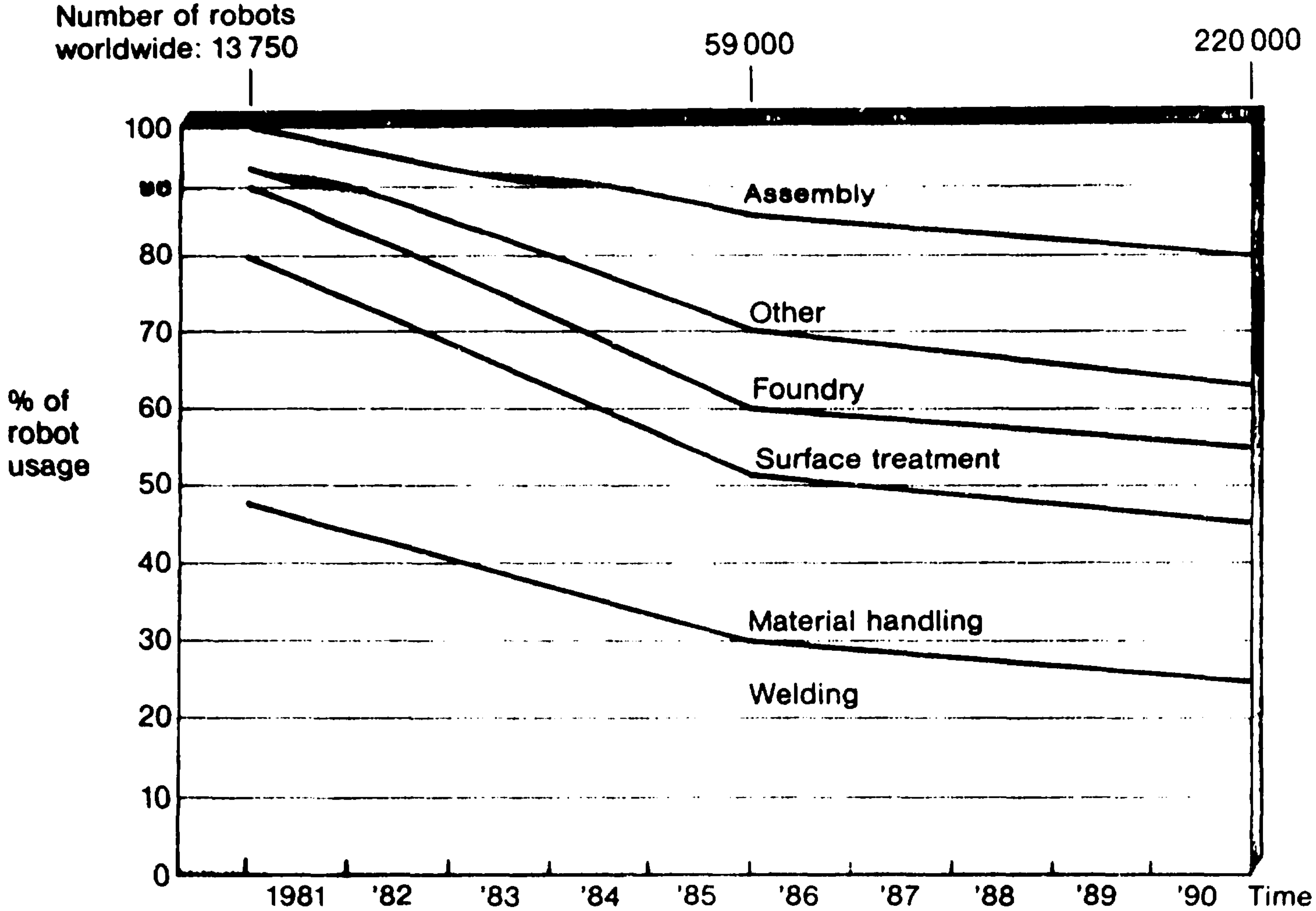
Worldwide Shipments, U.S. Manufacturers



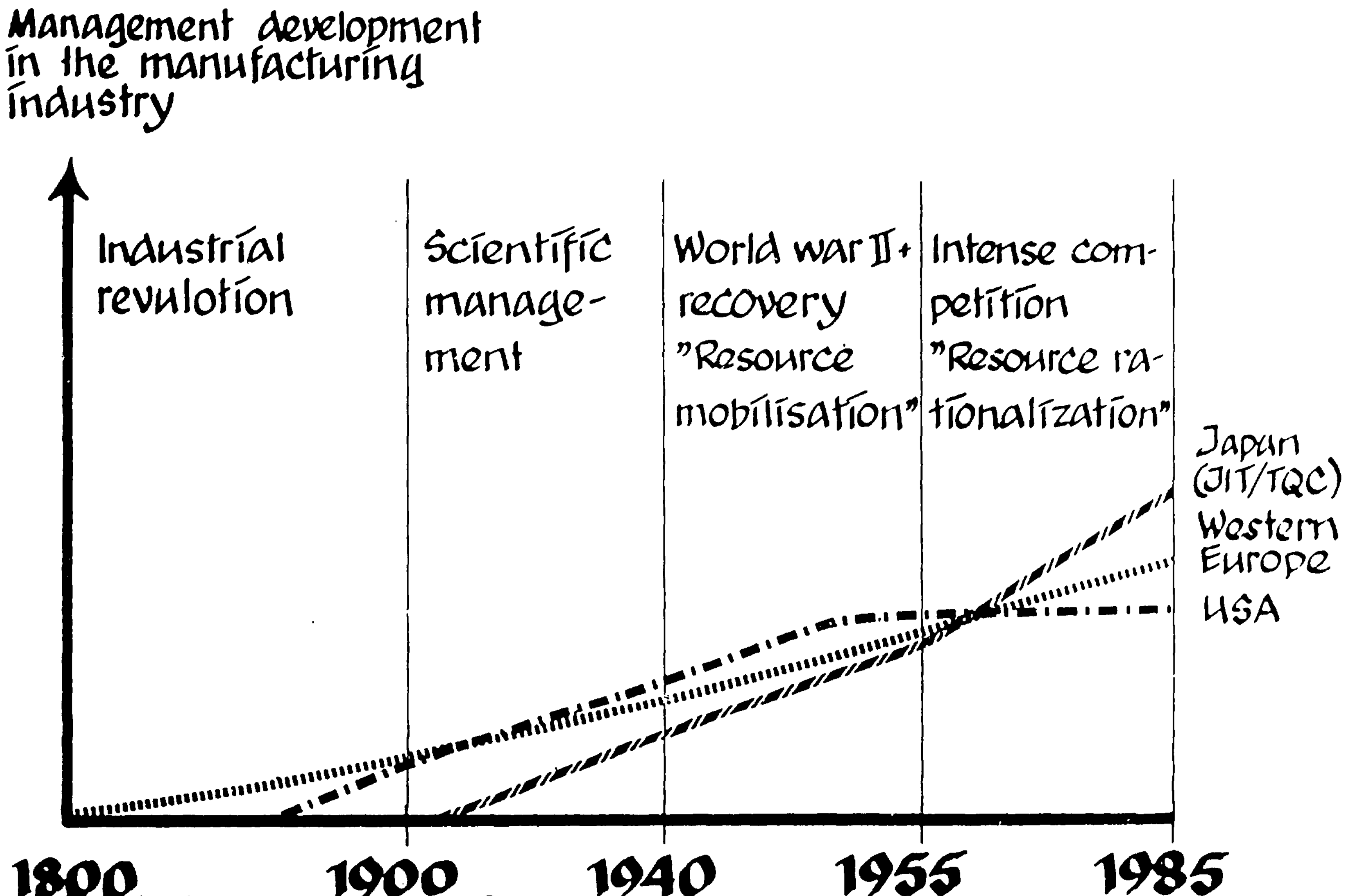
Robot applications will shift during the 80s.



Projected proportion of worldwide robot usage



The industrial development



COMPANY DEVELOPMENT

TOTAL PRODUCTIVITY

Productivity in product development
\+
Productivity in marketing/sales
= BUSINESS DEVELOPMENT

\+
Productivity in production
\+
Productivity in administration
= COST REDUCTION

\+
Productivity in capital employed = CAPITAL RATIONALISATION

=

Summerized as rate return in % of capital employed (RoI)

