Factory Physics:
The Key to Green Industries

College of Engineering and Architecture - College Days 2012 EXHIBIT: Greening Industries

Student Chapter – Philippine Institute of Industrial Engineers (PIIE)
Holy Angel University
Angeles City, Pampanga, Philippines

In association with:

proplanner

Process & Industrial Engineering Software

Factory Physics – Green Industries

Presentation Overview

- Introduction
- Inventory Analysis
- Factory Layout Analysis
- Work Methods Analysis
- Energy Observations

Factory Physics – Green Industries
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Factory Physics: Introduction
Industrial Engineering & Greening Industries

- Industrial Engineers (IEs) - We analyze and improve work systems, which are simply collections of resources (human, equipment, material, and energy) that combine to make products or services.

- By showing how a small furniture factory in Lubao can more efficiently use their human, equipment, material, and energy resources, we demonstrate how IEs make factories more green.

Factory Physics: Introduction
Client Company Overview

- Mallari’s Nursery Furniture – manufacturer of baby furniture and other household furniture.
- Major product is a Baby Crib (kuna).
- The wood used for the product comes from old pallets from nearby industrial parks (low cost, green raw material).

Factory Physics: Introduction
Client Company Overview

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- Major product is a Baby Crib (kuna).
- The wood used for the product comes from old pallets from nearby industrial parks (low cost, green raw material).
- Located in Lubao, Pampanga.   Hometown of 2 former PHL Presidents (Diosado Macapagal and Gloria Macapagal-Arroyo).
- 15 employees. All perform manufacturing operations, and serve as material handlers.

Factory Physics: Introduction

Industrial Engineering & Greening Industry

The major product of importance to Mallari is the Baby Crib, and is therefore the primary focus of this project.

Factory Physics – Green Industries
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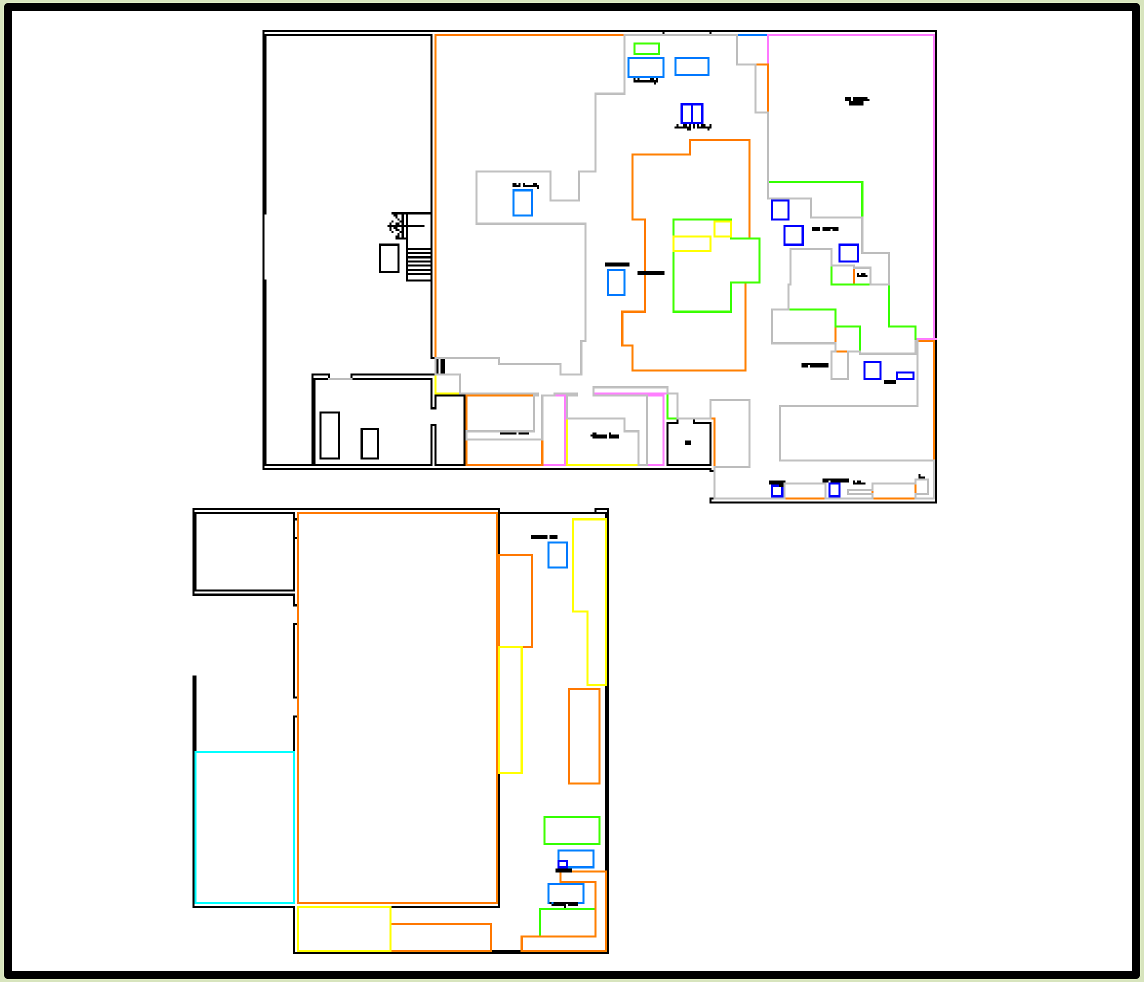
- **Inventory Analysis**
- Factory Layout Analysis
- Work Methods Analysis
- Energy Observations

Factory Physics: Inventory Analysis
Factory Overloaded with WIP Inventory

Large piles of Work In Process (WIP) inventory shown throughout the factory.

