Sort it Out!

The engineering behind industrial sorting processes

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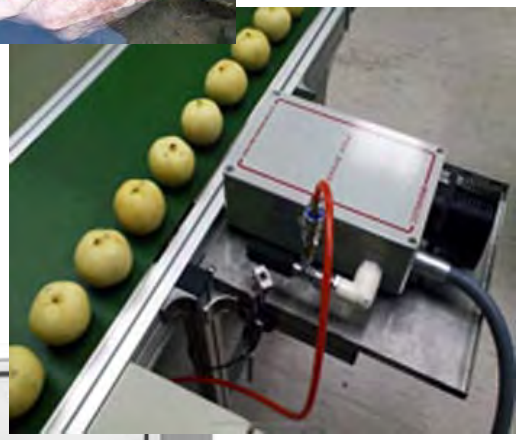
Objectives

- Learn about engineering of systems and about measurements
- Learn about sorting mechanisms
- Get an introduction to Performance Indices and measures of errors
- Learn about teamwork and cooperation

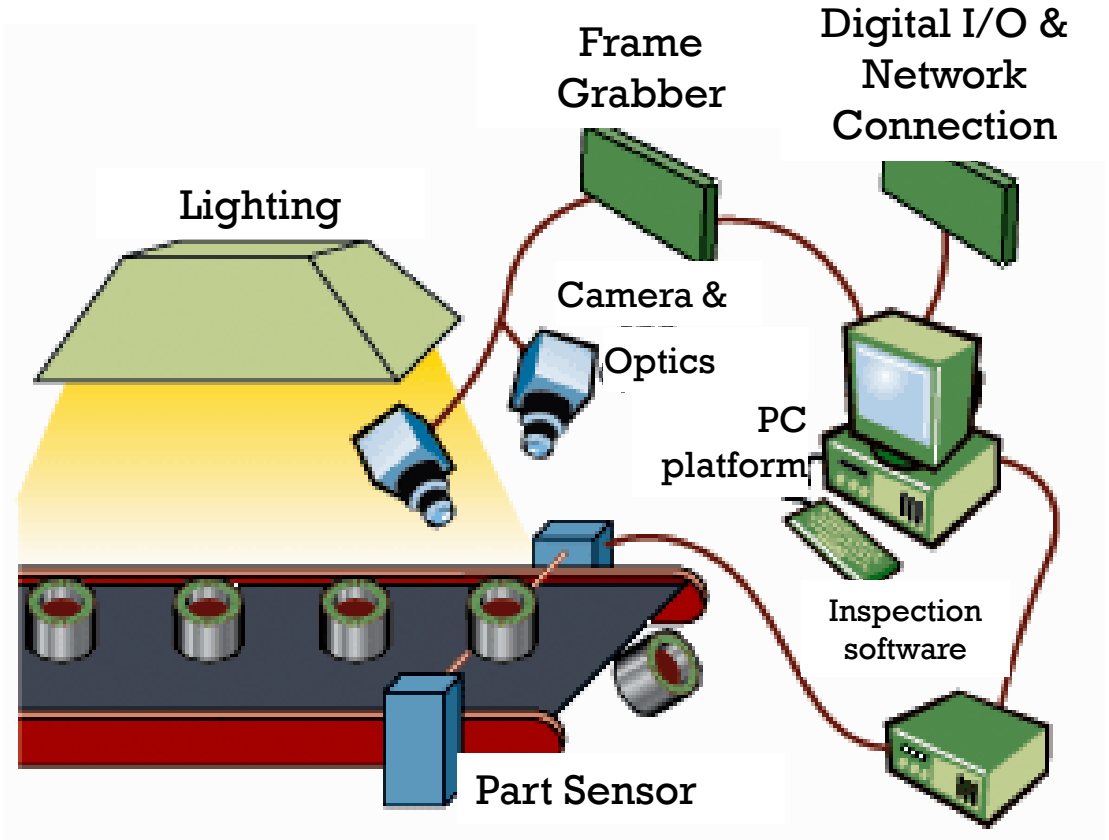
Sorting through History

- Miners panning for gold
- Quality control in food and other industries
- Bottle sorting for recycling



