68K Blade Process Handling

Team 9

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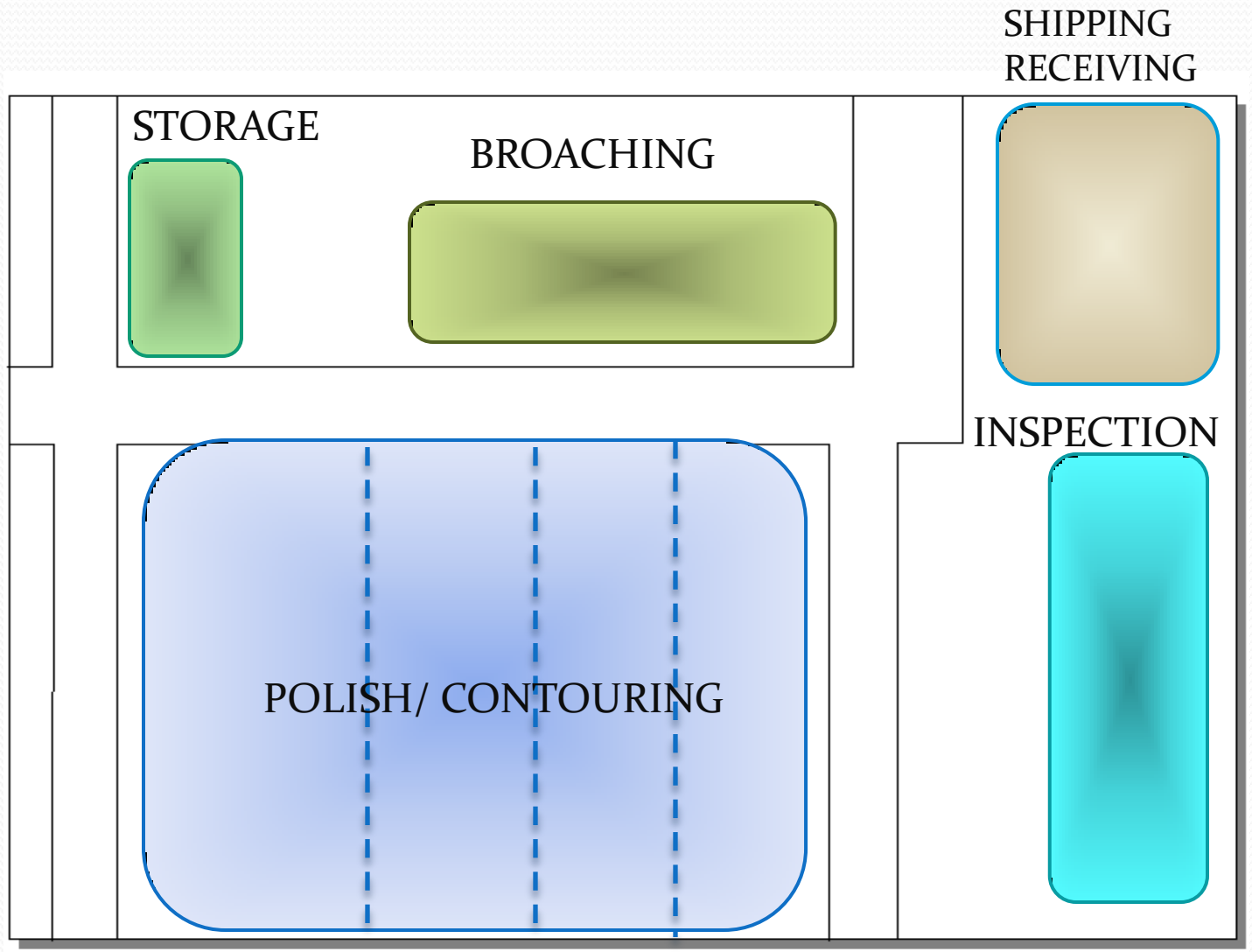
Outline

- Background
- Problem statement
  - Tools
- Concept generation
  - Mechanism
  - Container
  - Storage
- Conclusion

Background

- TECT Power
  - Thomasville, Georgia
  - Boeing, Pratt & Whitney, GE
- 68k blades
  - 2000 68k/ Year, 7-8 per day
  - Weighs 45lbs