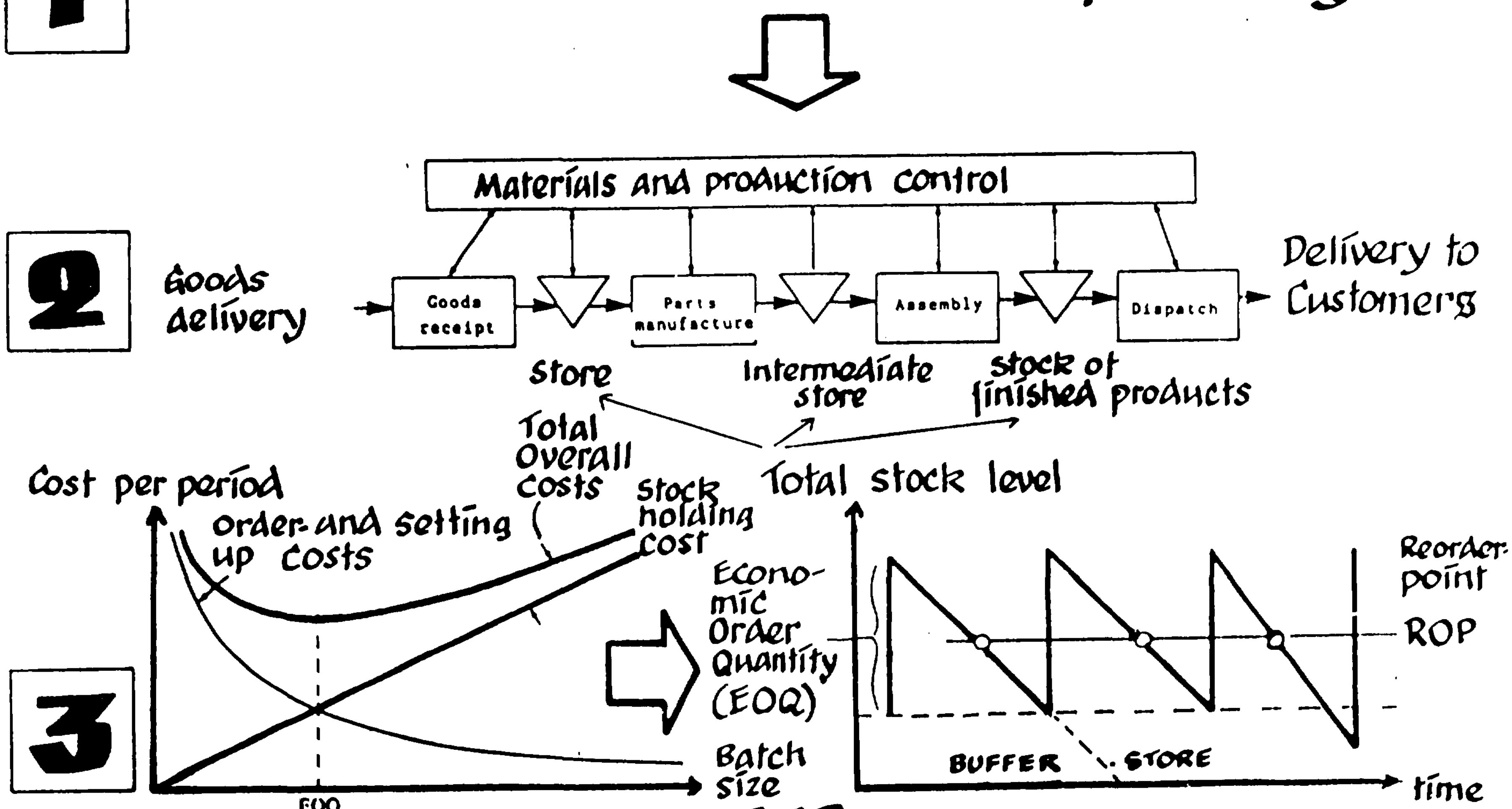
Western philosophy for control of manufacturing

Maynard MEC AB International Management Consultants

1 **MRP:** Material requirements planning

2

3



EOQ: Economic order quantity **ROP:** Reorder point

Japanese philosophy for control of manufacturing

Just-in-time (JIT)

Basic thesis:

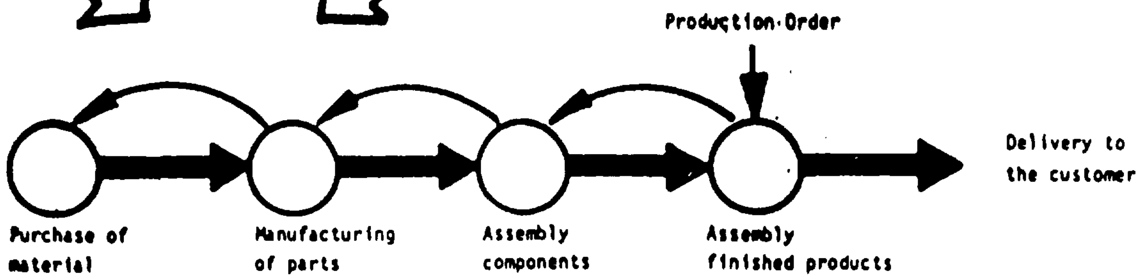
- Inactive, "dead" stores means waste of short material resources and, indirectly, waste of energy in extracting and refining raw materials.
- Stockholding of dead stocks means waste of valuable space.
- Defective parts, preassembled units and stock of finished products means a waste of material and energy.

Total quality control (TQC)

Basic policies:

- The objective is continued quality improvments. The western term "Acceptable quality" is rejected.
- The individual operator has the responsibility for perfect quality not a quality Control - or Final Inspection department.
- Preventive inspection is carried out at source so that the problem can be adjusted directly instead of a random discovery after a whole batch has passed through the production process.
- Only such measures of quality which are obvious, visible, simple and understandable are justed.

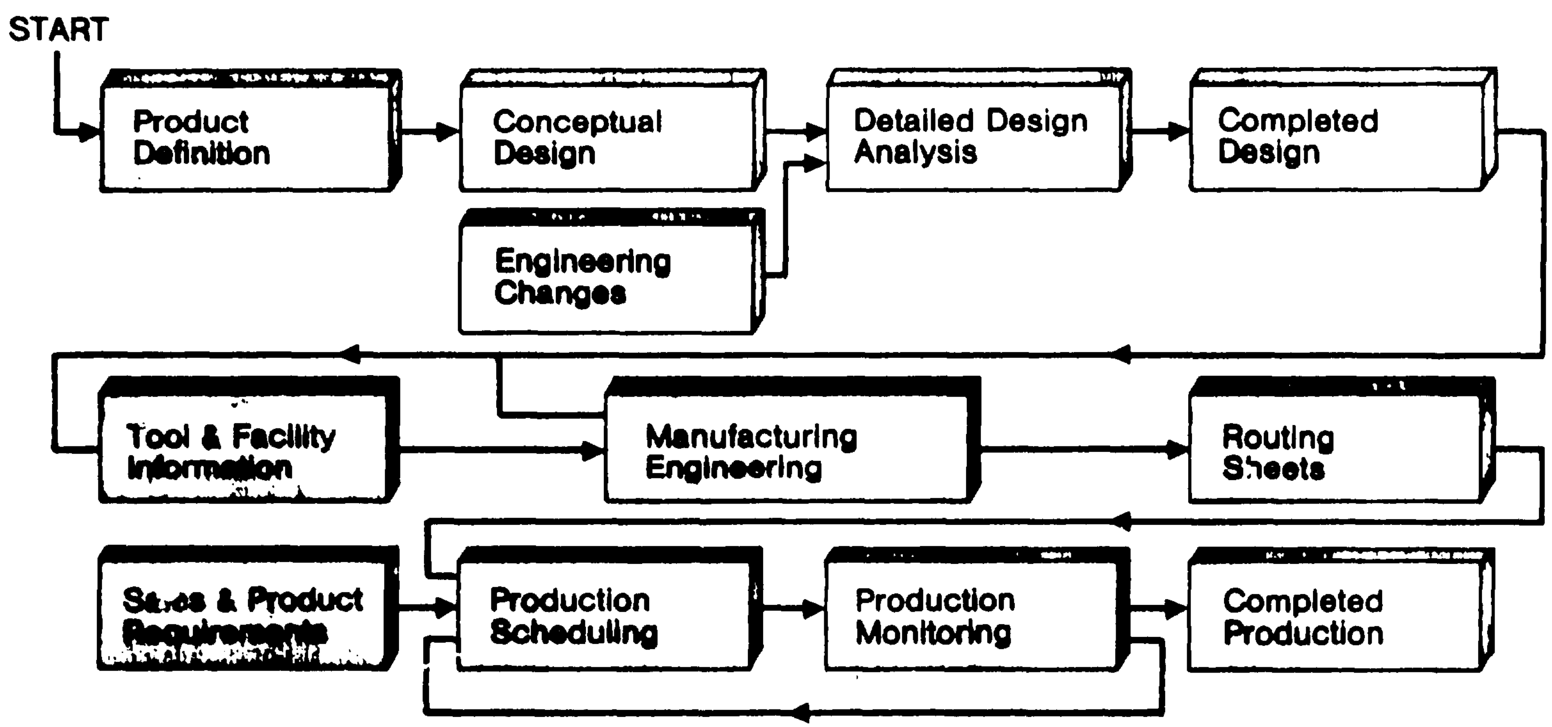
Production control procedure "KANBAN"



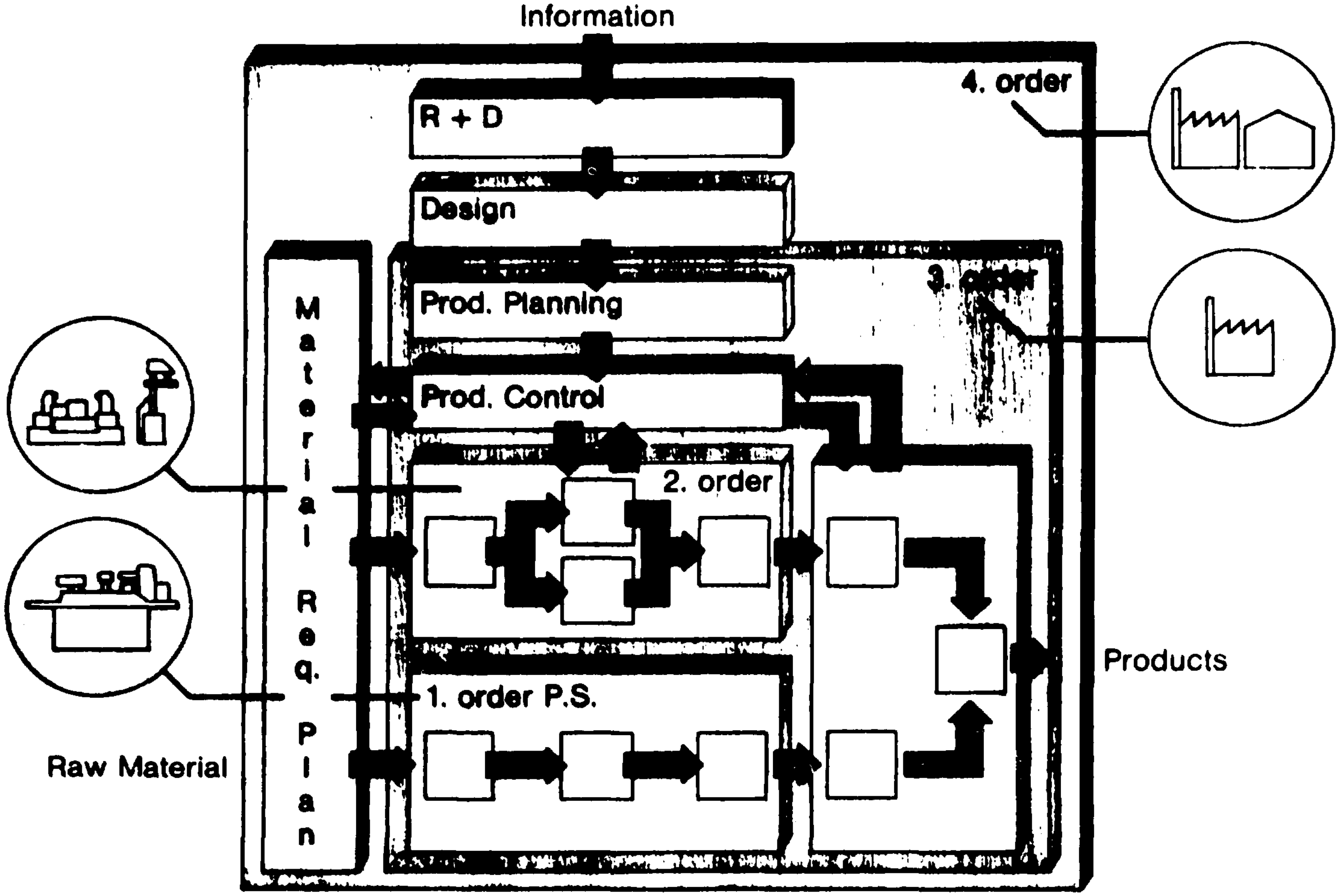
The KANBAN ordering procedure:

