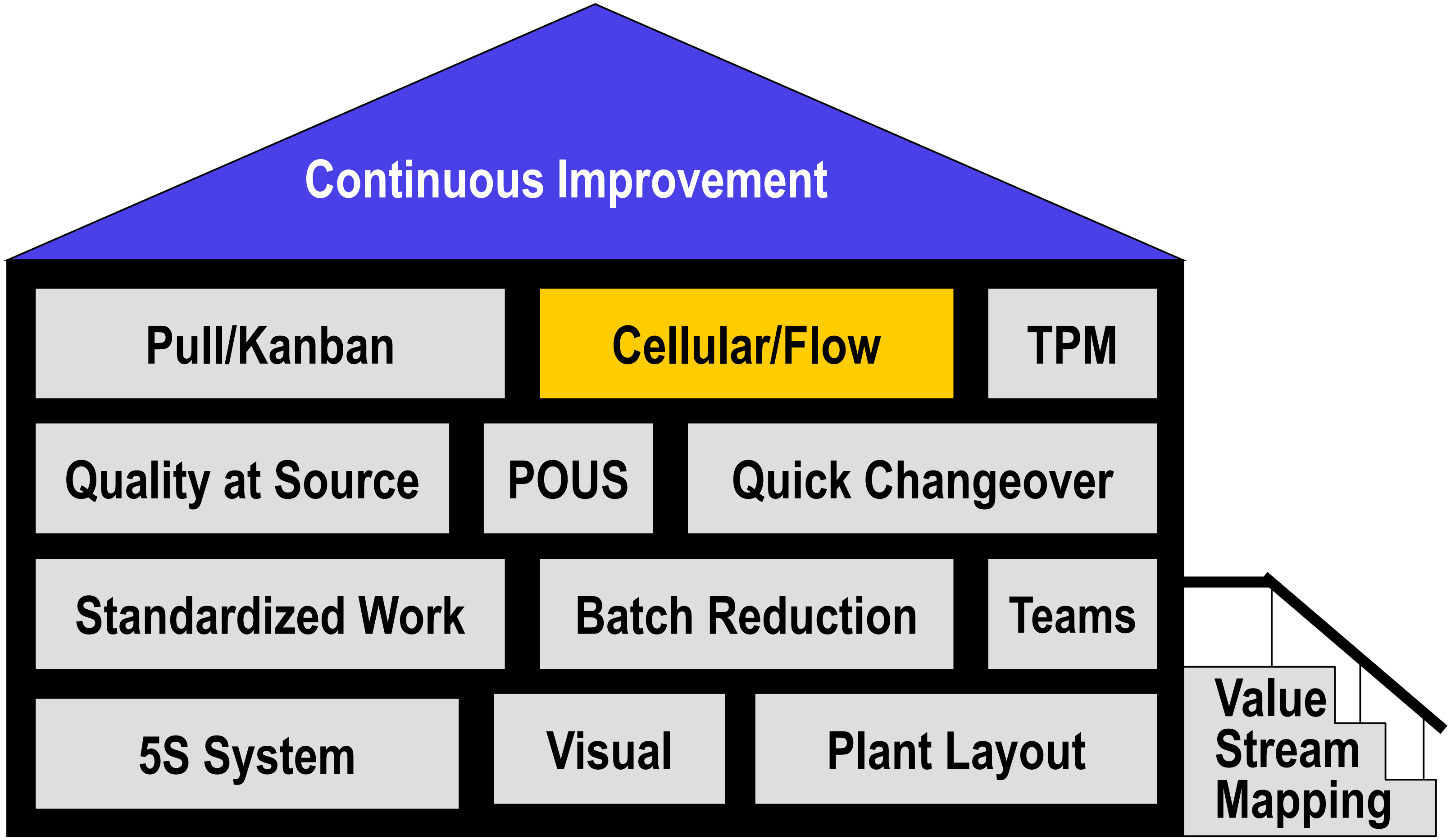
WORK CELL DESIGN

Definition

Cellular Flow Manufacturing is a method of organizing manual and machine operations in the most efficient combination to maximize value-added content and minimize waste.

Lean Building Blocks



Cellular Manufacturing Benefits

- Simplified scheduling and communication
- Minimal inventory needed between processes
- Increased visibility
  - provide quick feedback and problem resolution
- Development of increased product knowledge
  - workers are trained to understand the total process
- Shorter lead times
- Small lots and one piece flow
  - to match customer demand

Work Cell – Realization of a Lean Process

- **A work cell's effectiveness is not separable from related elements:**
  - The product(s)
    - Workers must be able to manufacture and assemble the product to meet customer demand **[DFA, DFM]**
    - A breadth of products often must be accommodated by a single manufacturer **[Product families]**
  - The people(s)
    - Work cells must produce varying products and varying rates to meet customer demand **[Product families, Takt time]**
    - Work cells must be designed such that workers can safely and repeatedly perform necessary steps to meet customer demand. **[Human factors]**

The Five Step Cell Design Process

- Group Products
- Establish Takt Time
- Review the Work Sequence
- Balance the Process
- Design the Cell Layout

Product Grouping Considerations

- Similar Process/Resource Requirements
- Changeover/Set-up Times
- Process Time Variation
- Demand vs. Capacity

Product Grouping Tool: The Product/Process Matrix

Cellular/Flow Toolkit: Product/Process Matrix

Use this form to group products into product families that could be included in various cells.
Step 1: Start by listing the products on the left side of the form. Step 2: Under "Process Requirements," list each of the tasks involved in the production of one or more of the products. Then, for each product, mark the tasks that are involved in its production. Step 3: Under "Daily Demand," list the minimum and maximum daily demand for each product. Step 4: Look for products that have similar production requirements and compatible demands. They are candidates for inclusion in a cell.

Product (List each product below)	Process Requirements (List each task in the process)							Daily Demand	
	ME1	AOS	Cutter	DCI	Drill	Shrink Wrap	Pack	Min	Max
Harris	X	X			X	X	X	150	675
HB2				X			X	110	486
HB3	X			X			X	23	333
HB7				X			X	95	251
HB4		X	X				X	25	425
21D				X			X	351	1,267

Product Portfolio

- **“The set of different product offerings that a company provides. Products can be unique, share common systems, and/or production methods.”**
- **Product portfolio architecture – “system strategy for layout out components and systems on multiple products”**

- Otto and Wood, 2000

- **3 Portfolio Architectures**
  1. **Fixed unsharing** – each product is unique, no sharing of components, typically very high volume
  2. **Modular platform** - share modules, components, or systems to meet the needed variety - common elements are called the platform and each supported product is called a variant
  3. **Massively customizable** – varies to meet customer need – either by customer (e.g. car seat) or manufacturer

motors.