Plant Layout



Broaching Machine

- Raised Oil Bed
- 8 inches high

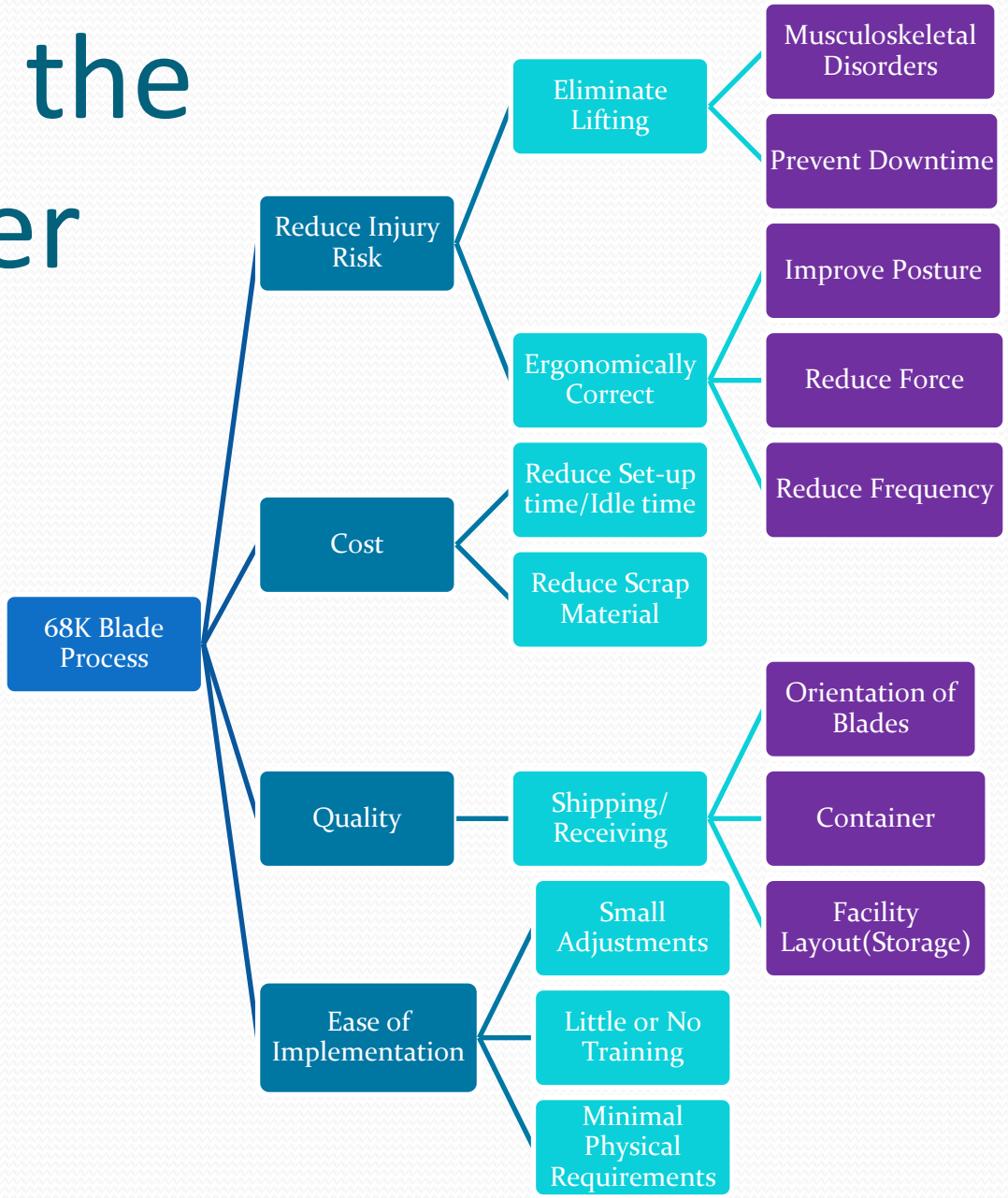
Problem Statement

- Blades arrive unorganized
  - 5-12 blades per container
  - Nested
- Operators manually lift blades from receiving container
  - Lift a minimum of 30 in.
  - From cart onto milling fixture

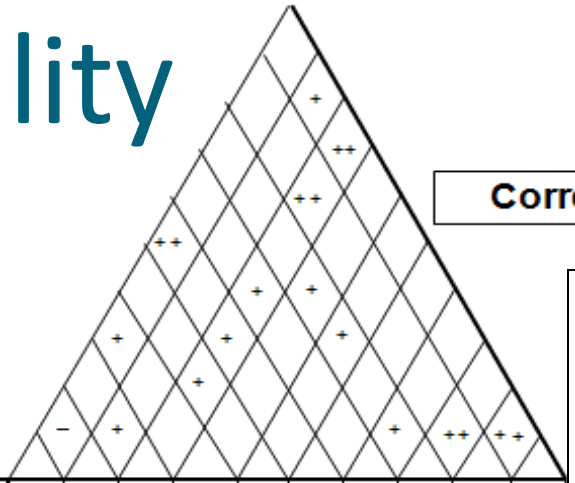
Objectives

- Eliminate manual lifting
- Redesign the receiving methods
  - Redesign storage area (optional)
- Design and fabricate a blade handling mechanism
  - Easy maneuverability
  - Stability
- Constraints

Voice of the Customer



House of Quality



				MAX / MIN / SAME	↑	↑	↓	0	↓	0	0	↓	↓	0
				Technical Requirements										
	Customer Requirements		IMPORTANCE		Height Range (Blade)	Strength	Weight	Blade Angle	Width	Height	Length	Time	Force Required	Density
Ergonimic Features	Minimize Lifting	1	5.00		S	M		M						
	Hold The Blades	2	4.00			S			M					
	High Mobility	3	4.00				M		S	W	M	M	S	M
	Ease of Use	4	3.00				S							
	Efficiency	5	2.00									M		
	Container Design	6	3.00					S		W				
	Technical Weights				45	51	39	42	12	7	12	18	36	12

Correlations

Direction of Improvement:

↑ Increase
↓ Decrease
0 Negligible

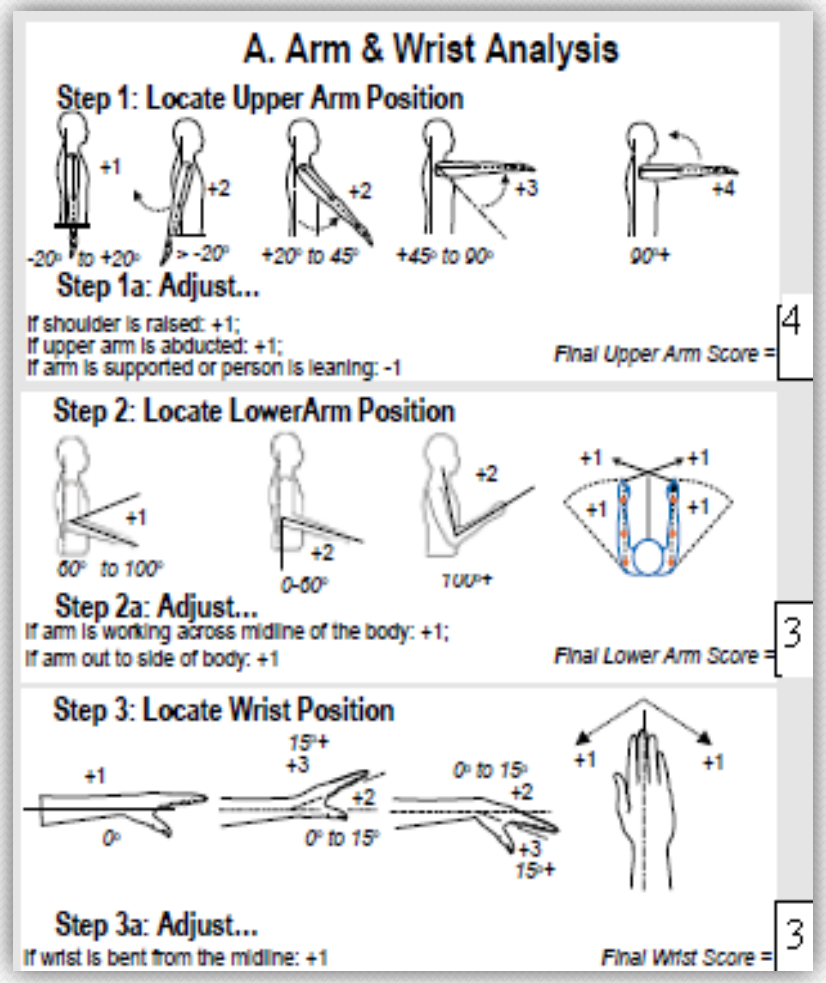
Correlation Key:

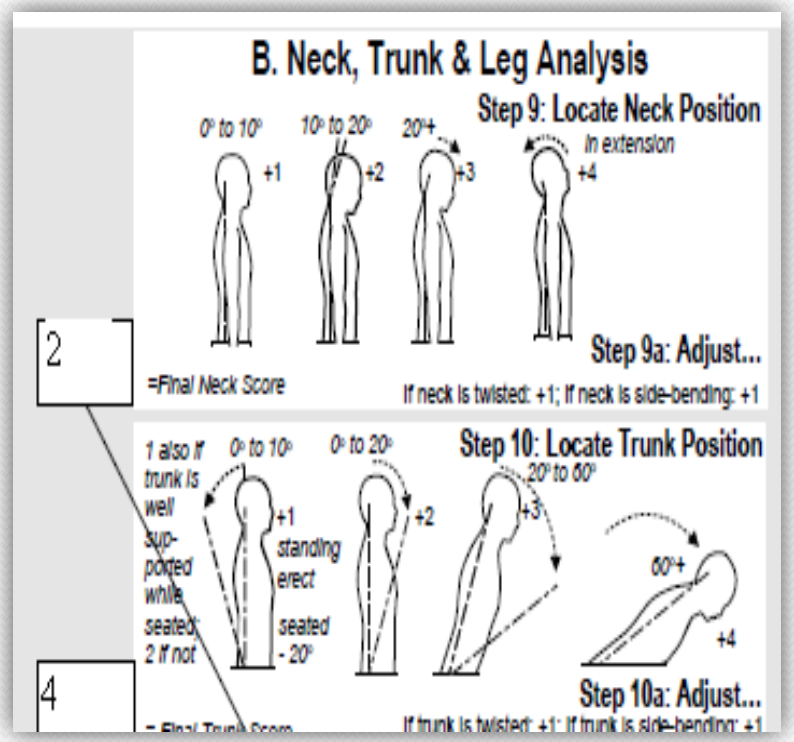
\+ Positive
\- Negative

Relationship Key:

(S) Strong = 9
(M) Moderate = 3
(W) Weak = 1

RULA Worksheet



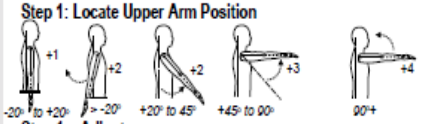


RULA Employee Assessment Worksheet

Complete this worksheet following the step-by-step procedure below. Keep a copy in the employee's personnel folder for future reference.

A. Arm & Wrist Analysis

Step 1: Locate Upper Arm Position

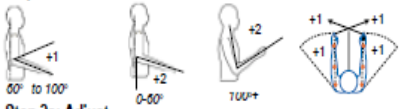


Step 1a: Adjust...

If shoulder is raised: +1;
If upper arm is abducted: +1;
If arm is supported or person is leaning: -1

Final Upper Arm Score = 4

Step 2: Locate LowerArm Position

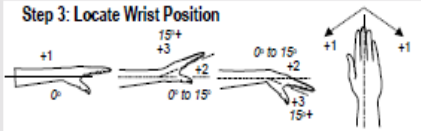


Step 2a: Adjust...