The Production Order is just given to the last operation in the manufacturing chain. This station than orders the exact number of components they want from the previous stage, which order parts from the previous stage ... etc.

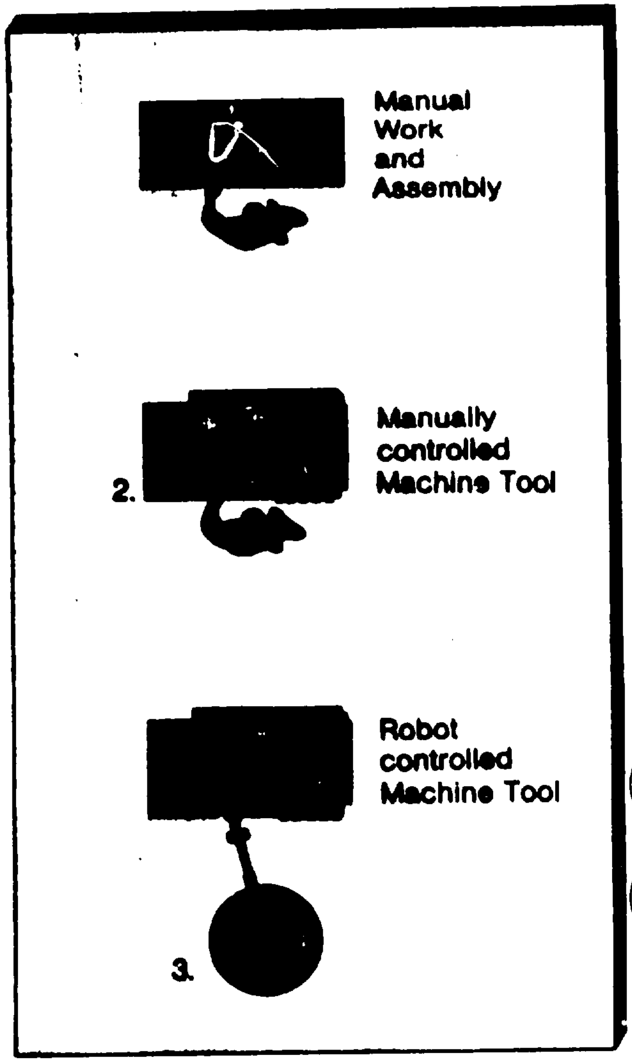
Manufacturing Information Flow

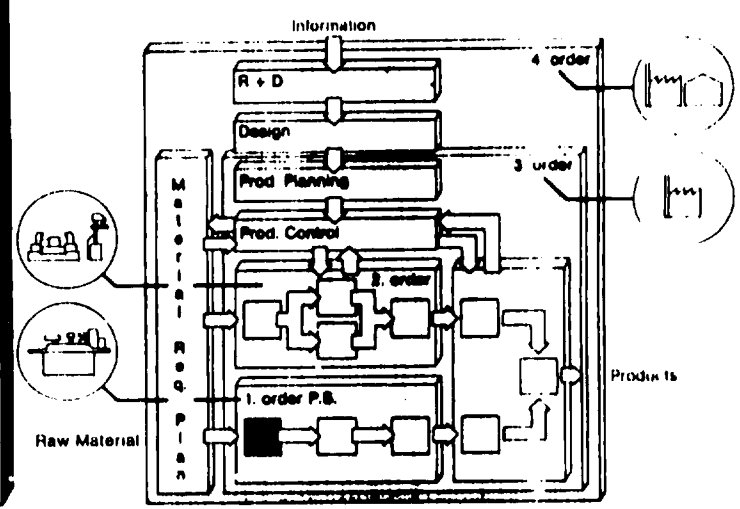


A Production System-P.S.