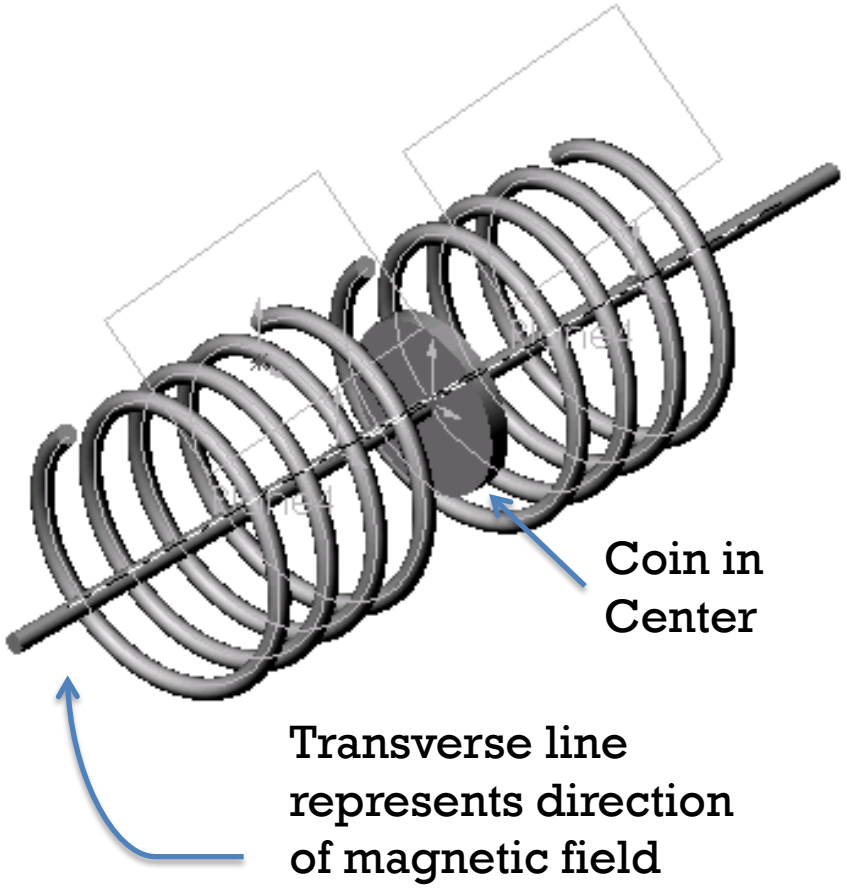
Different Types of Sorting

- Image Processing for the operation of Casinos:
- Off-the-shelf cameras, frame grabbers, and image-processing software used to develop a casino-coin sorting system



Different Types of Sorting

- Material Properties of Coin:
  - Current run through left coil, creates magnetic field
  - Magnetic field passes through and is attenuated by coin
  - Right coil receives magnetic field, creates measurable current with different value depending on the coin



Why Coin Sorting is Needed

- Mixed coins come from a variety of sources and must be sorted out before they can be redistributed
  - Coins from vending machines
  - Coins from parking meters
- Also helpful to identify fake or foreign coins