If arm is working across midline of the body: +1;
If arm out to side of body: +1

Final Lower Arm Score = 3

Step 3: Locate Wrist Position



Step 3a: Adjust...

If wrist is bent from the midline: +1

Final Wrist Score = 3

Step 4: Wrist Twist

If wrist is twisted mainly in mid-range =1;
If twist at or near end of twisting range = 2

Wrist Twist Score = 1

Step 5: Look-up Posture Score in Table A

Use values from steps 1,2,3 & 4 to locate Posture Score in table A

Posture Score A = 5

+

Step 6: Add Muscle Use Score

If posture mainly static (i.e. held for longer than 1 minute) or;
If action repeatedly occurs 4 times per minute or more: +1

Muscle Use Score = 0

+

Step 7: Add Force/load Score

If load less than 2 kg (intermittent): +0;
If 2 kg to 10 kg (intermittent): +1;
If 2 kg to 10 kg (static or repeated): +2;
If more than 10 kg load or repeated or shocks: +3

Force/load Score = 3

=

Step 8: Find Row in Table C

The completed score from the Arm/wrist analysis is used to find the row on Table C

Final Wrist & Arm Score = 8

SCORES

Table A

Upper Arm	Lower Arm	Wrist 1 Wrist Twist 1	Wrist 1 Wrist Twist 2	Wrist 2 Wrist Twist 1	Wrist 2 Wrist Twist 2	Wrist 3 Wrist Twist 1	Wrist 3 Wrist Twist 2	Wrist 4 Wrist Twist 1	Wrist 4 Wrist Twist 2
1	1	1	2	2	2	3	3	3	3
	2	2	2	2	3	3	3	3	4
	3	2	3	3	3	3	4	4	4
2	1	2	3	3	3	4	4	4	4
	2	3	3	3	3	4	4	4	5
	3	3	4	4	4	4	5	5	5
3	1	3	3	4	4	4	5	5	5
	2	3	4	4	4	4	5	5	5
	3	4	4	4	4	5	5	5	5
4	1	4	4	4	4	5	5	5	6
	2	4	4	4	4	5	5	5	6
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

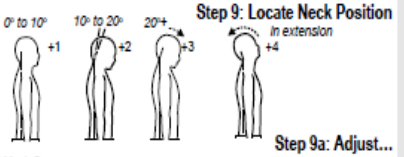
Table C

	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Final Score= 7

B. Neck, Trunk & Leg Analysis

Step 9: Locate Neck Position

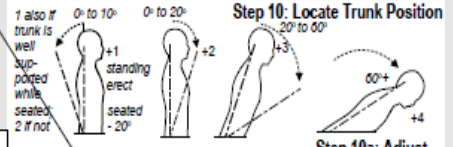


Step 9a: Adjust...

If neck is twisted: +1; If neck is side-bending: +1

2 =Final Neck Score

Step 10: Locate Trunk Position



Step 10a: Adjust...

If trunk is twisted: +1; If trunk is side-bending: +1

4 = Final Trunk Score

Step 11: Legs

If legs & feet supported and balanced: +1;
If not: +2

1 = Final LegScore

Table B

Neck \ Trunk Posture Score	1 Legs	2 Legs	3 Legs	4 Legs	5 Legs	6 Legs
1	1	2	1	2	1	2	1	2	1	2	1	2
2	1	3	2	3	3	4	5	5	6	6	7	7
3	2	3	2	3	4	5	5	6	6	7	7	7
4	3	3	3	4	4	5	5	6	6	7	7	7
5	5	5	5	6	6	7	7	7	7	8	8	8
6	7	7	7	7	8	8	8	8	8	8	9	9
7	8	8	8	8	8	8	9	9	9	9	9	9

Step 12: Look-up Posture Score in Table B

Use values from steps 8,9,& 10 to locate Posture Score in Table B

5 = Posture B Score

+

Step 13: Add Muscle Use Score

If posture mainly static or;
If action 4/minute or more: +1

0 = Muscle Use Score

+

Step 14: Add Force/load Score

If load less than 2 kg (intermittent): +0;
If 2 kg to 10 kg (intermittent): +1;
If 2 kg to 10 kg (static or repeated): +2;
If more than 10 kg load or repeated or shocks: +3

3 = Force/load Score

=

Step 15: Find Column in Table C

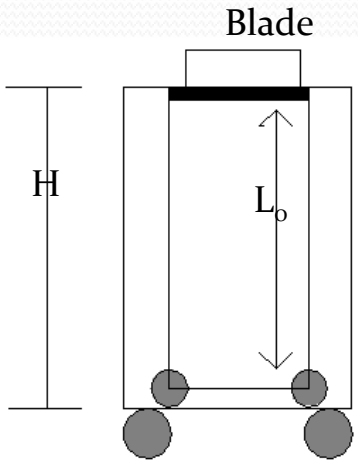
The completed score from the Neck/Trunk & Leg analysis is used to find the column on Chart C

8 = Final Neck, Trunk & Leg Score

Subject: 68K Blade Process
Company: TECT Power
Department: Industrial/Mechanical
Date: 10/24/11
Scorer: Group 5