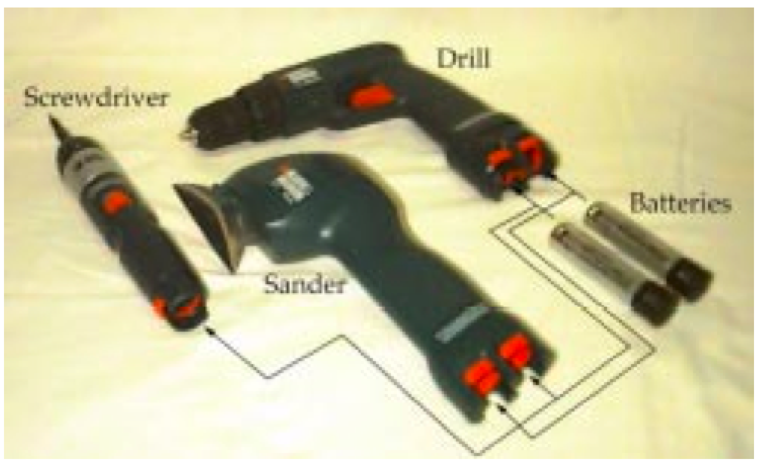


Figure 3.1 The three VersaPak power tools from Black and Decker represent examples of component sharing. All use the same batteries (2 are shown of the right side of the figure) as energy sources.

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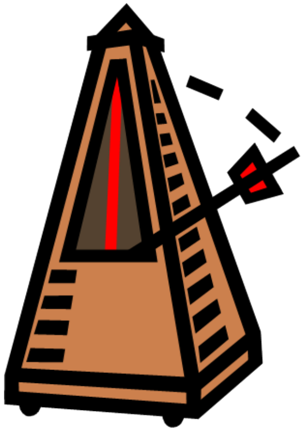

More on Takt Time

- **Takt time can change!!**
- **What can you change to match takt time?**
  - Number of people
  - Number of cells (requires investment in machinery)

- **Takt Time Rounding Rules:**
- ***Crew size* calculation for an assembly line doing one piece flow paced to Takt Time is:**
  - **Crew size = Sum of Manual Cycle Time / Takt Time**
- **If Manual Cycle Time = 1,293 seconds and a Takt time = 345 sec**
- **Crew size = 1,293 person-seconds / 345 seconds**
- **Crew size = 3.74 people**
- **In this case the crew size will be 4 people since 3 people would not be able to meet customer demand.**

Example from
http://www.gemba.com/uploadedFiles/Know%20Your%20Takt%20Time.pdf

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Steps in the Process

① Observe and document the tasks each worker performs

- Observe, don't just ask
- The steps are defined (explicitly or implicitly) by the designer

② Break operations into observable segments

③ Study machine capacity, cycle times, and changeover times

④ Look for value-added and non-value-added elements

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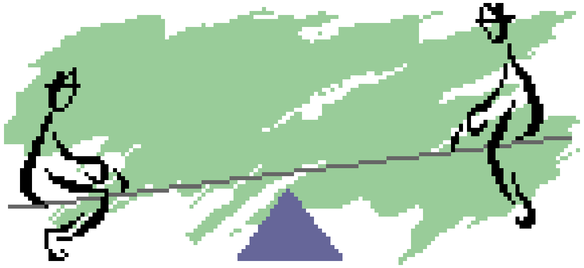
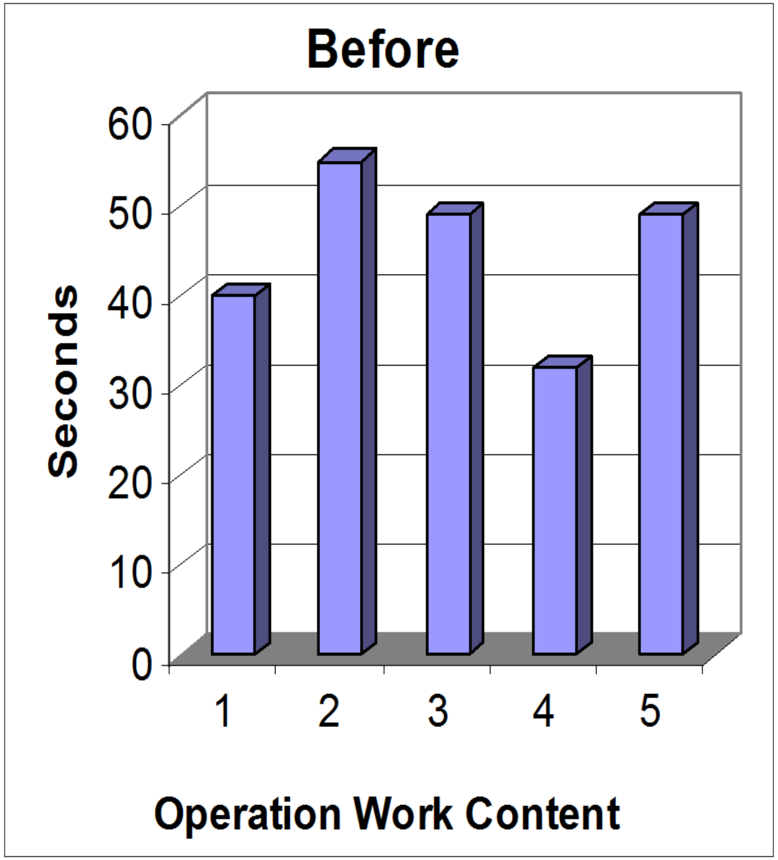
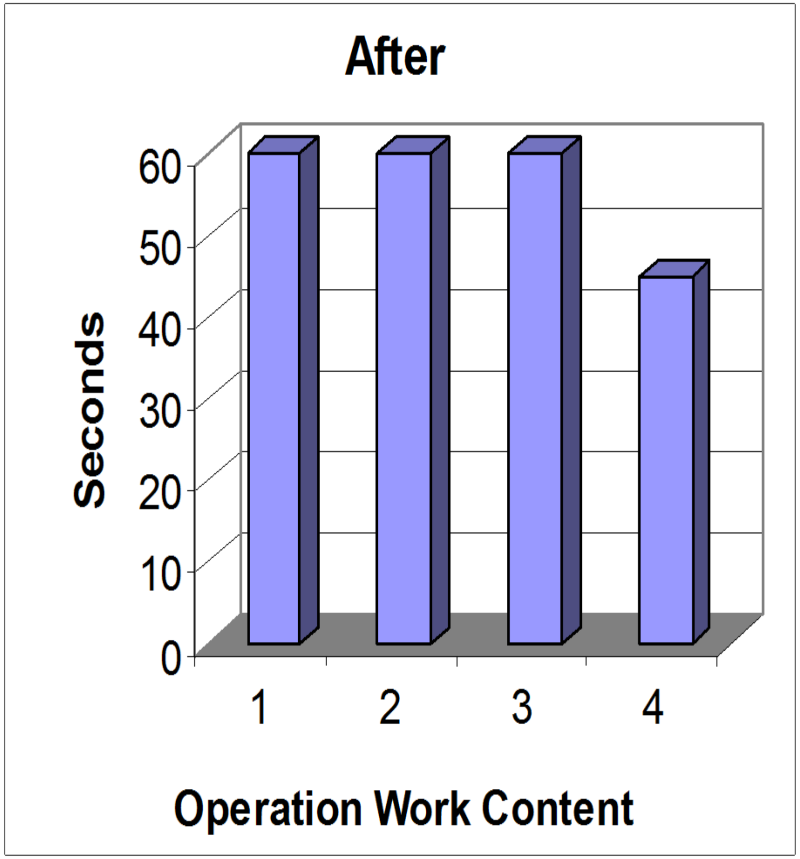