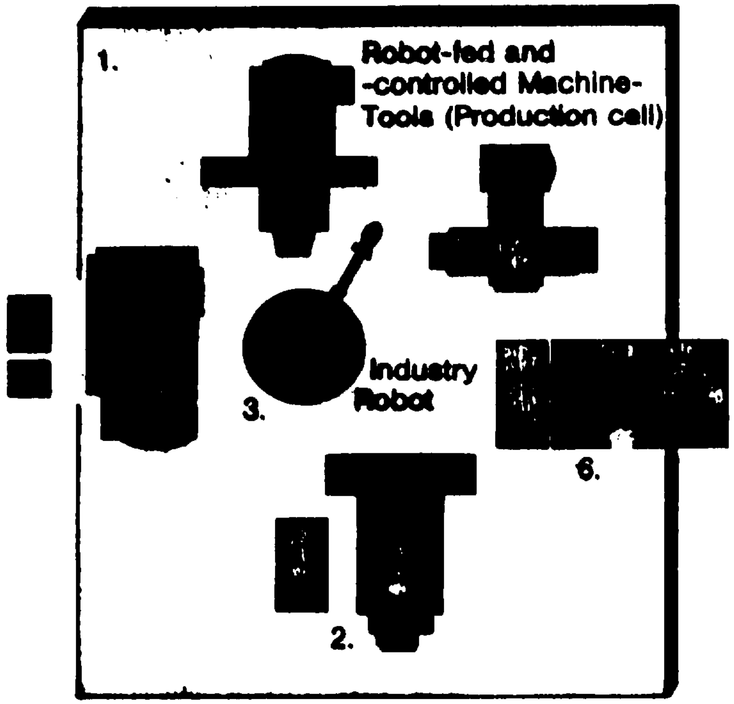


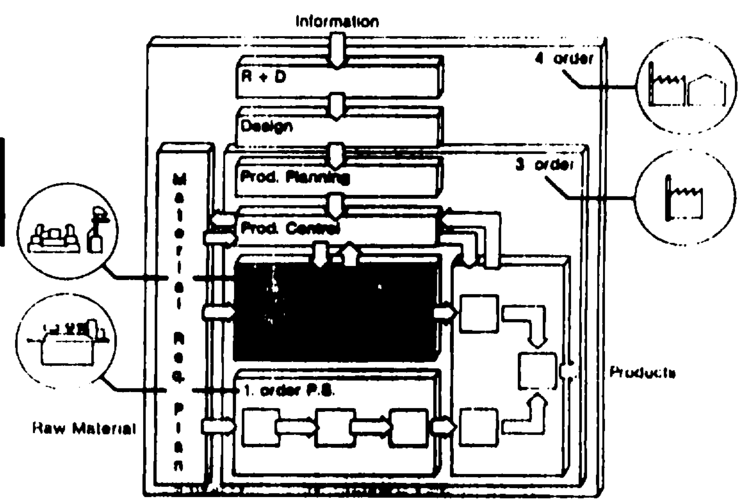
1. Order Production system



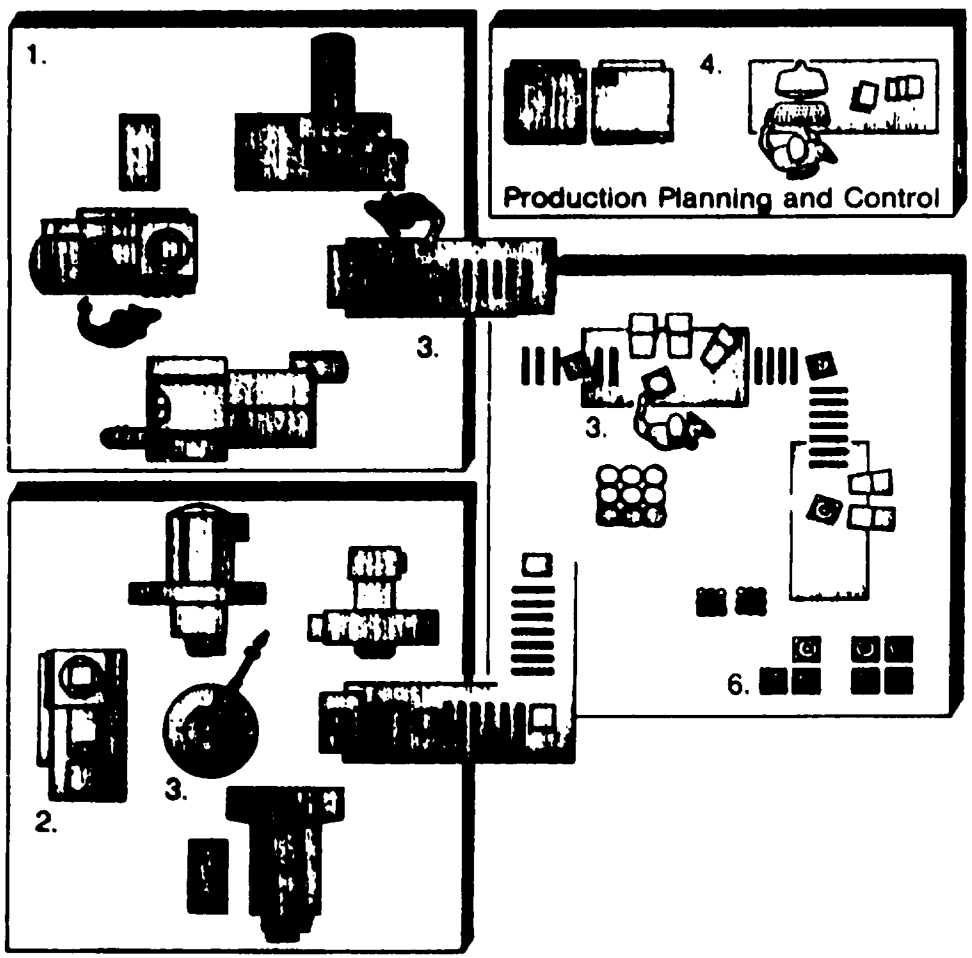


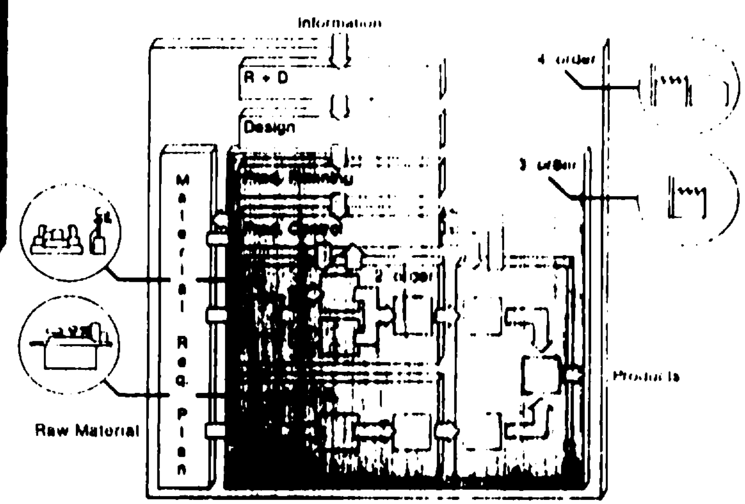
2. Order Production system



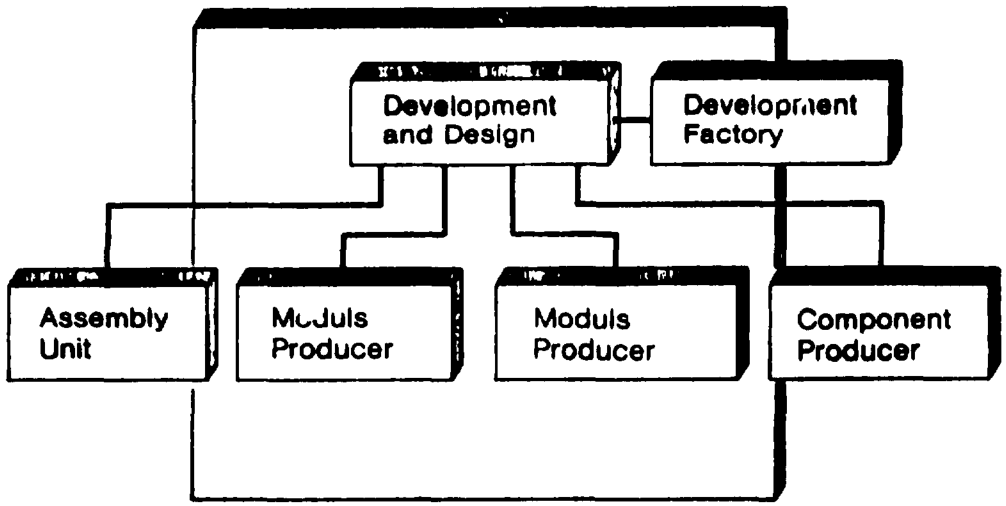


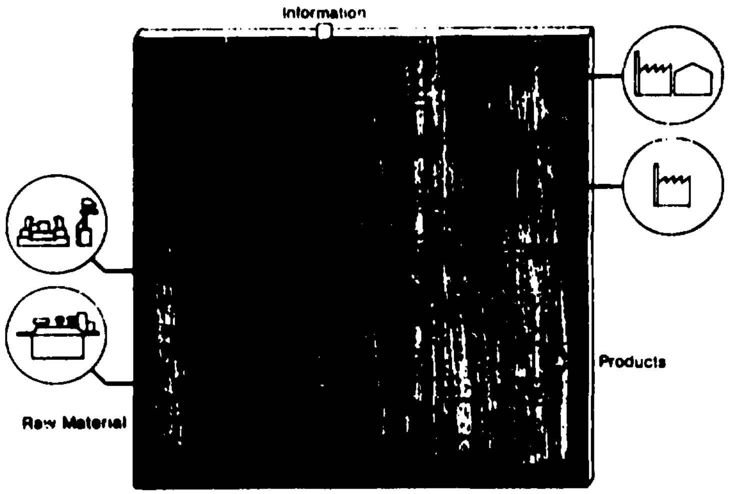
3. Order production system



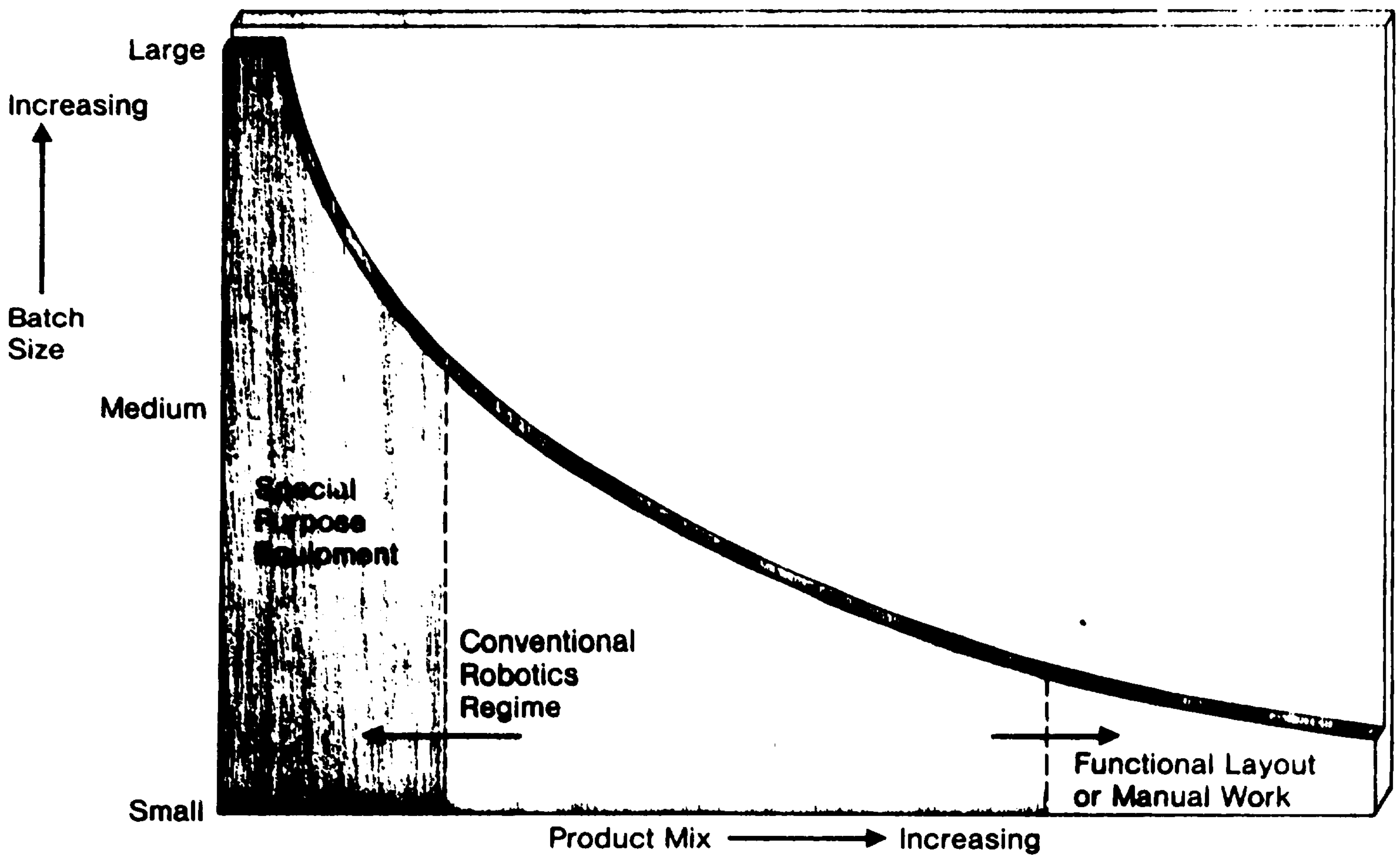


4. Order production system

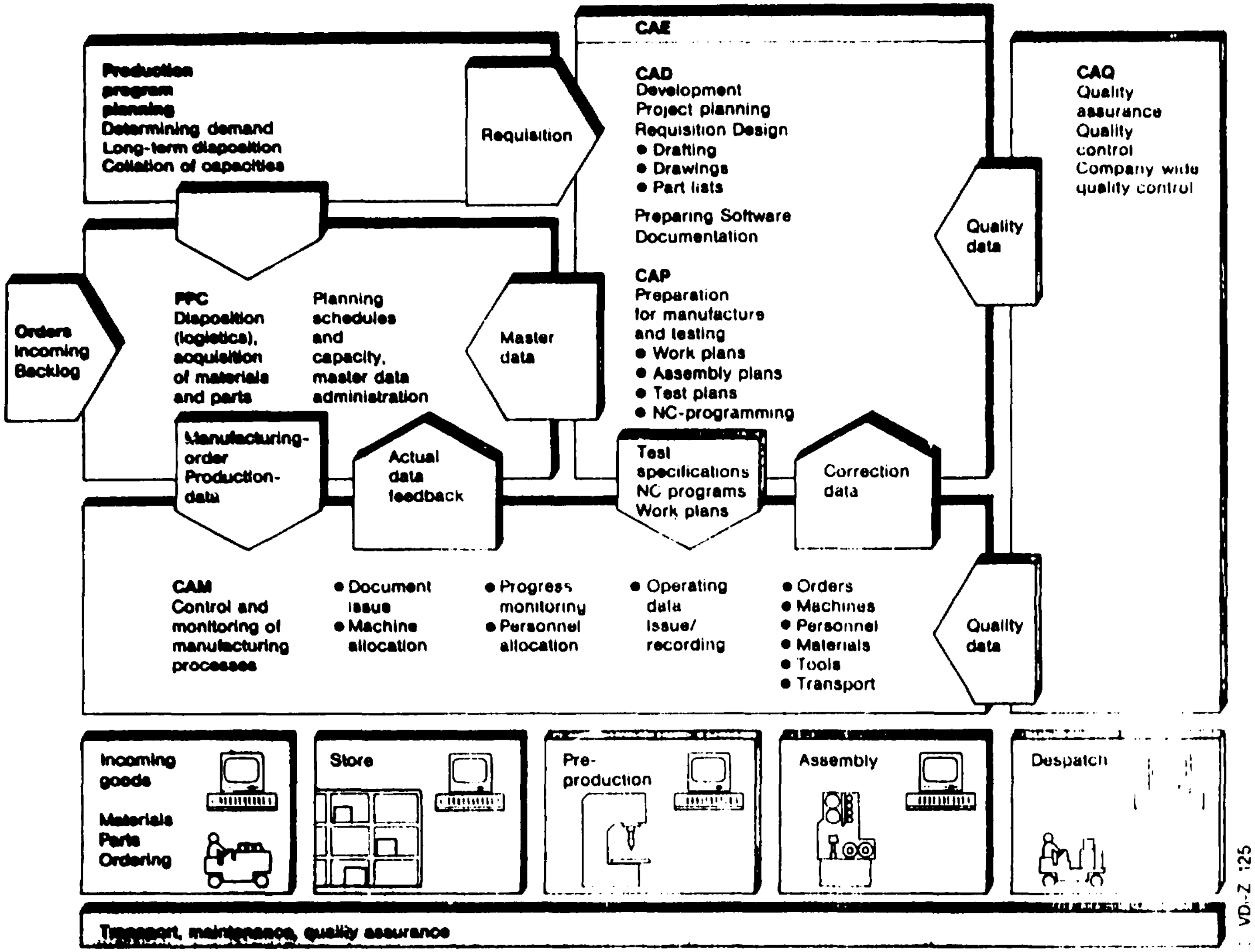




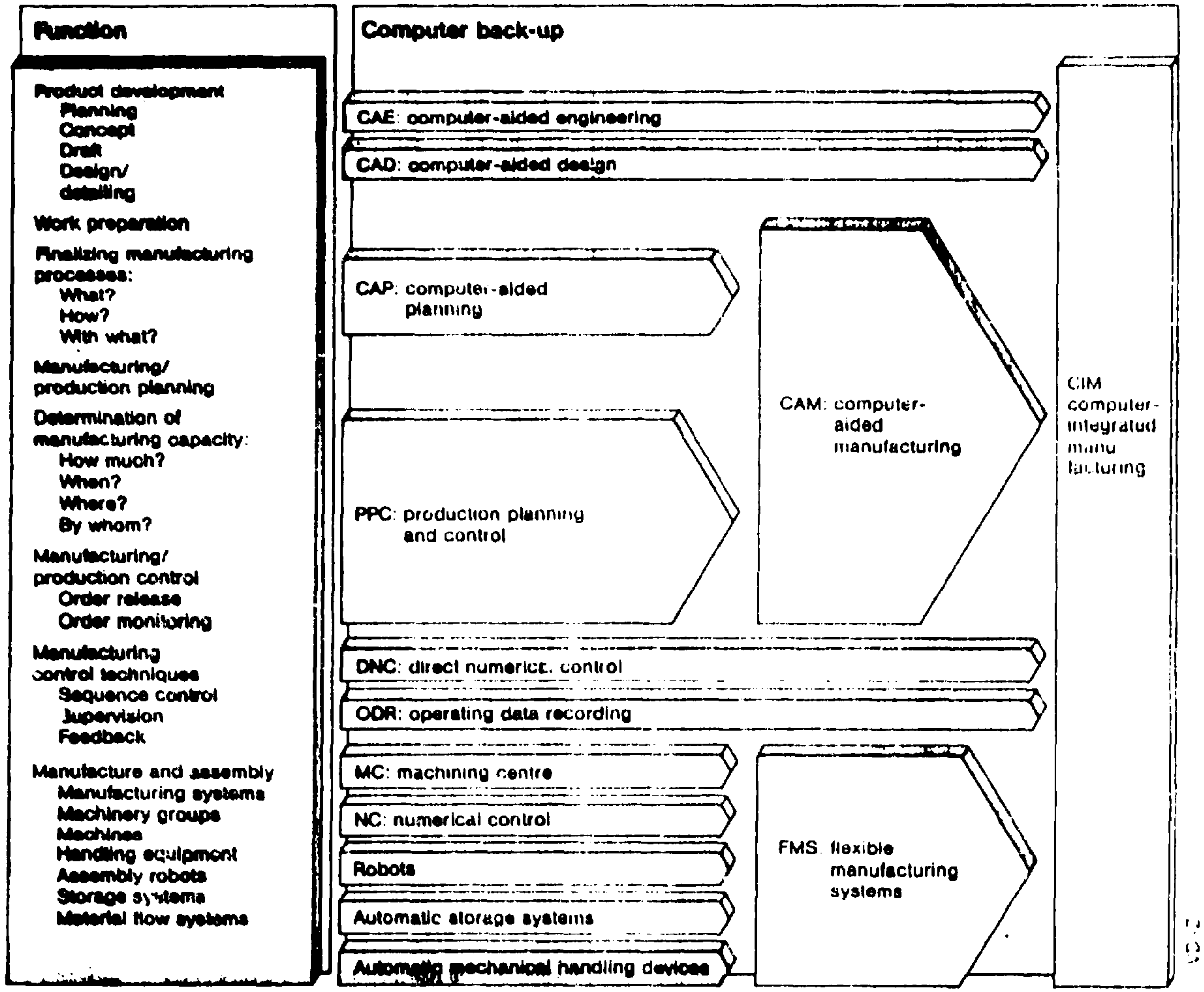
Manufacturing mode spectrum



CIM - computer integrated manufacturing functions

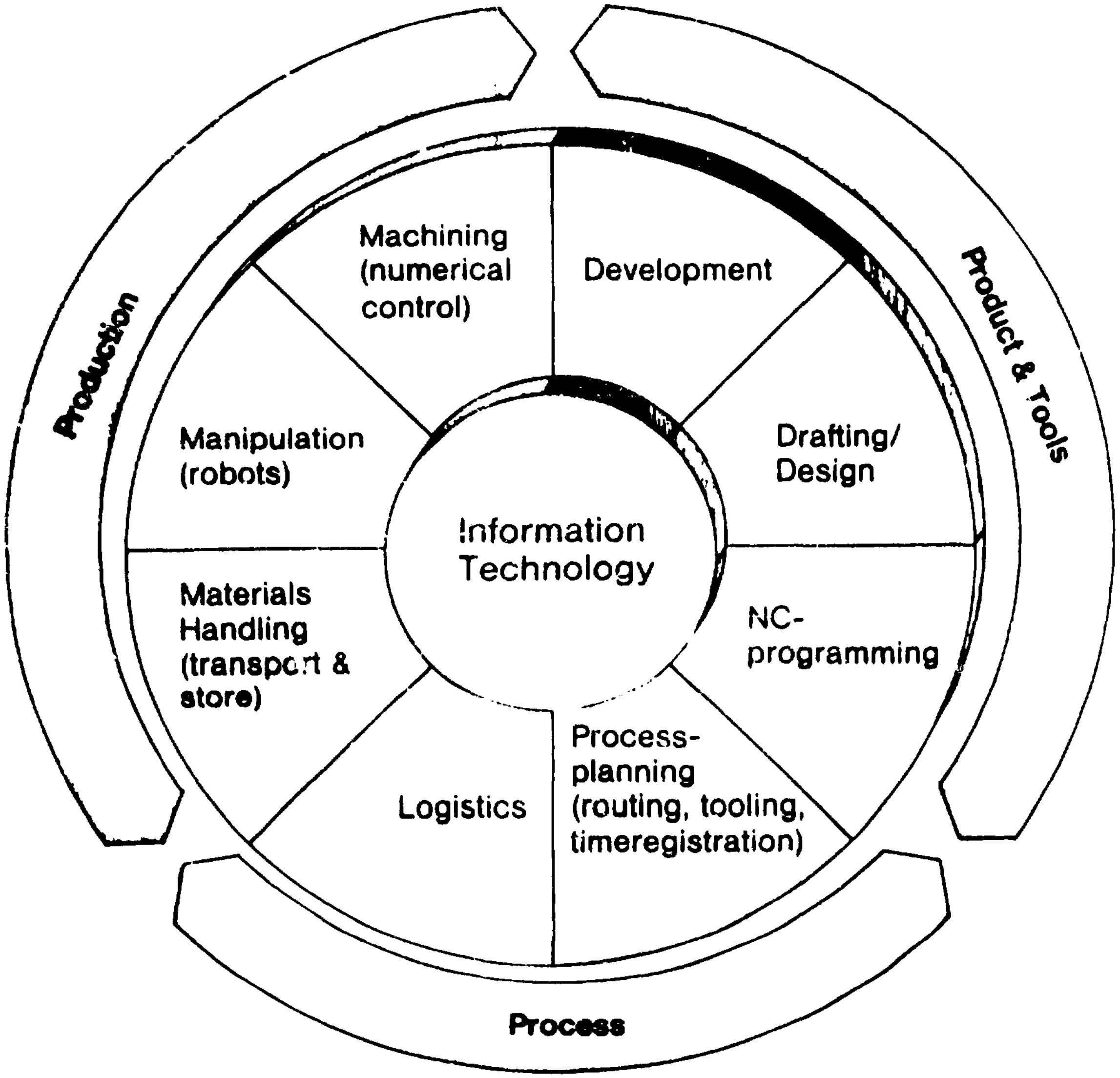


Technical order processing terms

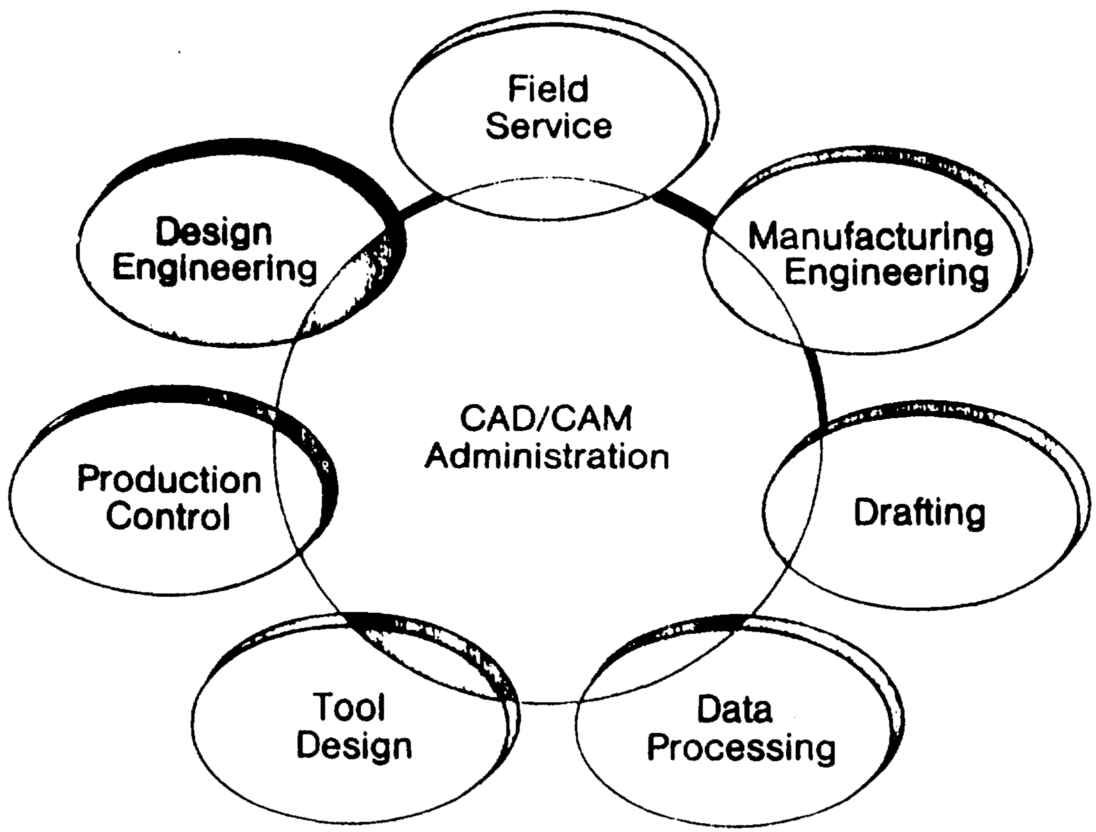


MTC

Concept of computer aided technolgies in manufacturing