Factory Physics: Inventory Analysis

Factory Space Analysis



Factory Physics: Inventory Analysis

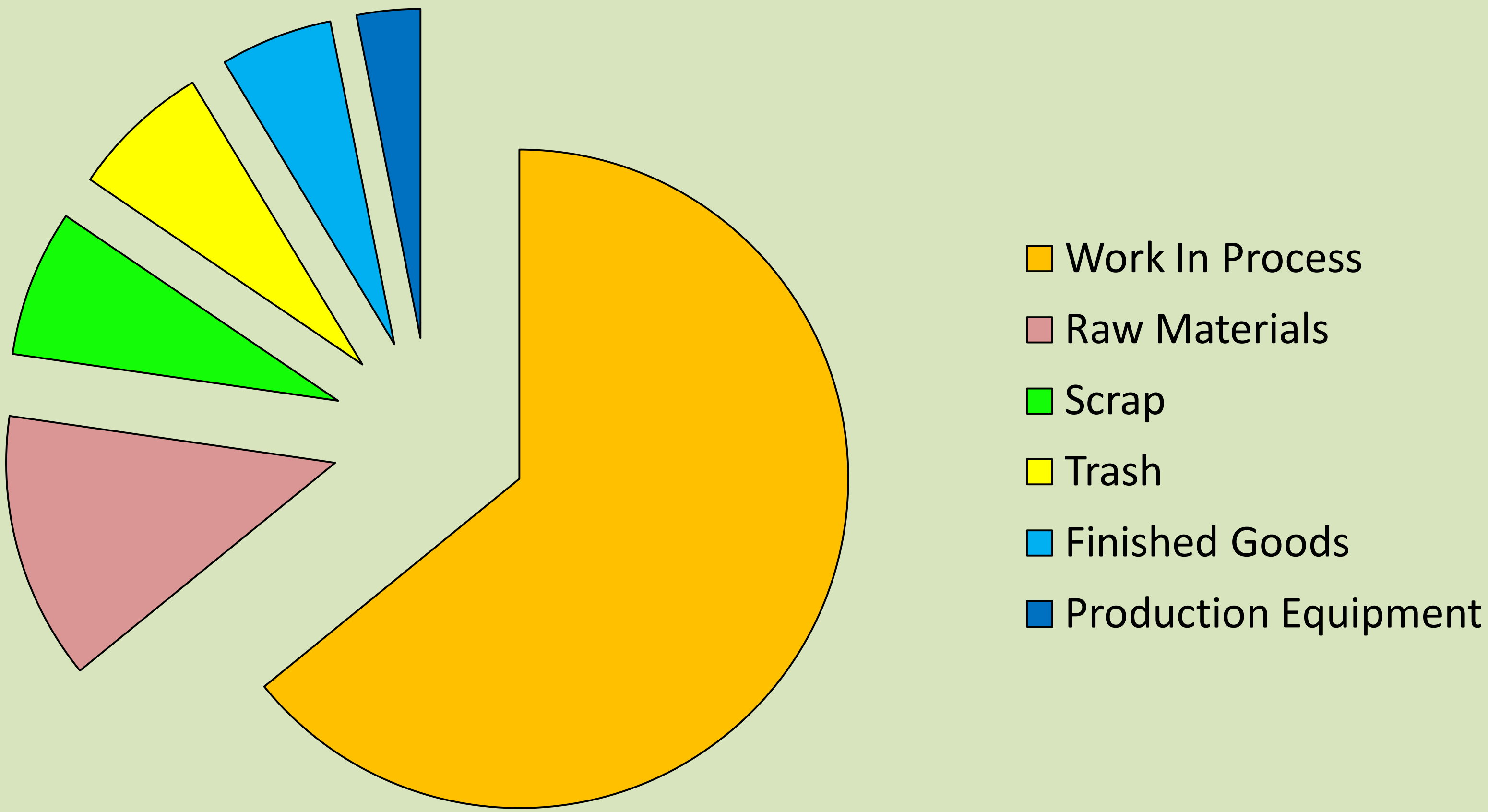
Factory Space Analysis

INVENTORY - RAW MATERIALS | INVENTORY - WORK IN PROCESS | INVENTORY - FINISHED GOODS | SCRAP

PRODUCTION EQUIPMENT | TRASH | MISCELLANEOUS SUPPORT | AISLES

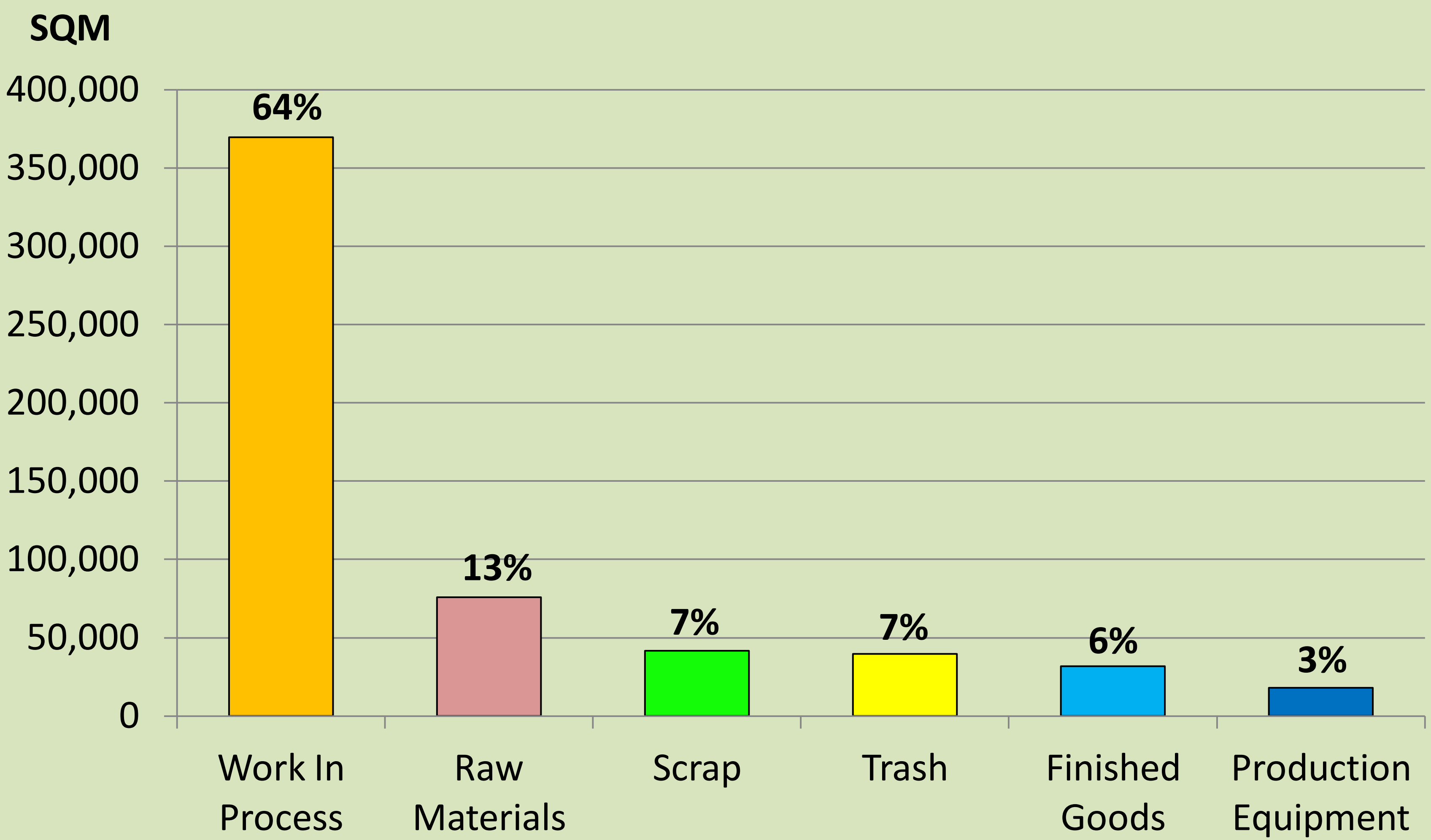
Factory Physics: Inventory Analysis

Factory Space Analysis



Factory Physics: Inventory Analysis

Factory Space Analysis



Factory Physics: Inventory Analysis
Laws of Factory Physics

Little's Law

$$CT_{System} = WIP_{System} / TH_{System}$$

Factory Physics: Inventory Analysis

Laws of Factory Physics

The higher the level of Work-In Process inventory, the longer it takes products to go through the system.

$$CT_{System} = WIP_{System} / TH_{System}$$

Factory Physics: Inventory Analysis
Laws of Factory Physics

Therefore, to utilize factory resources more efficiently (and increase output), we need to decrease the amount of WIP inventory in the factory.

CT Sy… S… / TH …stem

Factory Physics: Inventory Analysis
Increased WIP = Increased Waiting Times

- Currently, each work station produces parts for 30 finished products. This is called a Lot, or Batch.
- When a Lot arrives at a station, the worker processes the 1st part of the Lot, while the 29 other parts 'Wait to Process.'

Factory Physics: Inventory Analysis
Increased WIP = Increased Waiting Times

- Currently, each work station produces parts for 30 finished products. This is called a Lot, or Batch.

- When a Lot arrives at a station, the worker processes the 1st part of the Lot, while the 29 other parts ‘Wait to Process.’

- When the 1st part completes processing, it experiences ‘Wait to Batch’ time, as it cannot move to the next station until all 30 parts are complete.

- Large Lot / Batch sizes increase the waiting times in the factory, and only serve to increase WIP, and the time for products to move through the factory (CT).

Factory Physics: Inventory Analysis
Recommendations

- Reduce Lot Sizes from 30 cribs to 15 cribs.
- Reduce space available for WIP inventory, and better organize its locations (addressed in factory layout analysis).
- Remove trash permanently (12% of total space).
- Remove scrap from production area frequently.