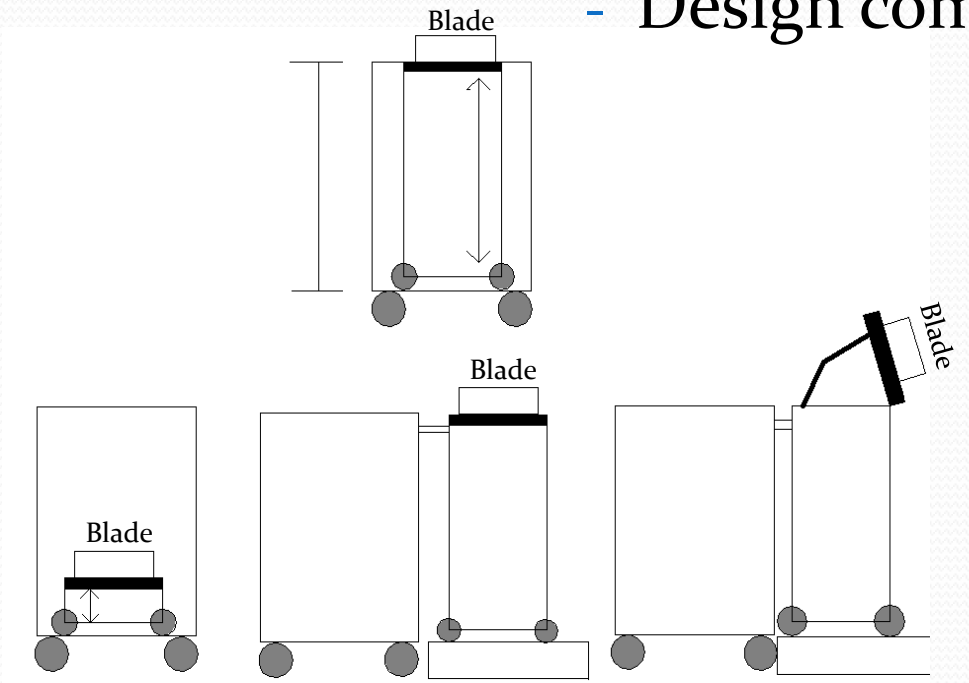
Mechanism Concept 1: Cart-in-Cart

- L_o is maximum height of inner cart
- H is the outer cart height
- Variable Height for Loading/Unloading
- Extendable to reach milling fixture
- Vertically Rotating Holder



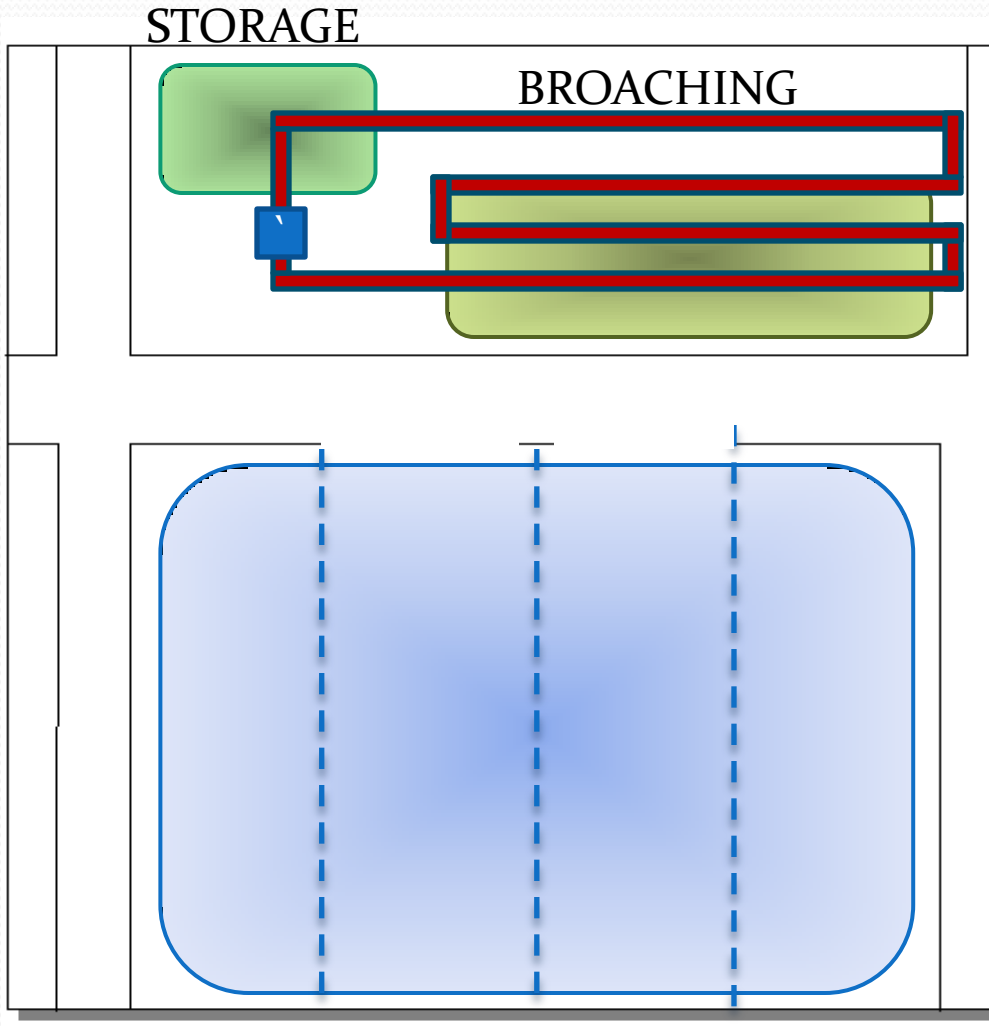
Mechanism 1: Cart-in-Cart

- Pros
  - Highly maneuverable
  - Three axis control
- Cons
  - Only holds one blade
  - Uni-axial elevation
  - Design complexity