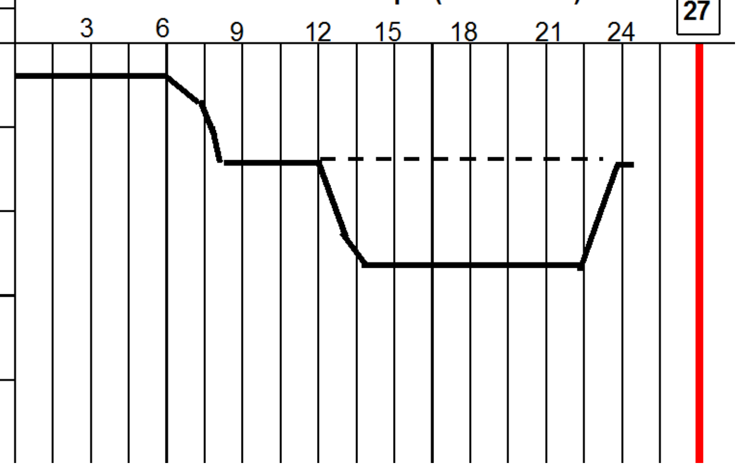
Combine Work to Balance the Process



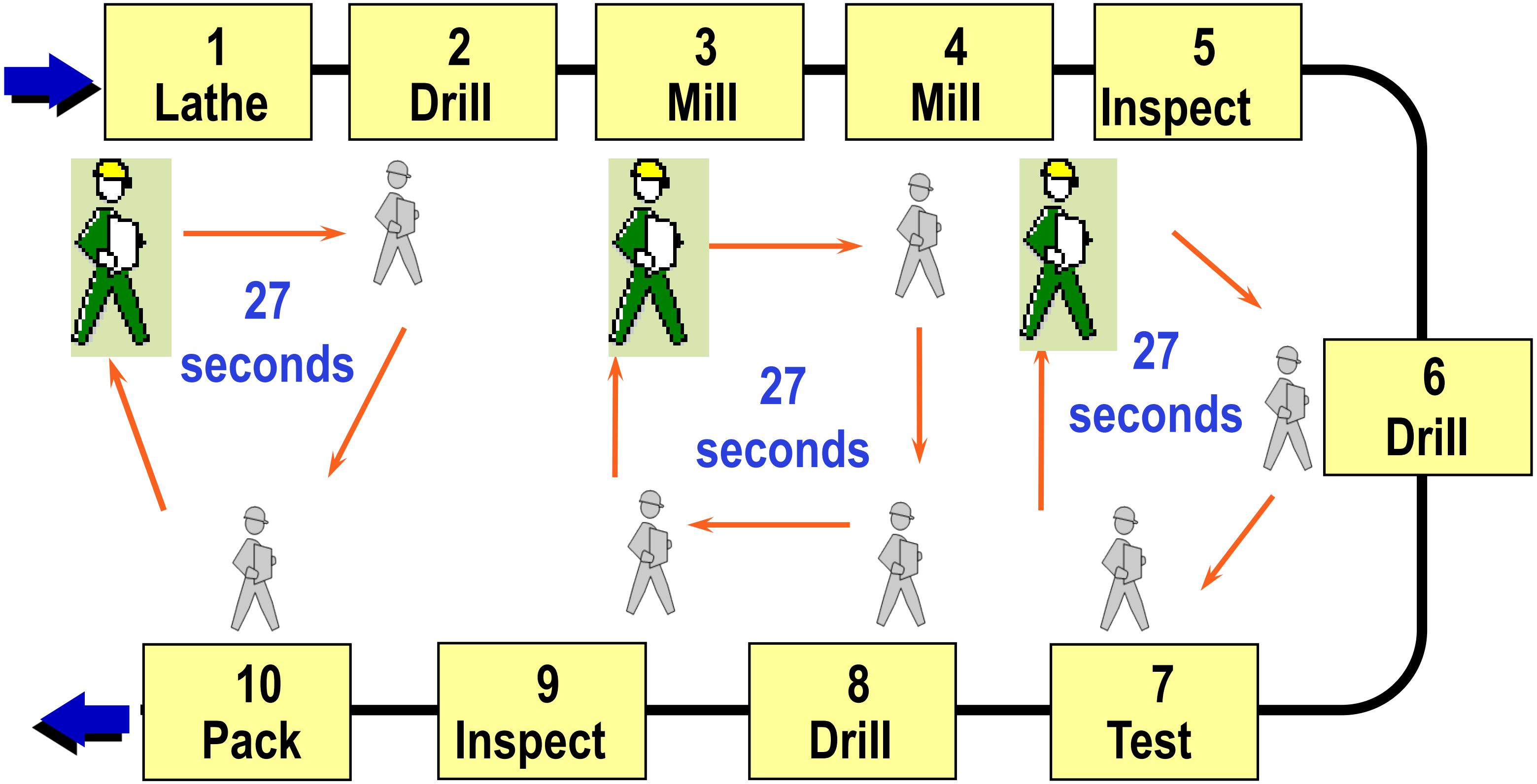


Standard Work Combination Sheet – Example

Date: 8/20/00	Work Sequence: 7 of: 15				Quota: 1,000 per shift	Manual ——— Machine - - - - - Walking
Part Name: Circulation Pump					Takt Time: 27 seconds	
Step #	Work Content Description	Time			Work Content Graph (1.5 sec/div)	
		Manual	Auto	Walk		
1	Pick up shaft and rotor; load, assemble, unload	4	2	2		
2	Unload, load, start	4	11	2		
3	Pick up 2 nuts & bracket; load, assemble, unload	6	2	2		
	Total = 24	14	4	6		