Factory Physics – Green Industries

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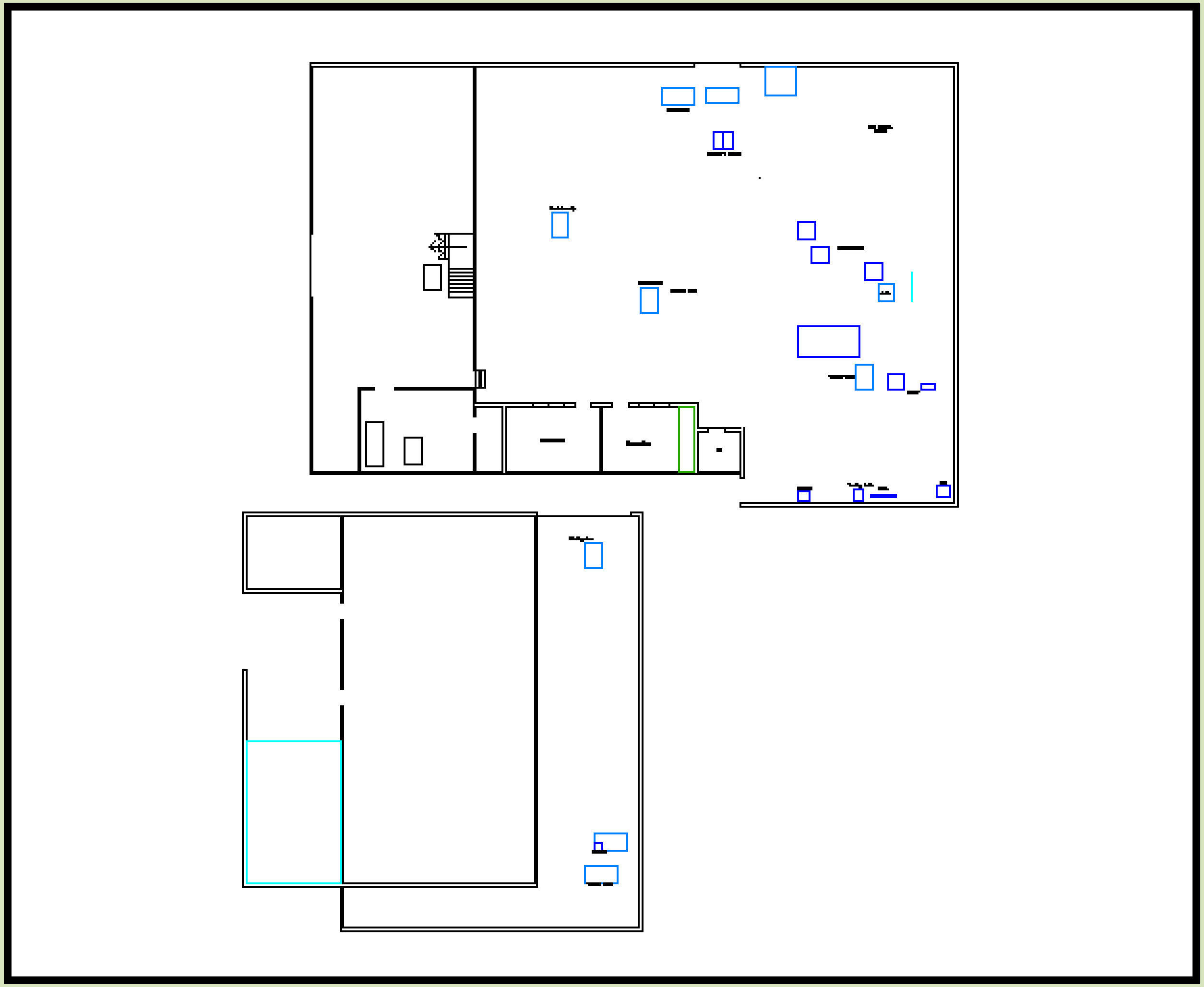
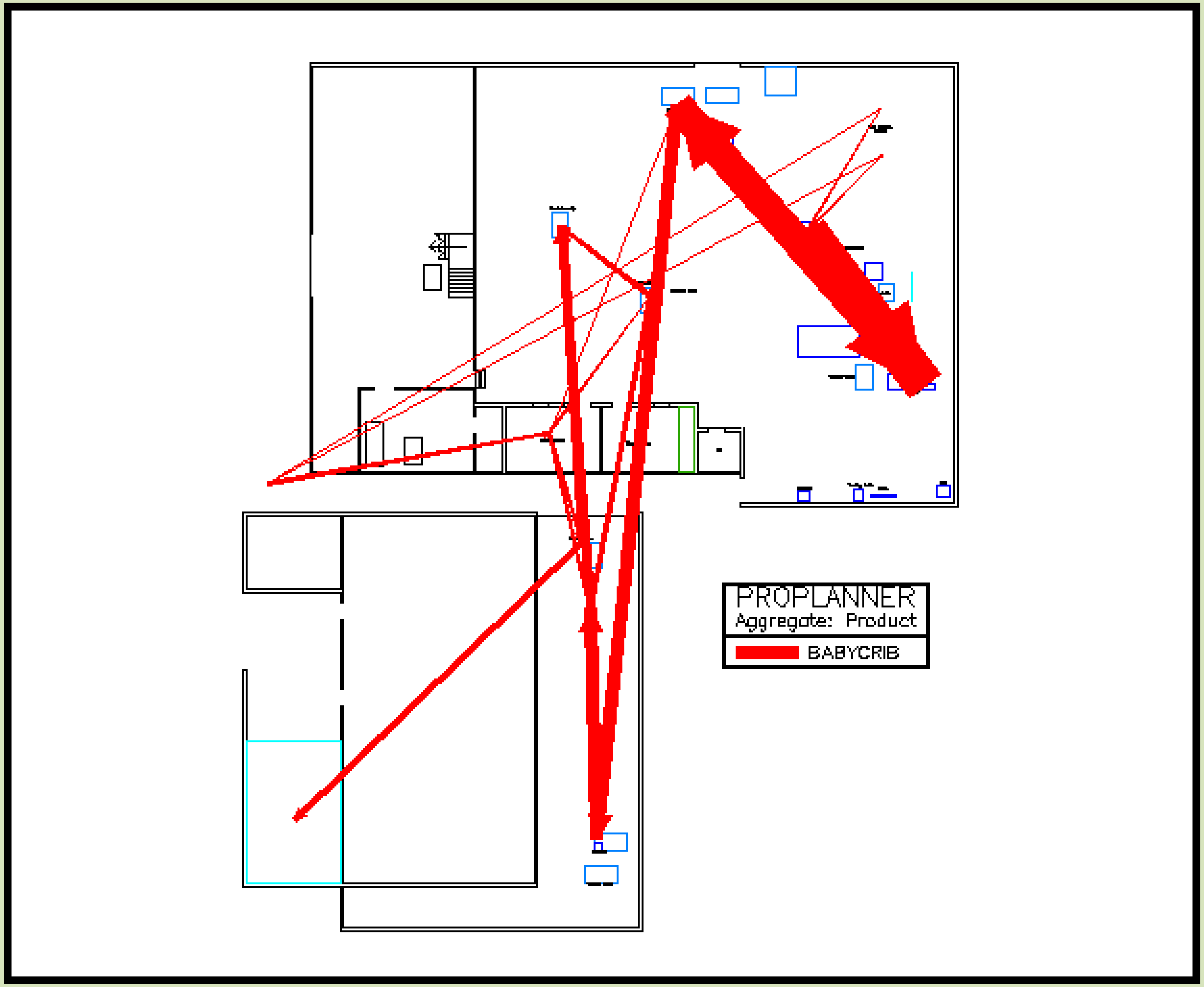
Factory Physics: Factory Layout