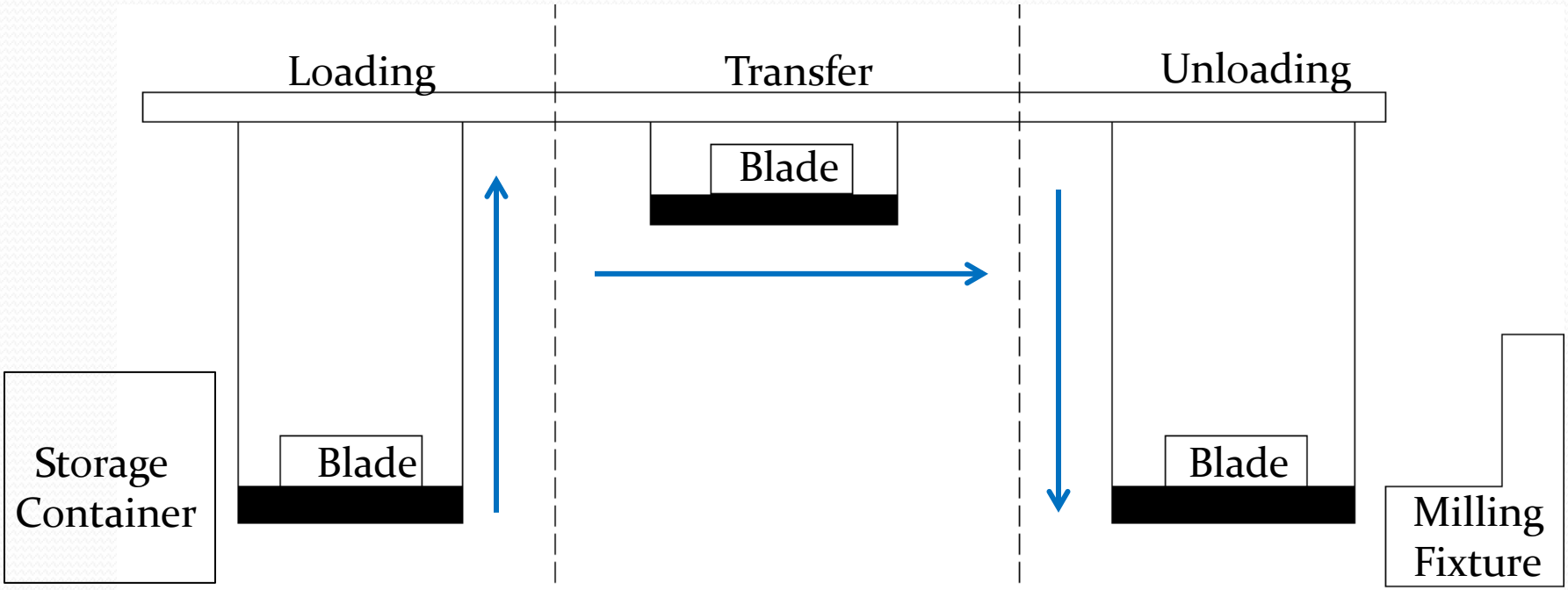
Mechanism 2: Conveyor

- Conveyor system suspended above broaching and storage
- Loaded in storage
- Off loaded at each machine
- Continuous rotation of parts



Mechanism 2: Conveyor

- Extended for loading
- Retracted for relocation
- Extended for milling



Mechanism 2: Conveyor

- Pros
  - Does not hinder factory traffic
  - Could have holders for vertical and horizontal mounting
- Cons
  - Expensive
  - High Maintenance
  - Requires constant loading
  - Increased time loading/unloading
  - Increased risk due to elevated blades
  - Failure prevents further blade processing