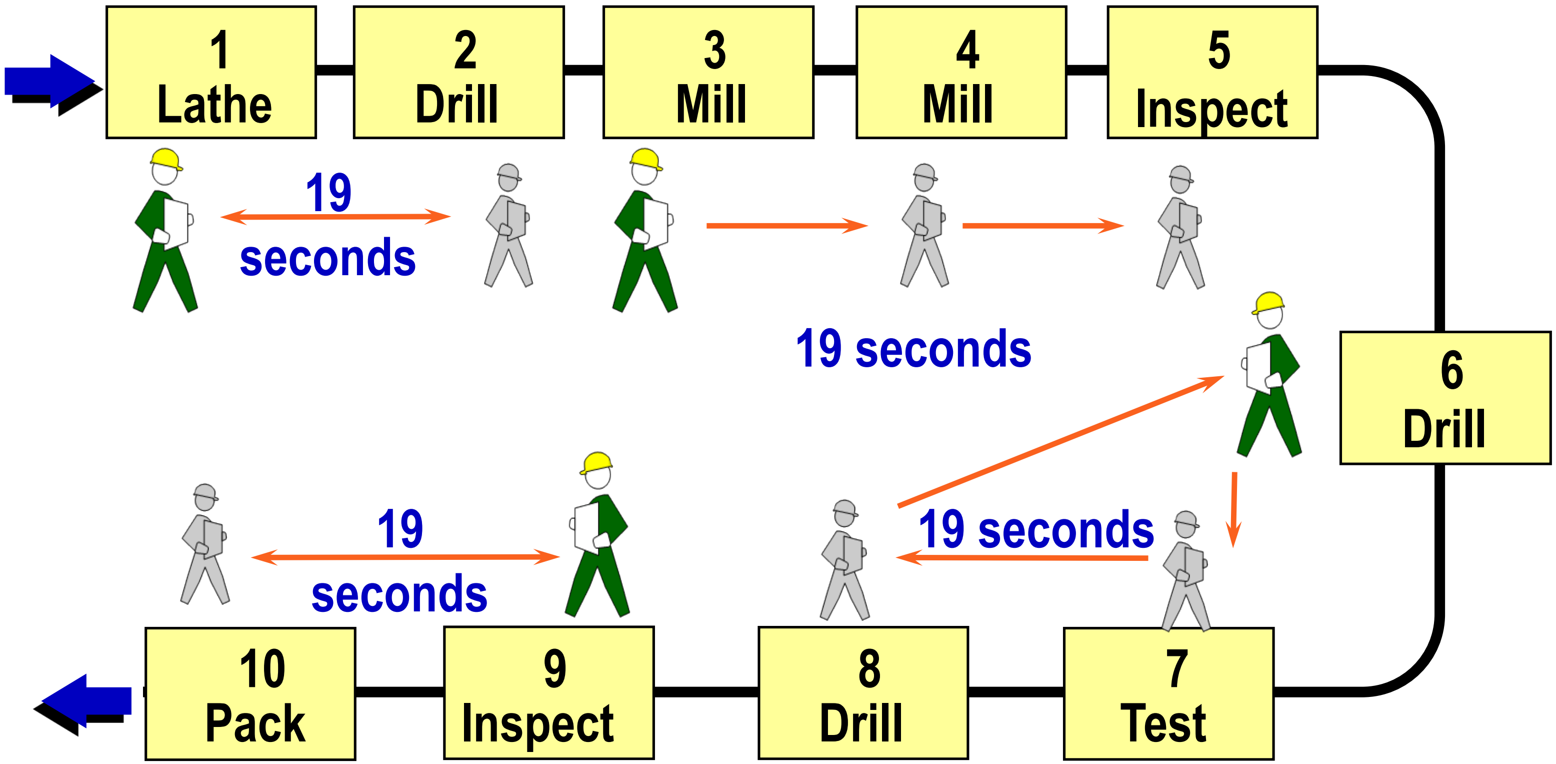


Alternative Work Combinations



Market demand = 220,000 units per year
Takt time = 27 seconds

Staffing For Increased Demand



Market demand = 312,000 units per year
Takt time = 19 seconds

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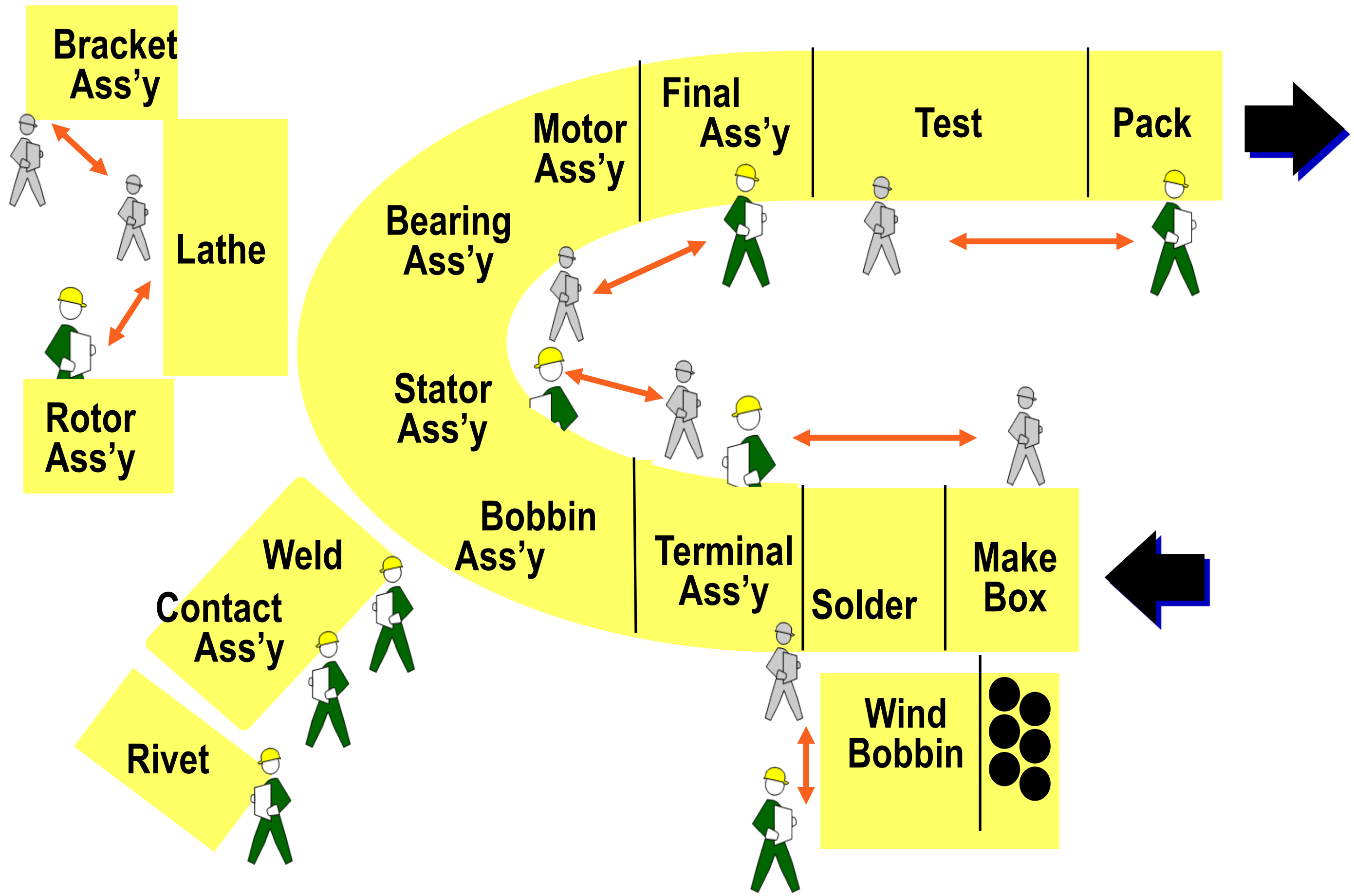
Design Goals for All Work Areas

- Flexible output
- Lot size of 1
- Point of Use Storage (POUS)
- Mixed models
- Visual management
- Source inspection
- Zero NVA activities