Current Layout



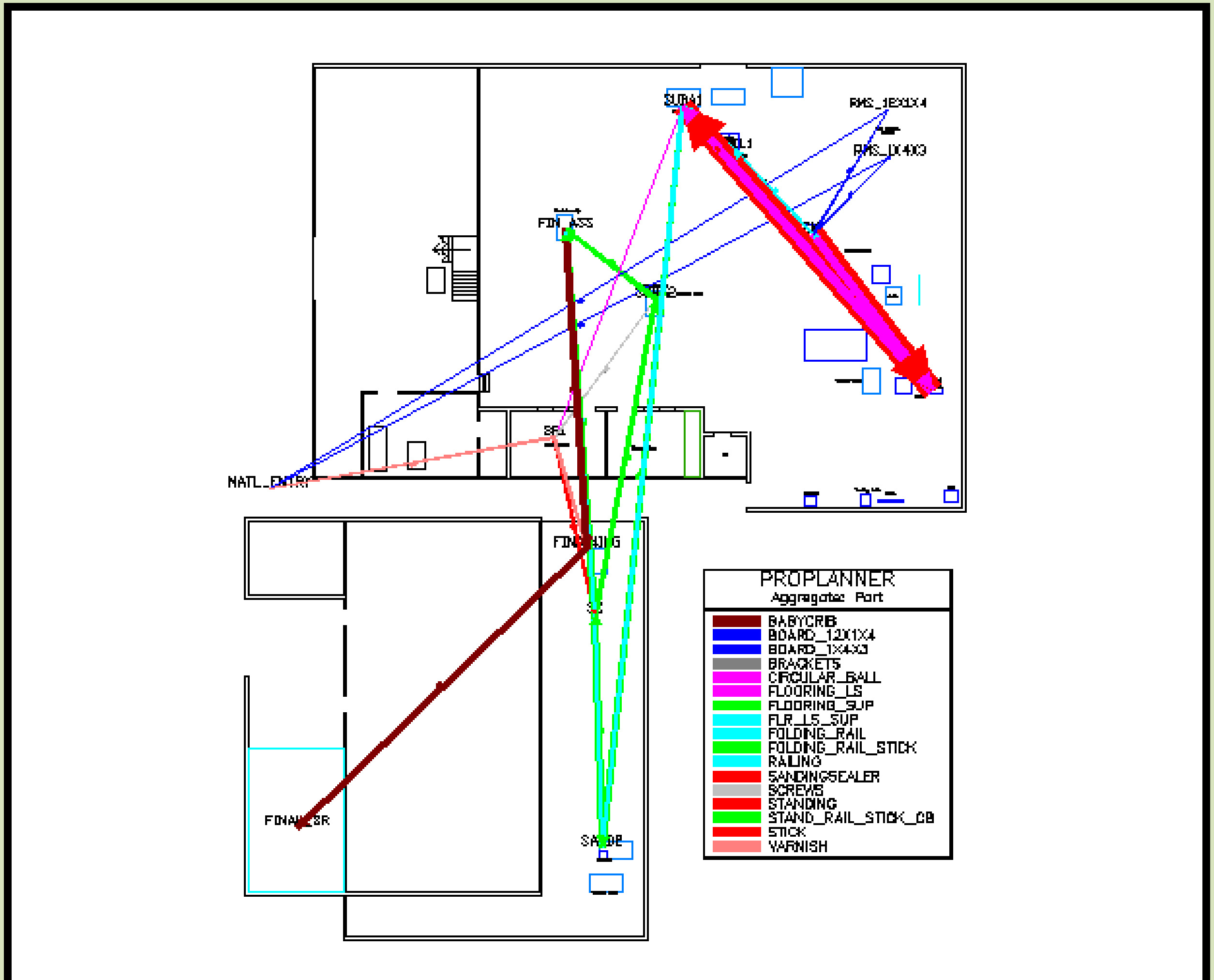
Factory Physics: Factory Layout

Current Layout – Material Flow



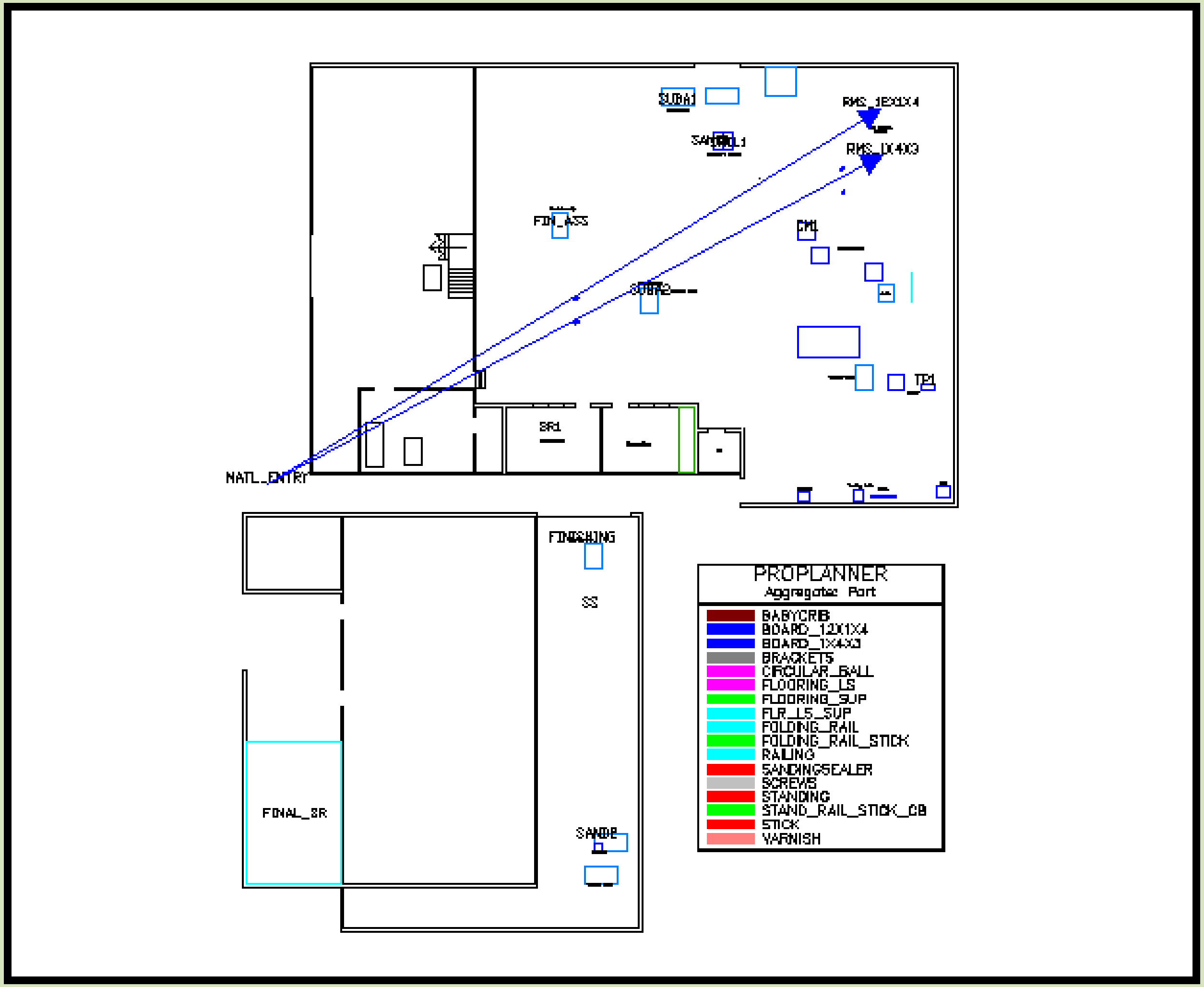
Factory Physics: Factory Layout

Current Layout – Material Flow (Parts)