Mechanism 3: Vehicle Lift

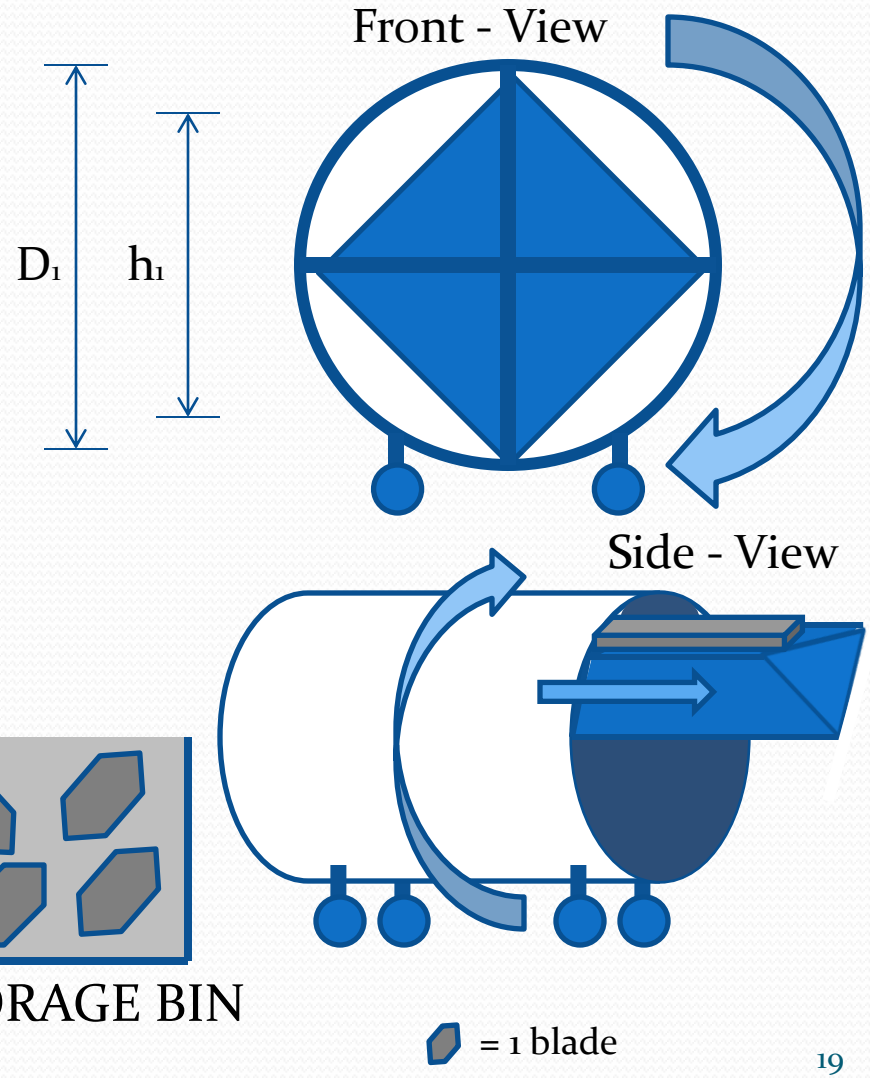
- Rear mounted lift on small vehicle
- Approximately 360° of rotation
- Holds entire blade container

Mechanism 3: Vehicle Lift

- Pros
  - Easy to Implement
  - Holds large number of blades
  - Could hold horizontally or vertically
  - Could be used for other needs
- Cons
  - Cost
  - Very low maneuverability
  - Could hinder access to other machines

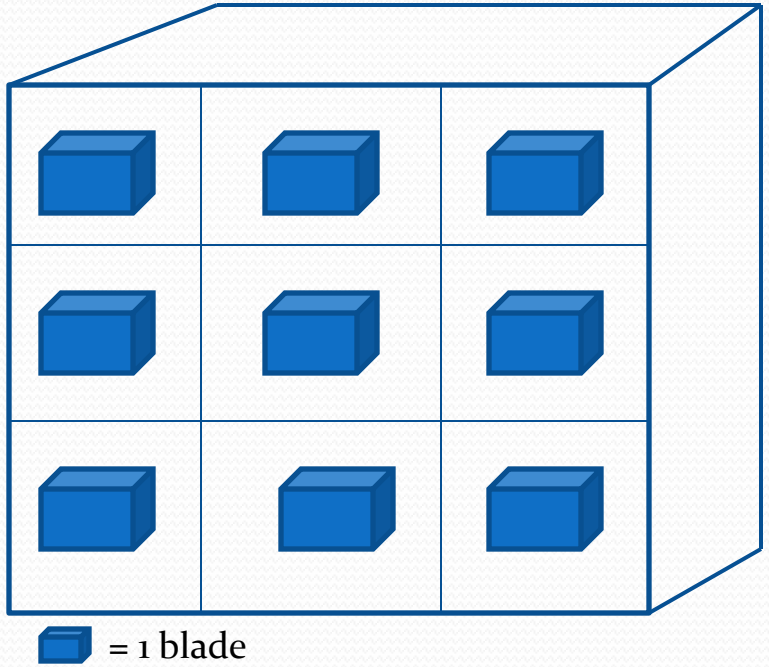
Mechanism 4: Revolving Barrel

- Extendable insert to reach milling fixture
- Pros
  - Rotational blade elevation
  - Holds multiple blades
- Cons
  - Weight of payload may decrease maneuverability



Storage Container Design 1

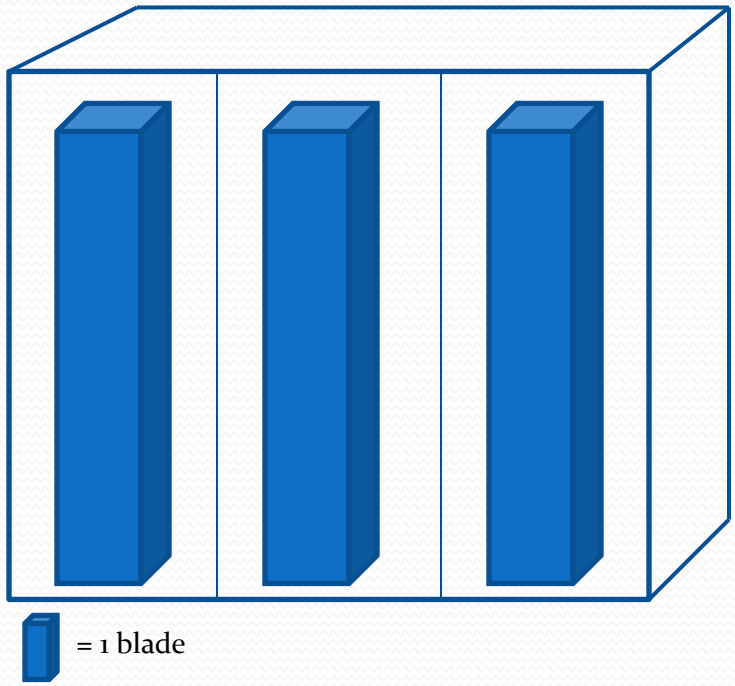
- Individual compartments
- Horizontal orientation
- Blades slide out onto the mechanism