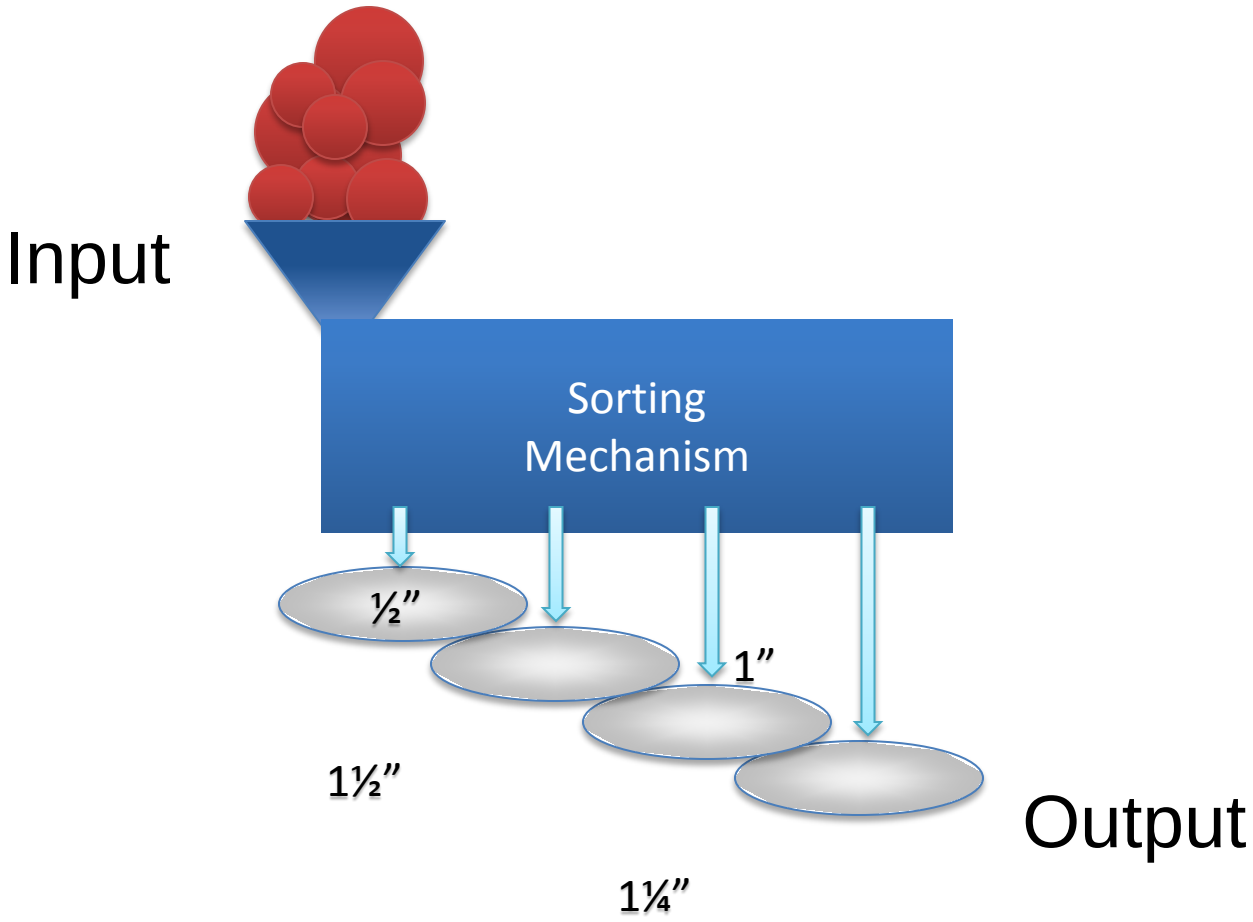
Why Coin Sorting is Needed

- Mixed coins are
  - Sorted
  - Rolled
  - Re-circulated through banks and businesses