CAD/CAM Administration Relationships



CIM FUNCTIONS

<u>BUSINESS PLANNING AND SUPPORT</u>

Economic Simulation
Long-term Forecasting
Customer Order Servicing
Finished Goods Inventory Mgmt.

<u>ENGINEERING DESIGN</u>

Computer-Aided Drafting
Computer-Aided Tool Design
Group Technology
CAD

<u>MANUFACTURING PLANNING</u>

Process Planning Systems
Parts Programming
NC Graphics
Tool & Materials Catalog
Material Requirements Planning
Production Line Planning Simulation
Bill of Materials Processors
Machinability Data Systems
Computerized Cutter, Die Selection
Materials/Parts Inventory Mgmt.

<u>MANUFACTURING CONTROL</u>

Purchasing/Receiving
Shop Routing
Methods & Standards
In-process Inventory Mgmt.
Short-term Scheduling
Shop Order Follow System

<u>SHOP FLOOR MONITORING</u>

Machine Load Monitoring
Machine Performance Monitoring
Man-time Monitoring
Material Stores Monitoring
Preventive Maintenance
In-process Quality Testing

CIM BENEFITS

GROUP TECHNOLOGY

New part design	52
Shop drawings	30
Industrial engineering	60
Production floor space	20
Raw material stock	40
Setup time	69
Production time	70
Work in process inventory	62
Overdue orders	82

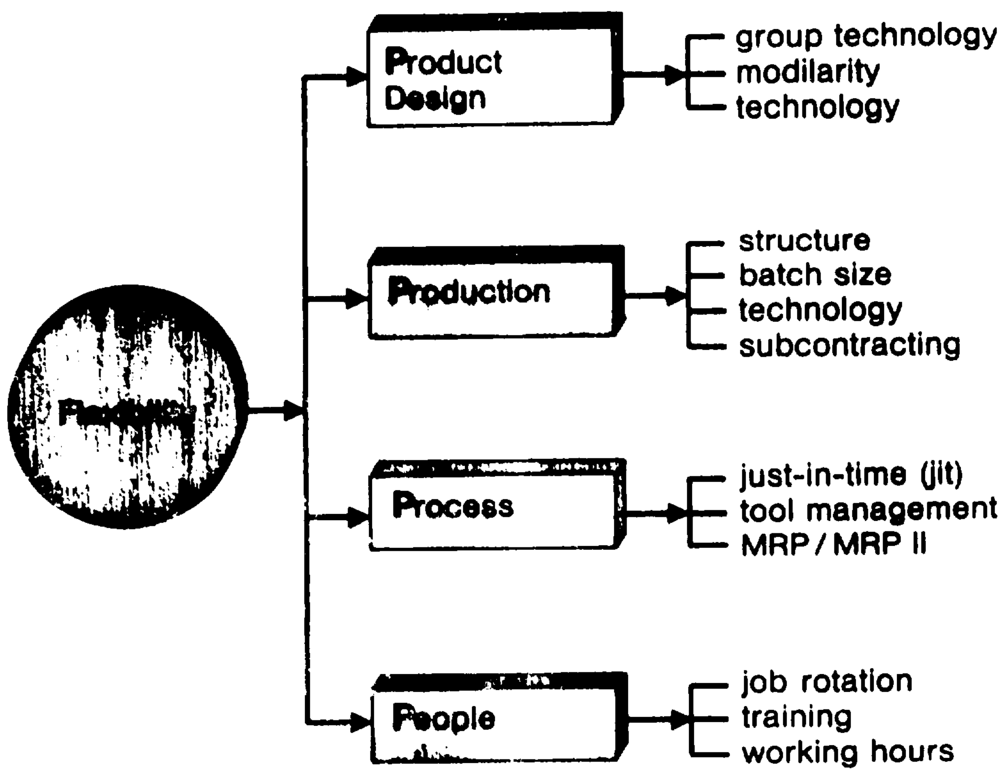
PROCESS PLANNING

Planning activities	58
Direct labor	10
Material	5
Scrap and rework	10
Tooling	12
Work in process	5

MATERIAL REQUIREMENTS PLANNING

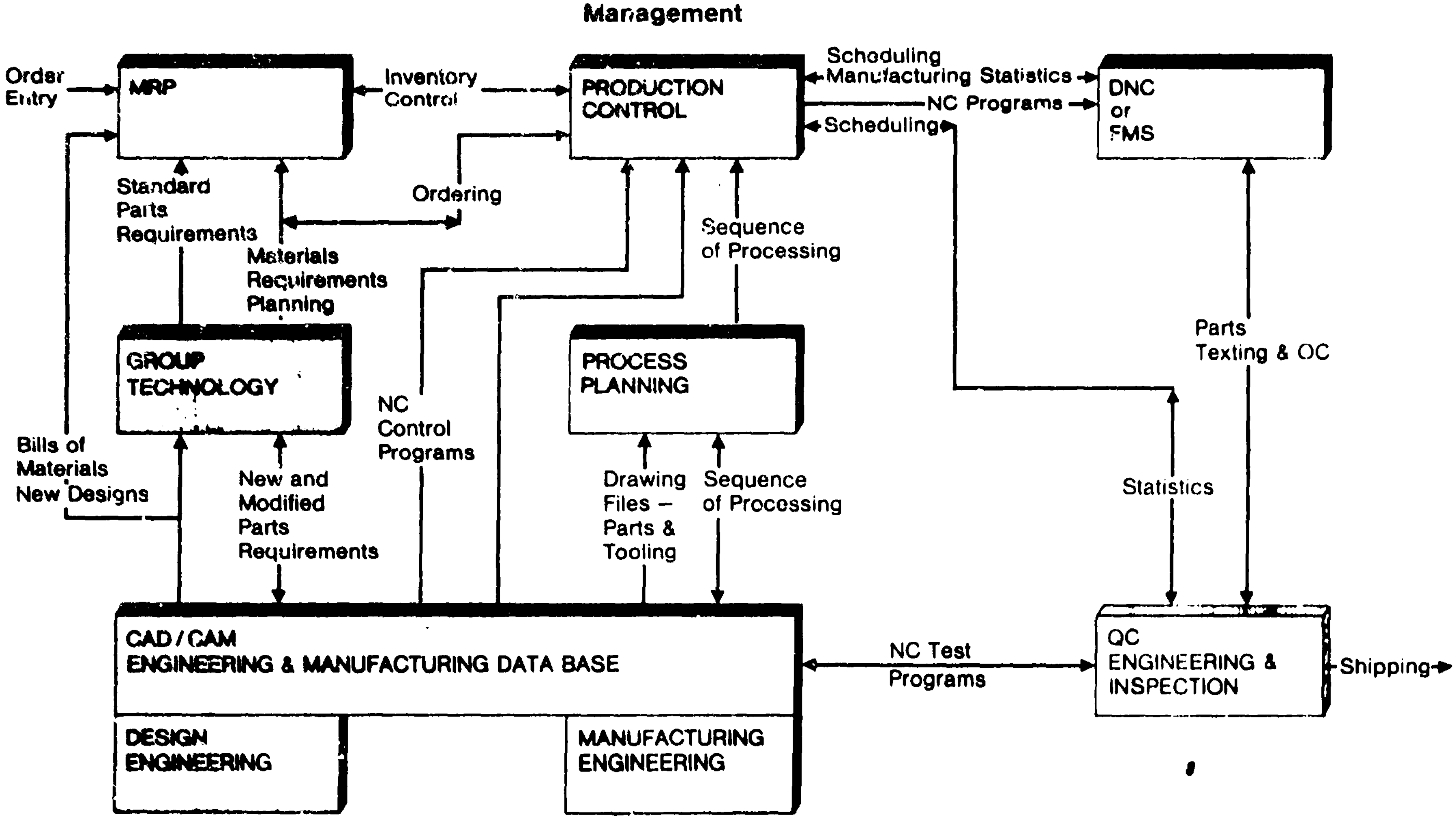
Productivity	5 to 30
Work in progress inventories	30 to 50
Late orders	90
Labor requirements	10