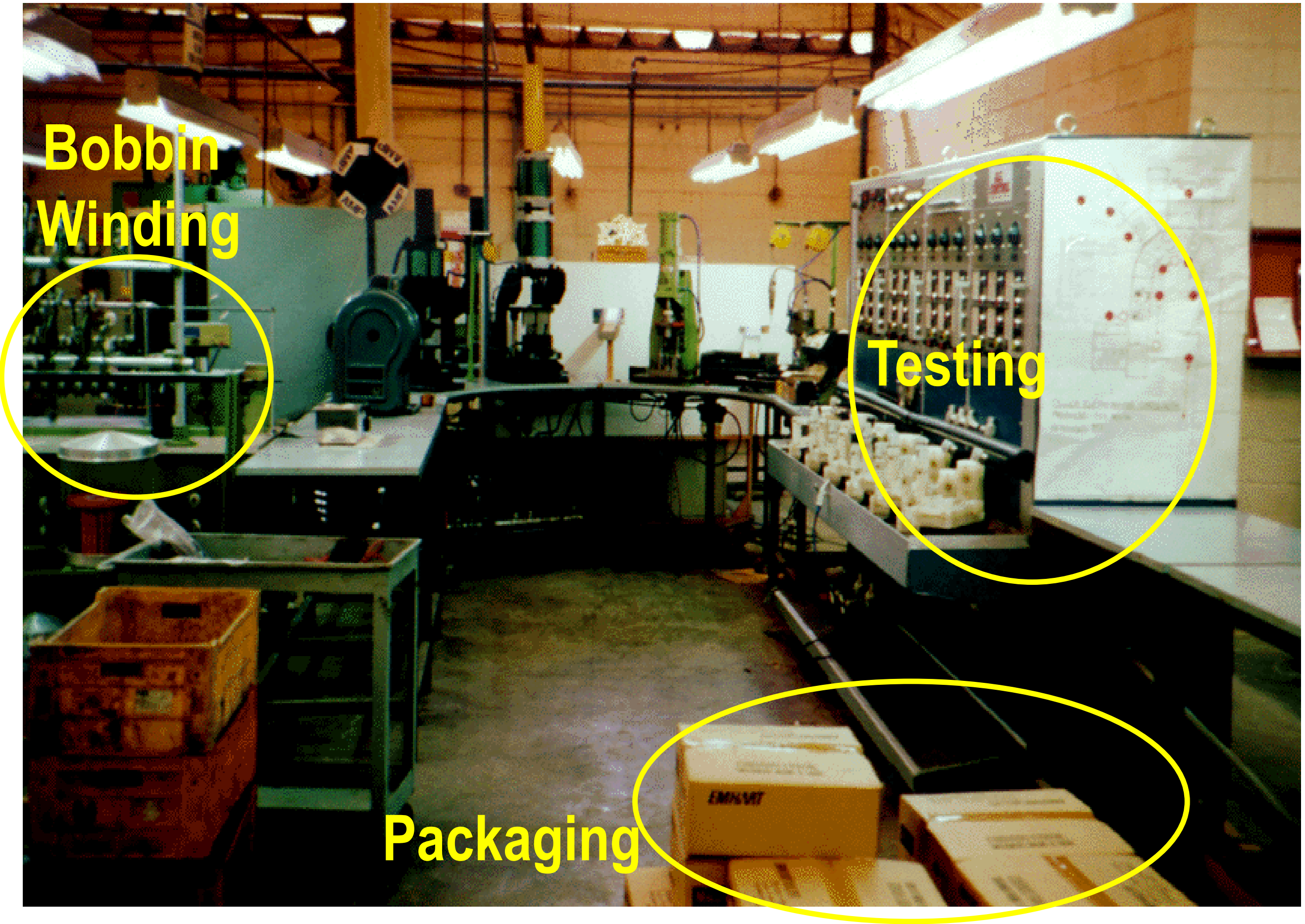
Water Pump Case Study

Circulation Pump Assembly Cell



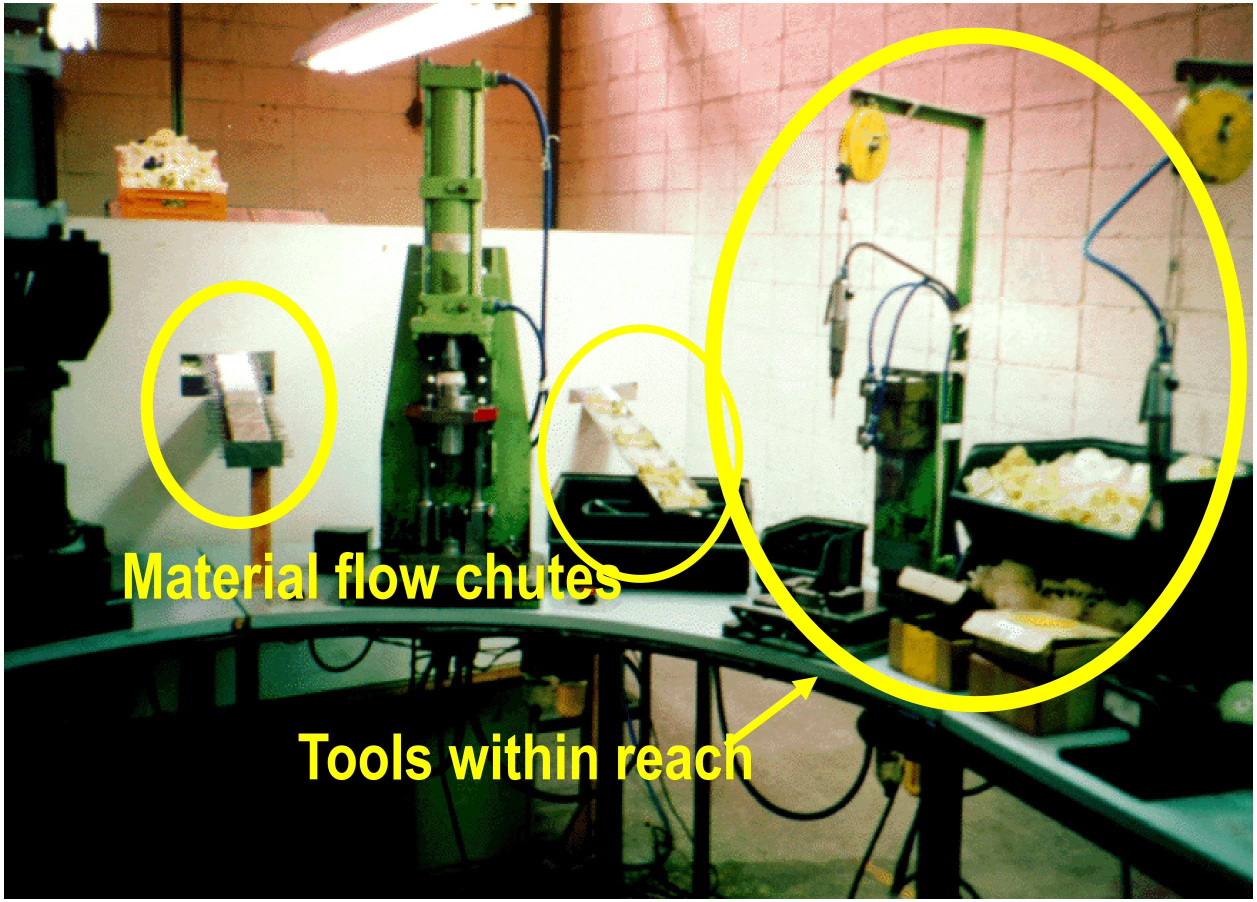
Water Pump Case Study

New U-Shaped Cell



Water Pump Case Study

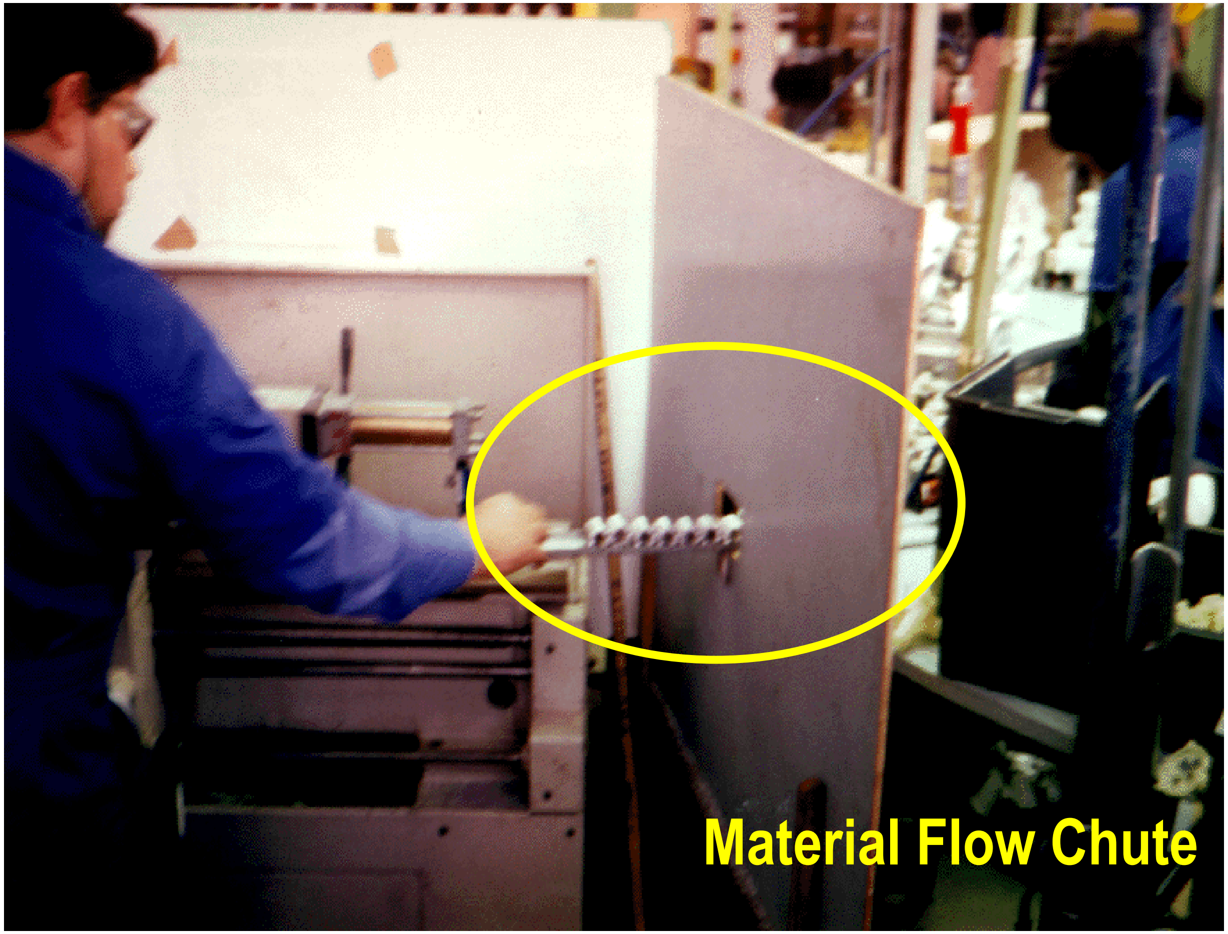
Workplace Organization



TECH:HELP

Water Pump Case Study

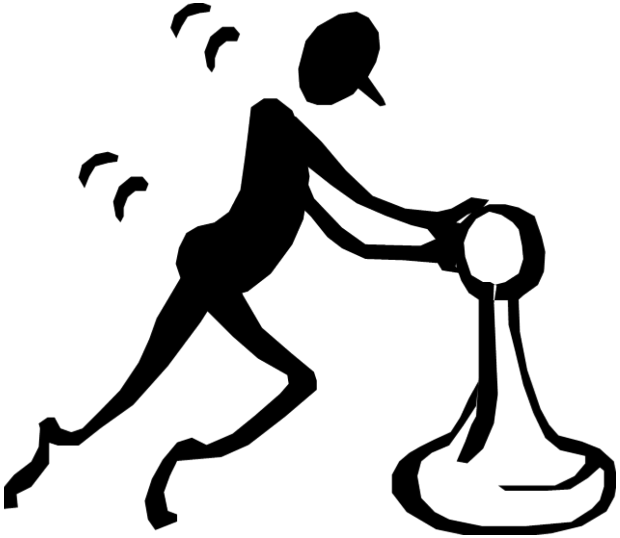
Machining and Assembly



Ergonomic Factors in Work Station (and Product) Design