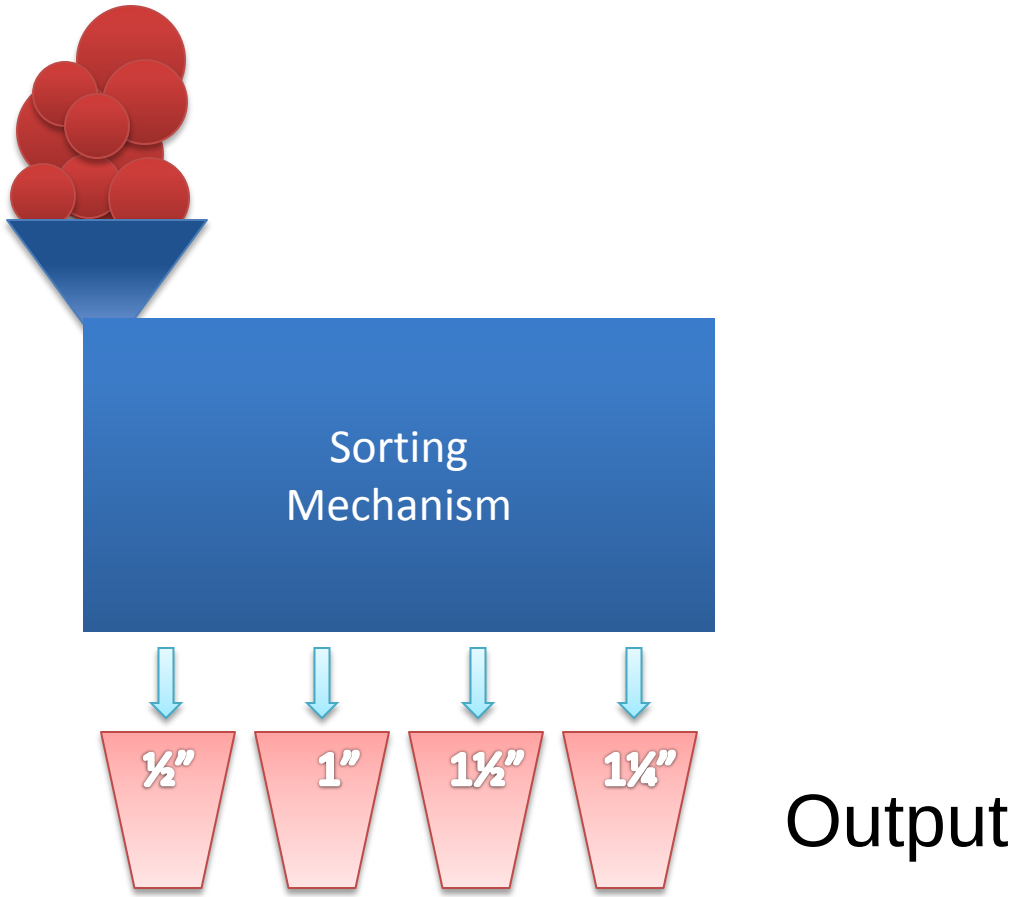
Your Turn

- Groups of 2
- You are a team of engineers hired by a bank to develop a machine to sort coins that are brought in by customers.
- Must mechanically sort mixed coins into separate containers.
- In our experiment we use washers:
  - ½ Inch
  - 1 Inch
  - 1¼ Inch
  - 1½ Inch