Improvement of Flexibility of Technical Organization

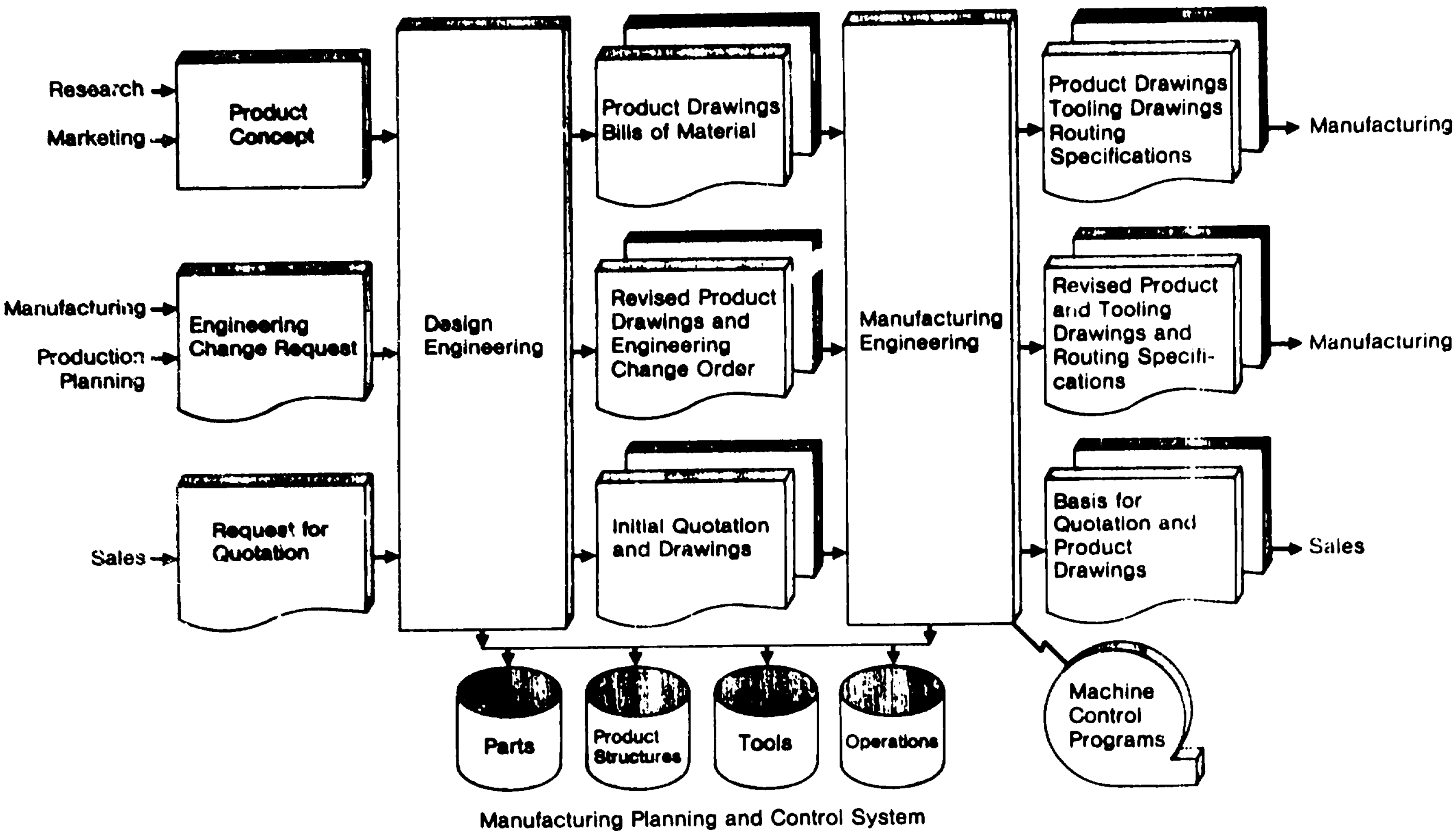


(The four "P's")

Process Flow Factory of the Future.