FRONT VIEW

Storage Container Design 2

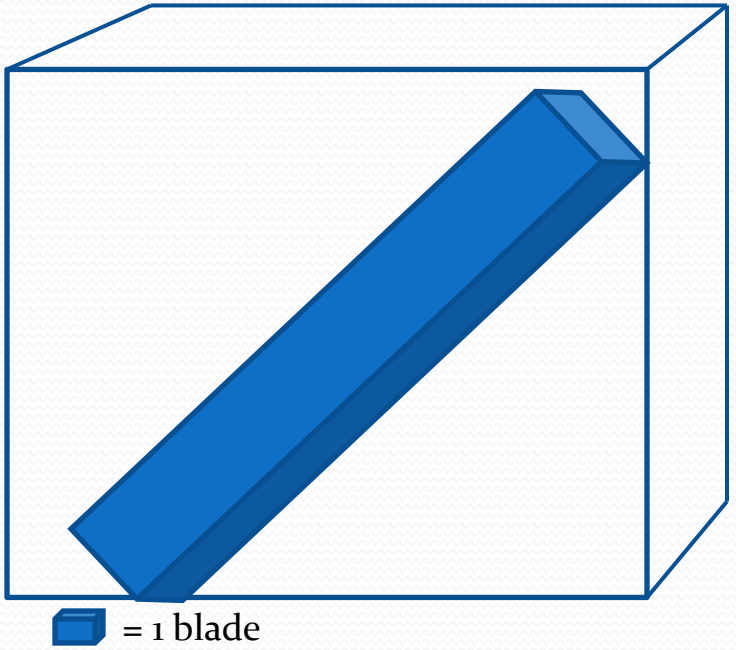
- Vertical orientation
- Blade will be picked up from top and pulled out
- Individual compartments



SIDE VIEW

Storage Container Design 3

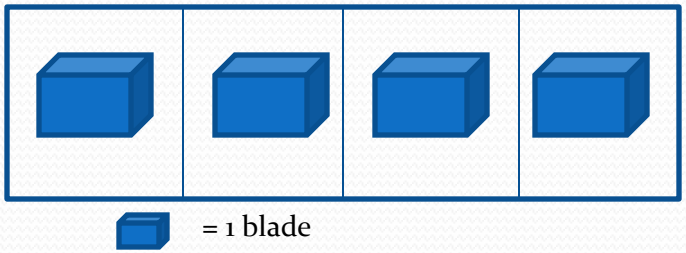
- Diagonal orientation
- Open structure
- Less restriction from the sides
- Blades can be accessed in multiple ways



SIDE VIEW

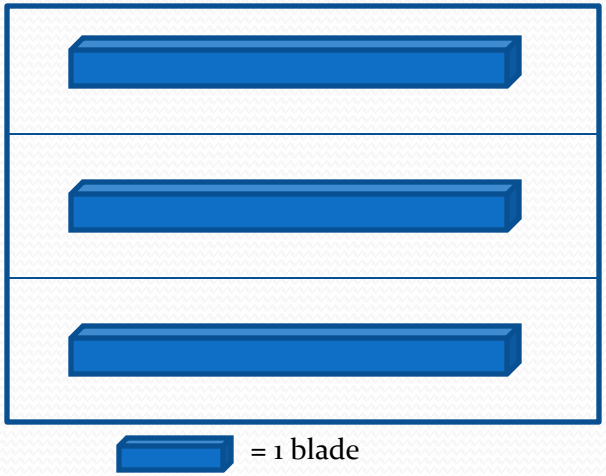
Storage Container Design 4

- Horizontal orientation
- Removed from side or from top



SIDE VIEW

- Single Layer



TOP VIEW

Storage area

- New layout proposed for better organization
- Mechanism requires more accessibility than current layout allows
- Elevated table with rollers

Selection Matrix

Factors	Weight	Cart-in Cart	Conveyor	Vehicle	Barrel
Minimize Lifting	0.45	7.6	7.8	9.6	8.9
Ease of implementation	0.1	7.7	4.6	5	8.3
Cost	0.05	8.6	1.6	3.2	7.76
Maneuverability	0.15	8.6	9	0.95	7.8
Efficiency	0.1	7.3	4.4	4.1	9.4
Durability/Maintenance	0.15	7.8	4	8	8.2
TOTAL (max 60)	1	47.6	31.4	30.85	50.36
		2	3	4	1

Conclusion

- Reduce risk of injury
- HOQ, RULA to interpret VOC
- Proposed concept ideas
  - Mechanism
  - Containers

Future Work

- Analyze the designs further
- Select the most feasible design
- Measure phase
  - Time study
  - Recommended Weight Limit
  - FBD for force measurements

Sources

- http://www.gti-power.com/turbine_package_parts.aspx
- http://www.chinahydraulicjacks.com/autorepairtools19/9861-1000lbcapacitypickuptruckcrane.htm
- http://www.lincolnservice.com/Modules/Webstore/Images/17/Ez-Go%20Industrial%20Utility%20Vehicle%20881.jpg
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- http://www.tectpower.com/company-overview/locations-and-contact/
- http://www.titanconveyors.com/assets/images/Assembly-1.jpg

Questions?