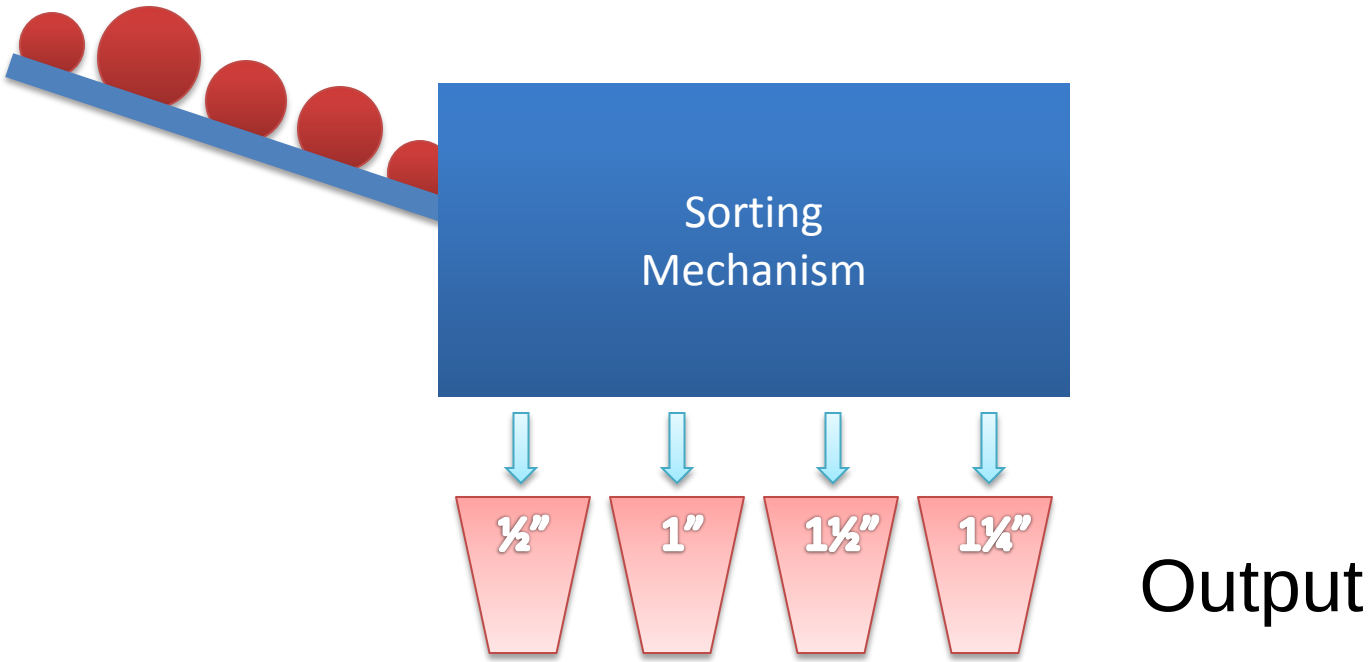
Parallel Sorter



Parallel Sorter



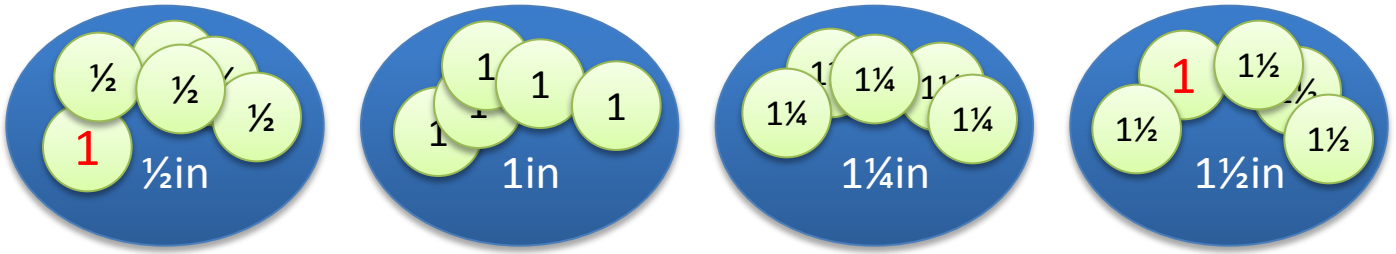
Serial Sorter



Performance Index 1: “Distance Index”

How good is it?

- 1: “Distance” performance index:



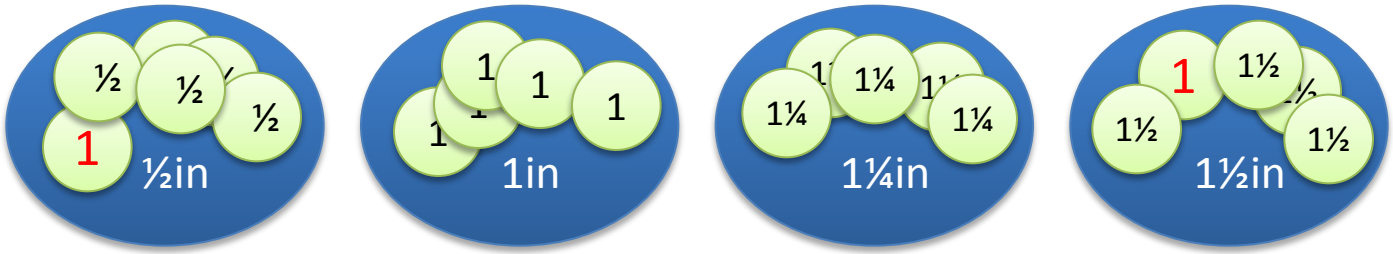
$$Index = \sqrt{\sum_i D_{error,i}^2} = \sqrt{4+1} \approx 2.24$$

- A washer that does not get sorted has maximum D_{error} = 3

Performance Index 2: “Percentage Index”

How good is it?