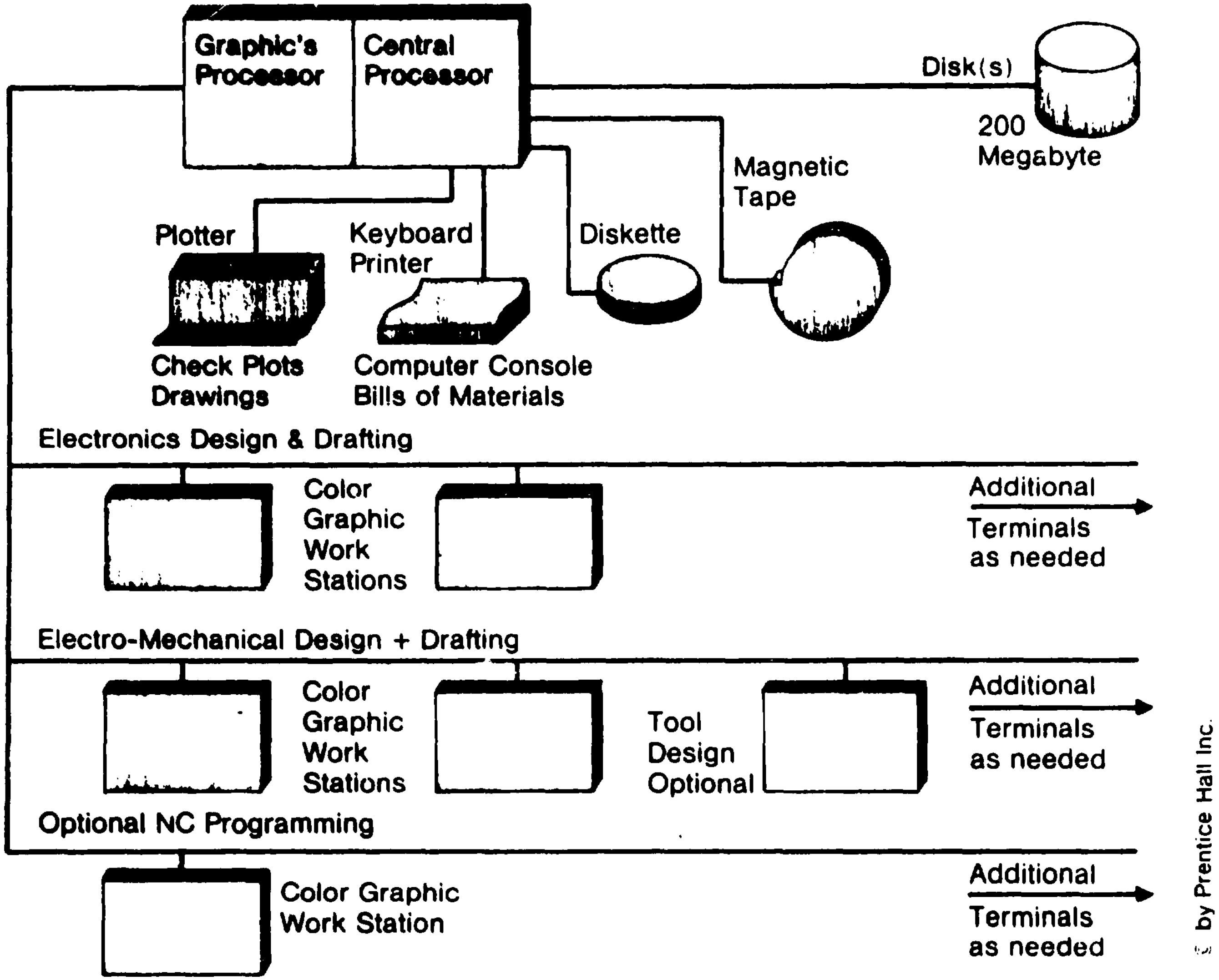


Ideal Structure for Product Design and Manufacture Information Flow

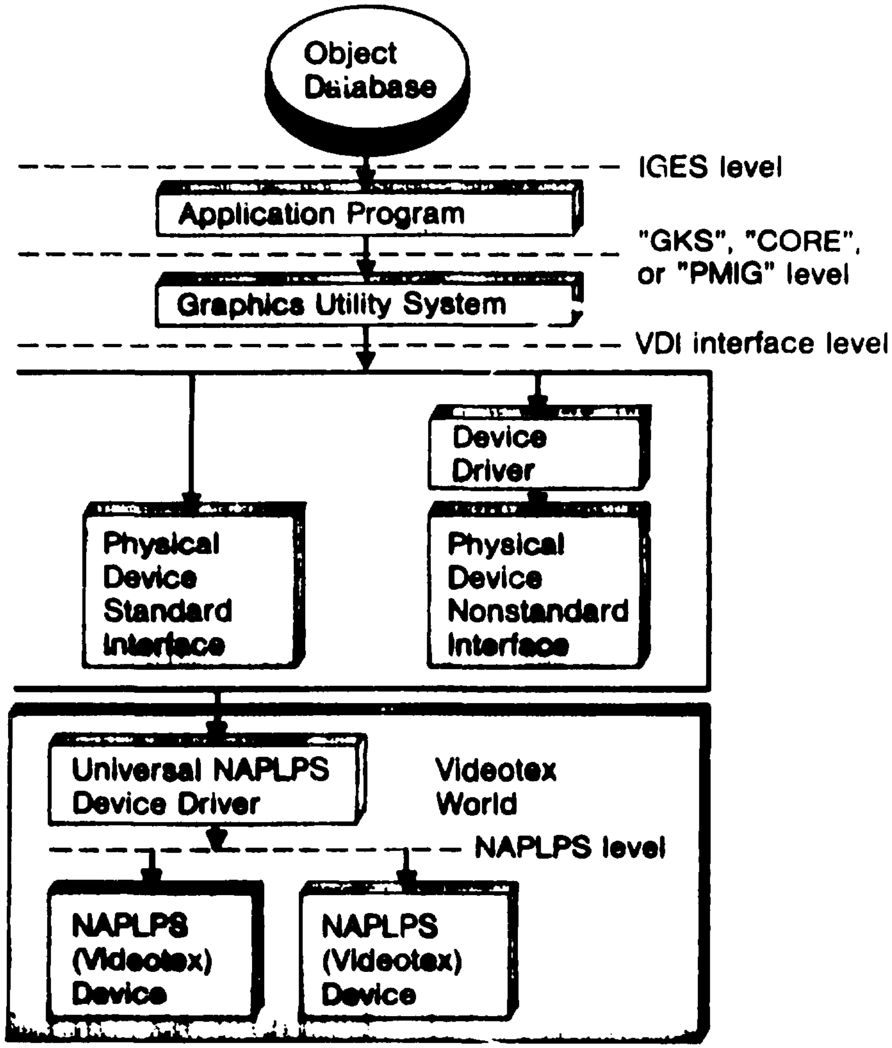


Mainframe Computer Based CAD/CAM System.

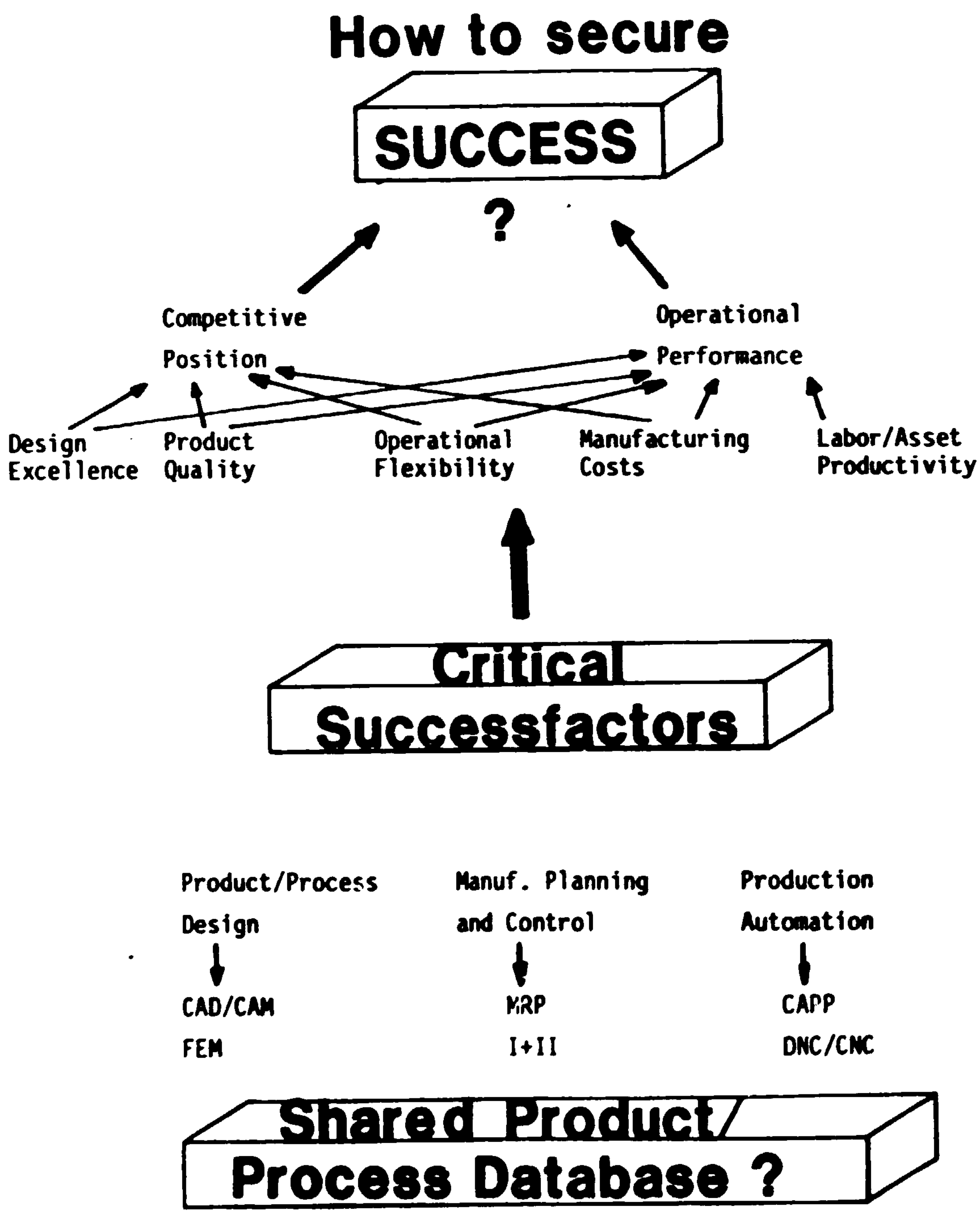
Graphics processor may be supplied to partially off-load the mainframe or central processor of some of the graphics manipulation.



Levels of Standards.

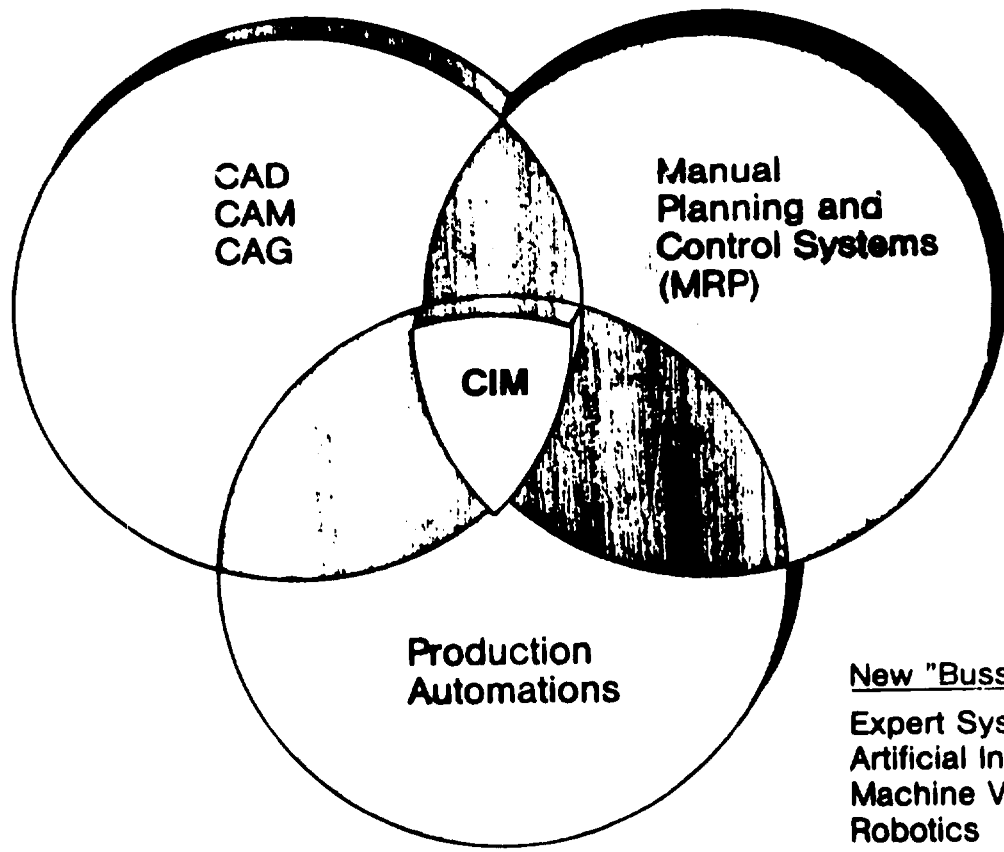


STRATEGIC IMPLEMENTATIO[N] OF CIM



CAE-Workshop Nanjing, August 1985

CIM State-of-practice today



New "Busswords"

Expert Systems
Artificial Intelligence (AI)
Machine Vision
Robotics

COMPUTER-INTEGRATED MANUFACTURING

AS A

STRATEGIC WEAPON

MANAGEMENT'S ROLE IN MAKING CIM SUCCESSFUL

I. Strategic Implications of Advanced Engineering/Manufacturing Technology

- Critical Success Factors
- Operational Requirements to Achieve CSF Goals
- Potential Contribution of CIM Technologies

II. Current State of CIM Technology and Practice

- Base Technologies
- Technical Integration: Communications and Data Sharing
- Organizational Integration: Treating CIM as a Strategy

III. Management's Role

- Understanding
- Stimulating
- Planning
- Organizing
- Guiding

MTC

Management's Role