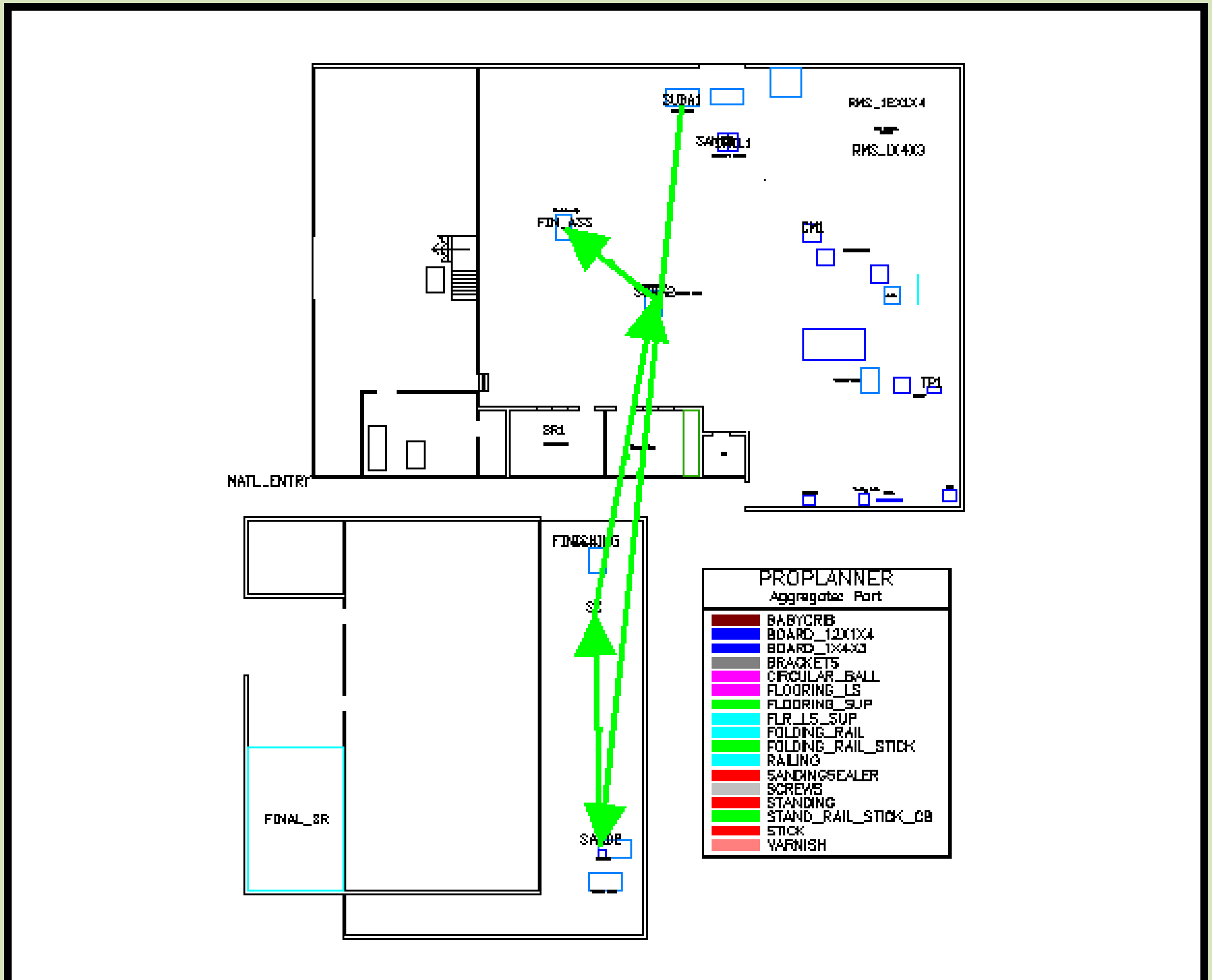
Factory Physics: Factory Layout

Layout Issues – Lengthy Flow for Raw Materials



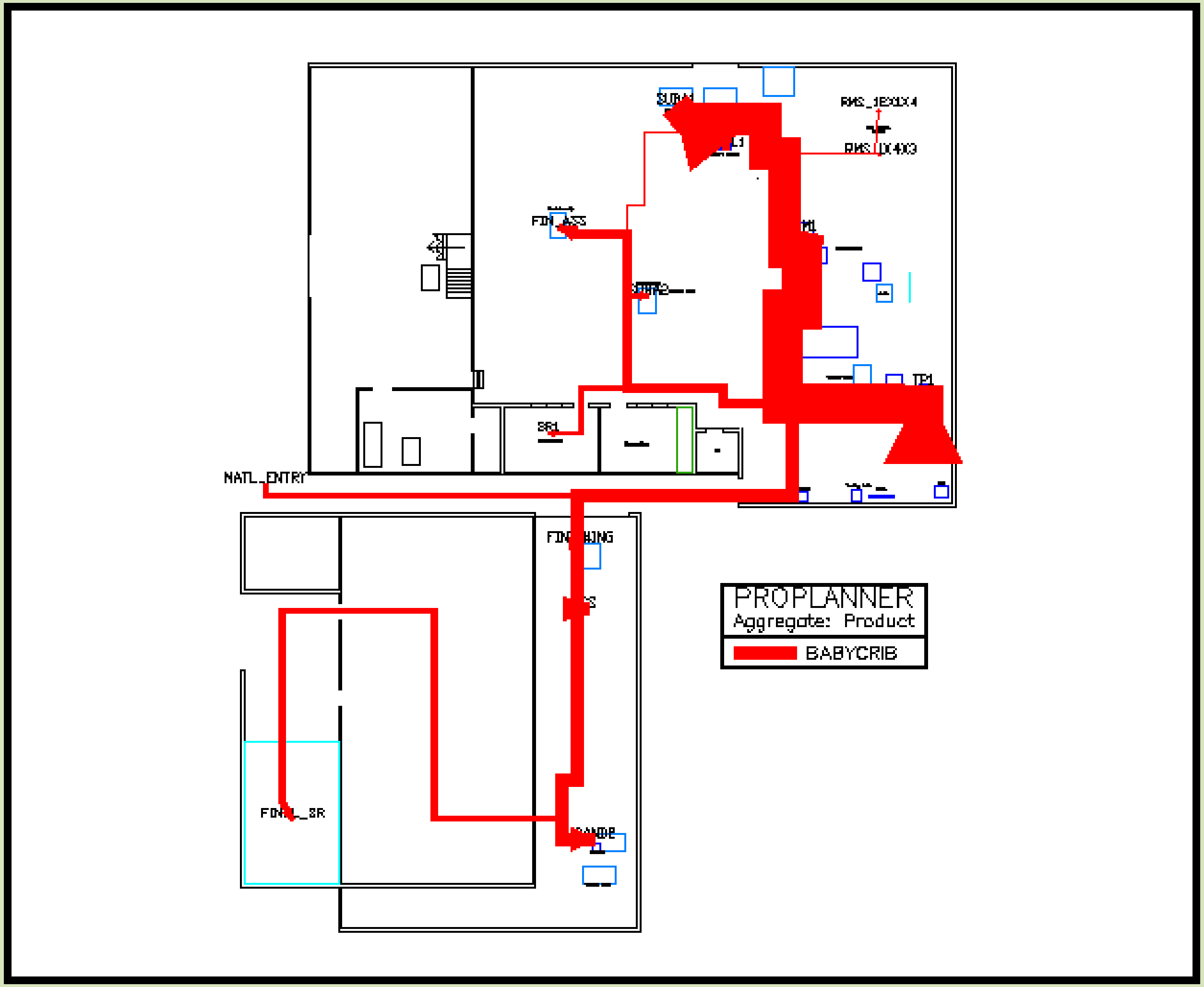
Factory Physics: Factory Layout