Design the work to:

- Minimize motion
- Avoid unnatural postures and movements
- Avoid sharp turns in motion
- Make moves easy to perform without much concentration
- Use hands and forearms instead of upper arms and shoulders for light work
- Minimize lifting
- Follow a rhythm



Tool and Material Design and Layout Guidelines

- Place tools and materials close to and in front of the operator
- Keep tools and materials in a designated place
- Design fixtures for specific purposes, not general purposes
- Combined usage tools are recommended when more than one tool is required

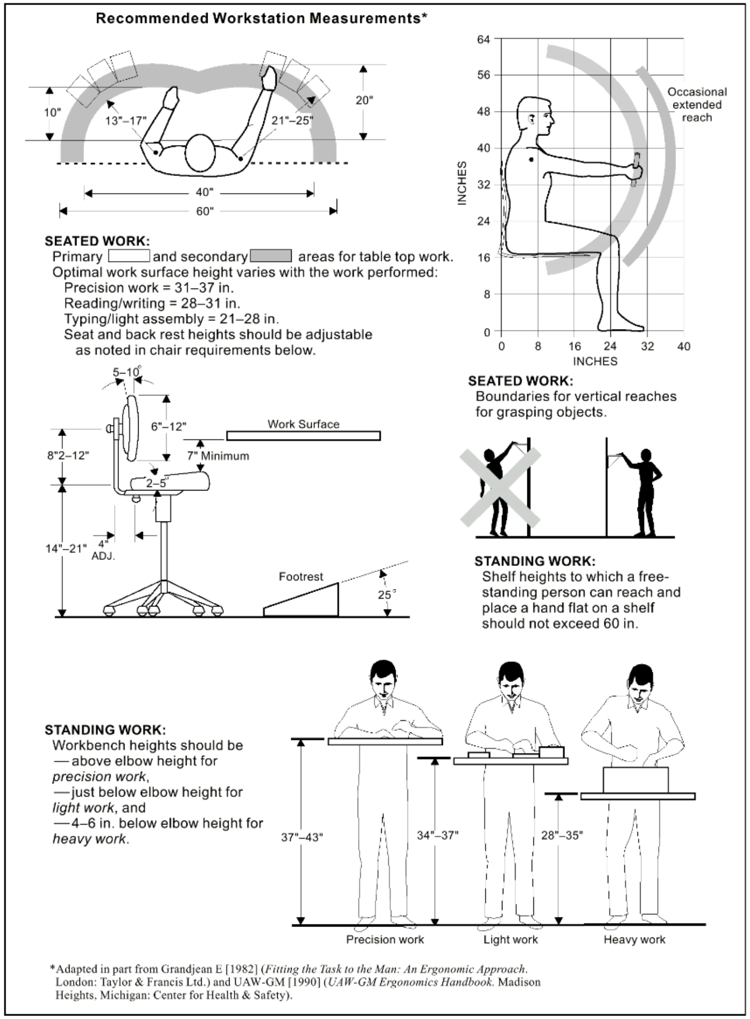
Ergonomic Resources

Ergonomic resources are understandable, practical, and affordable.

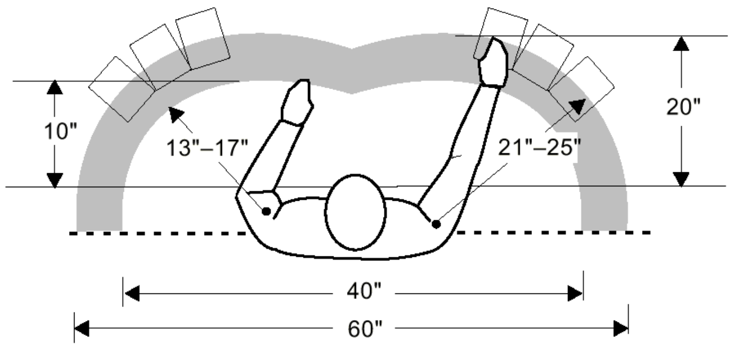
Fitting the Task to the Man: An Ergonomic Approach - Grandjean