- 2: “Percentage” performance index:



$$Index = \frac{\text{\# of washers incorrectly identified}}{\text{Total \# of washers to sort}} \times 100 = \frac{2}{40} \times 100 = 5\%$$

Sort It Out!

Table Number: Team Name:					Type of Sorter Serial Parallel
# of this type in each container	Container for this size washer: 1/2"	1"	1 1/4"	1 1/2"	Total washers sorted: 16
1/2":					Number left unsorted:
1":					Distance Index:
1 1/4":					
1 1/2":					Percentage Index:

Sort It Out!

Table Number: *16*

Team Name: *The Perfect Group*

Type of Sorter: (Serial) / Parallel

# of this type in each container	Container for this size washer: 1/2"	1"	1 1/4"	1 1/2"
1/2":	*4*			
1":		*4*		
1 1/4":			*4*	
1 1/2":				*4*

Total washers sorted: (16)

Number left unsorted: *0*

Distance Index: *0*

Percentage Index: *0%*

Sort It Out!

- Distance Performance Index
  - sqrt($0x1^2 + 0x2^2 + 0x3^2$) = 0
  - A Perfect Score!
    - Remember: Lower is better
- Percentage Performance Index
  - (0 / 16) x 100 = 0%
  - Another Perfect Score!

Sort It Out!

Table Number: *16*					Type of Sorter: Serial / Parallel (Serial)
Team Name: *Not That Perfect*					
# of this type in each container	Container for this size washer: 1/2"	1"	1 1/4"	1 1/2"	Total washers sorted: 16
1/2":	*4*				Number left unsorted: *0*
1":		*4*			Distance Index: *1*
1 1/4":			*4*		
1 1/2":			*1*	*3*	Percentage Index: *6.25%*

Sort It Out!

- Distance Performance Index
  - sqrt($1x1^2 + 0x2^2 + 0x3^2$) = 1
  - A Less Than Perfect Score!
    - Remember: Lower is better
- Percentage Performance Index
  - (1 / 16) x 100 = 6.25%
  - A Less Than Perfect Score!

Sort It Out!

Table Number: *16*					Type of Sorter (Serial) / Parallel
Team Name: *The Truly Miserable*					
# of this type in each container	Container for this size washer: 1/2"	1"	1 1/4"	1 1/2"	Total washers sorted: (16)
1/2":	*1*	*1*	*1*	*1*	Number left unsorted: *2*
1":		*4*			Distance Index: *6.16*
1 1/4":	*4*				
1 1/2":				*2*	Percentage Index: *56%*

Sort It Out!

1/2":	*1*	*1*	*1*	*1*	Number left unsorted: *2*	
1":		*4*			Distance Index:	6.16
1 1/4":	*4*					
1 1/2":				*2*	Percentage Index:	56%

- Distance Performance Index
  - sqrt($1x1^2 + 1x2^2 + 4x2^2 + 1x3^2 + 2x3^2$) = 6.16
  - Much higher score, much lower performance
    - Remember: Lower is better
- Percentage Performance Index
  - (9 / 16) x 100 = 56.25%
  - Again, much lower performance

Sort It Out

Your Turn

Mechanical "shaking" of your device is allowed as part of its operation

- Design (draw) a mechanical sorter that can separate the ½in, 1in, 1¼in, 1½in washers
- Input: either
  - Parallel – all 16 washers are inserted at start of your sorter together; or
  - Serial – 16 washers are inserted at start of your sorter one at a time
- Output: Each size of washer in its own physical container or surface
- Materials:
  - glue, tape, paper or plastic plates, cardboard, scissors or hole punch, foil, paper, cardboard tubes
  - washers

Your Turn

- You will have 45 seconds to allow your sorter to operate
- Predict the value of the two performance indices for your design
- Construct your sorting mechanism
- Test it!
- Can you do better?

Mechanical "shaking" of your device is allowed as part of its operation

Conclusion

- Did your sorting mechanism work? If not, why did it fail?
- What were your performance index values?
- What levels of error would be acceptable in:
  - Medical Equipment manufacturing?
  - Nail manufacturing?
- What redesigns were necessary when you went to construct your design? Why?