Layout Issues – Lengthy, Backtracking Flow



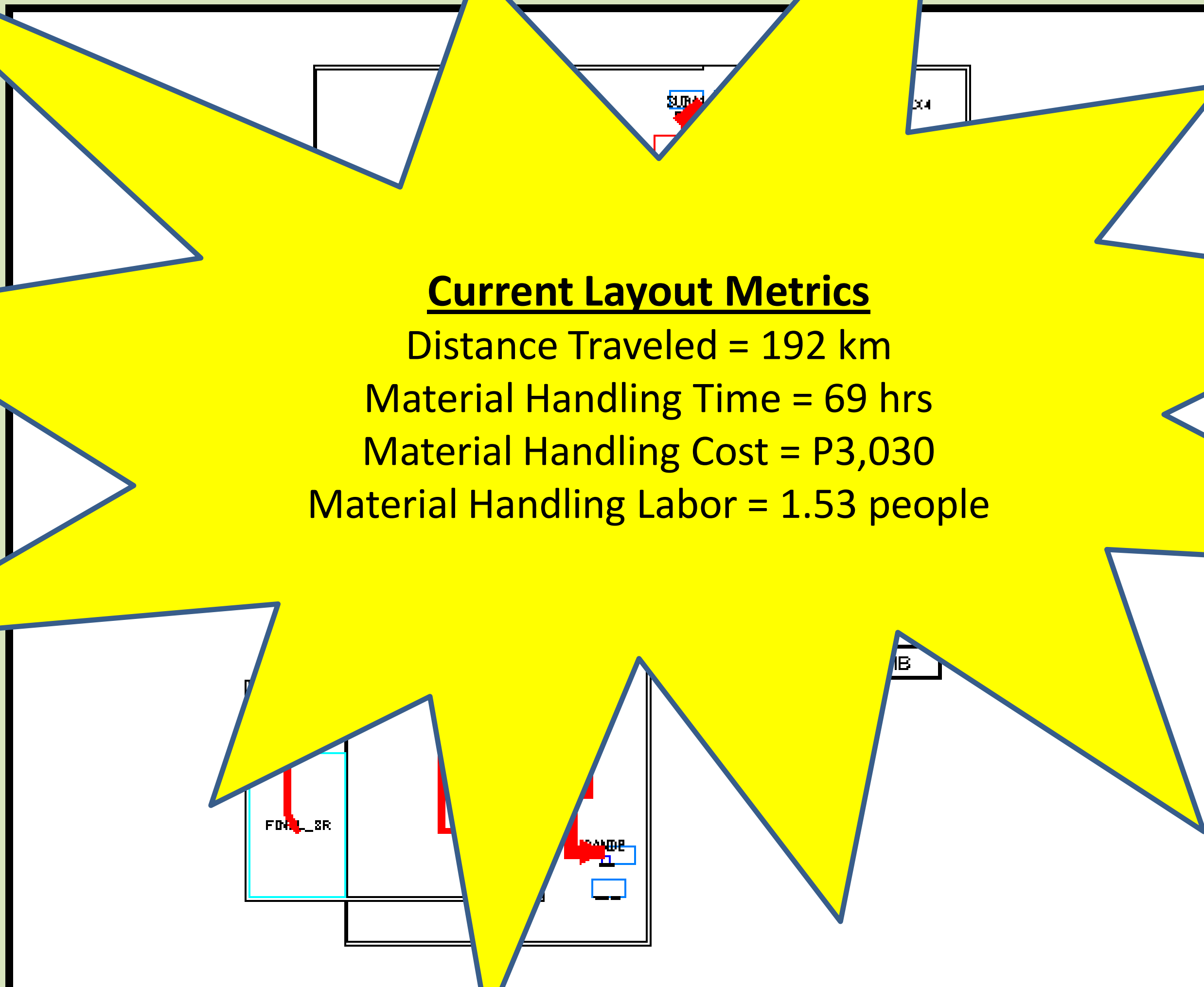
Factory Physics: Factory Layout

Current Layout – Actual Path Flow



Factory Physics: Factory Layout

Current Layout – Metrics (per week)