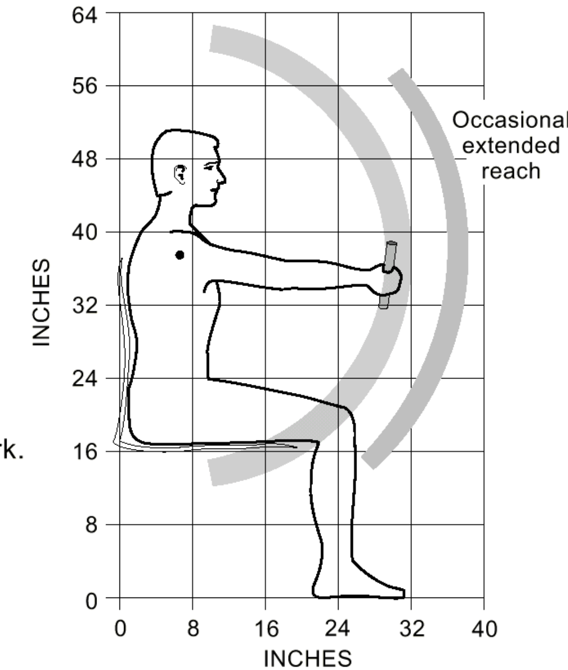
The Measure of Man and Woman: Human Factors in Design – Tilley and Dreyfuss

Your FE Resource Guide



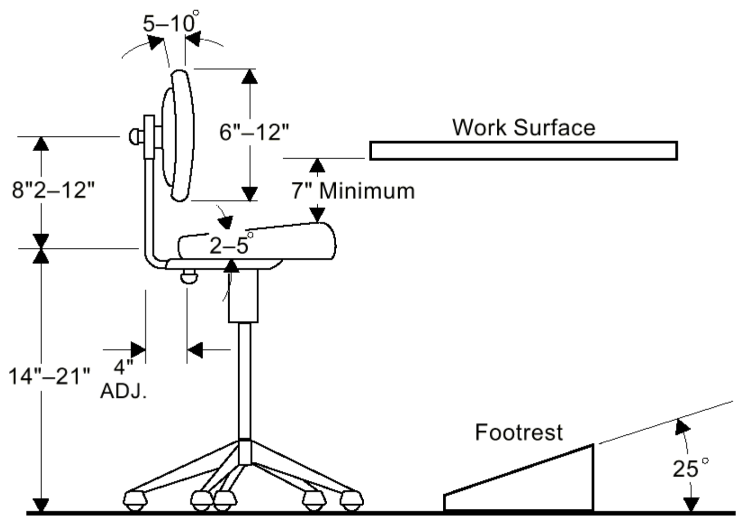
Recommended Workstation Measurements*

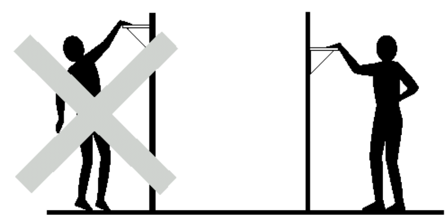




SEATED WORK:
Primary and secondary areas for table top work.
Optimal work surface height varies with the work performed:
Precision work = 31–37 in.
Reading/writing = 28–31 in.
Typing/light assembly = 21–28 in.
Seat and back rest heights should be adjustable as noted in chair requirements below.

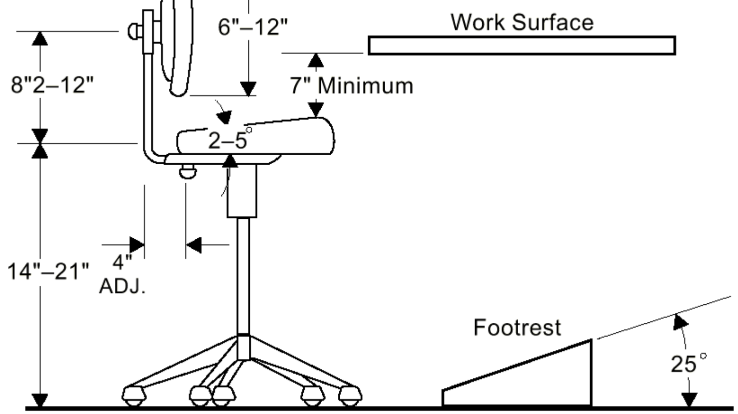
SEATED WORK:
Boundaries for vertical reaches for grasping objects.

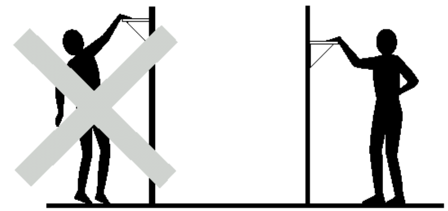




STANDING WORK:
Shelf heights to which a free-standing person can reach and place a hand flat on a shelf should not exceed 60 in.

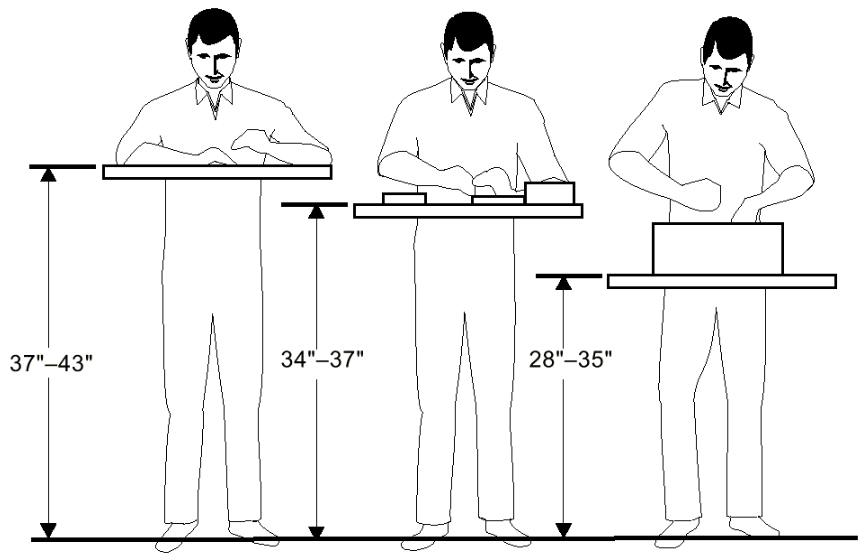
for grasping objects.





STANDING WORK:
Shelf heights to which a free-standing person can reach and place a hand flat on a shelf should not exceed 60 in.

STANDING WORK:
Workbench heights should be
—above elbow height for *precision work*,
—just below elbow height for *light work*, and
—4–6 in. below elbow height for *heavy work*.



*Adapted in part from Grandjean E [1982] (*Fitting the Task to the Man: An Ergonomic Approach*. London: Taylor & Francis Ltd.) and UAW-GM [1990] (*UAW-GM Ergonomics Handbook.* Madison Heights, Michigan: Center for Health & Safety).