<u>Current Layout Metrics</u>

Distance Traveled = 192 km

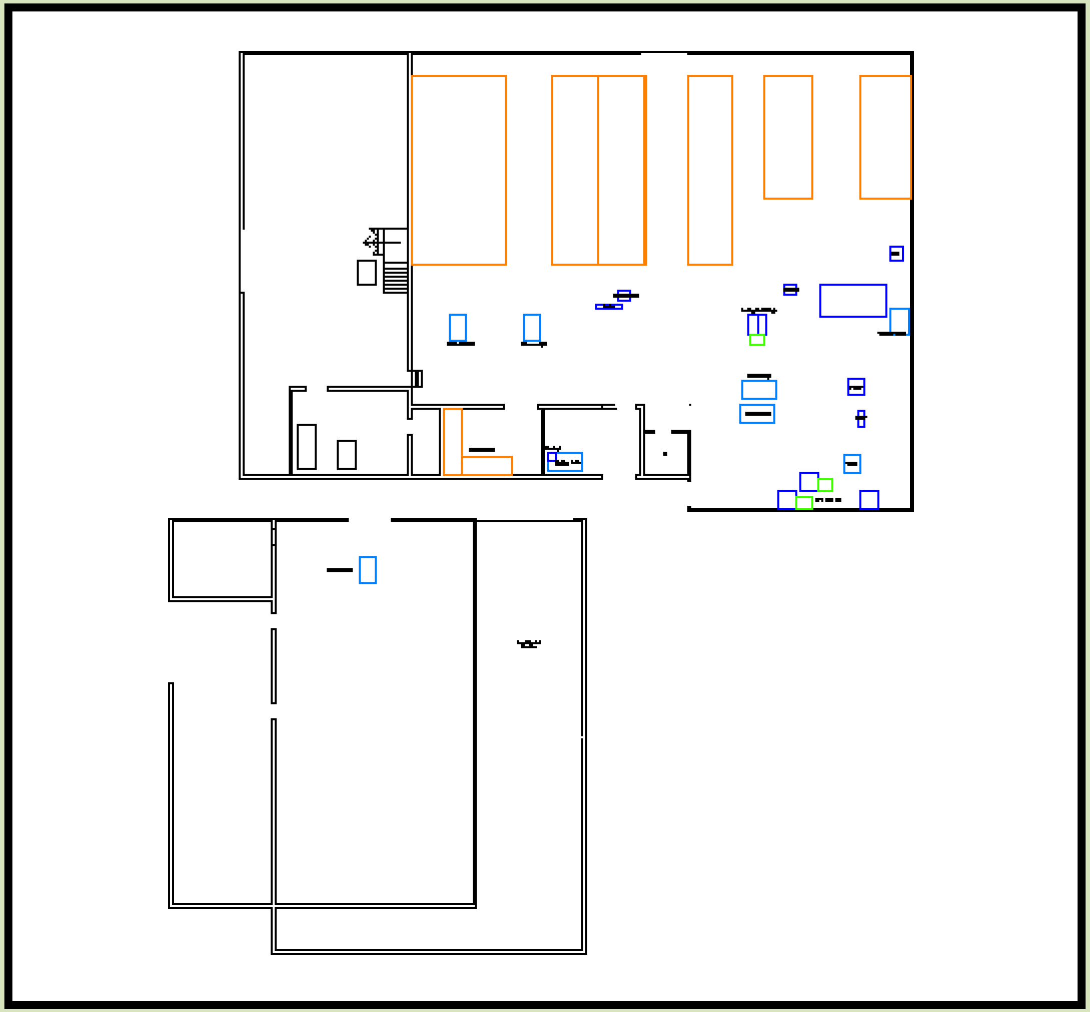
Material Handling Time = 69 hrs

Material Handling Cost = P3,030

Material Handling Labor = 1.53 people

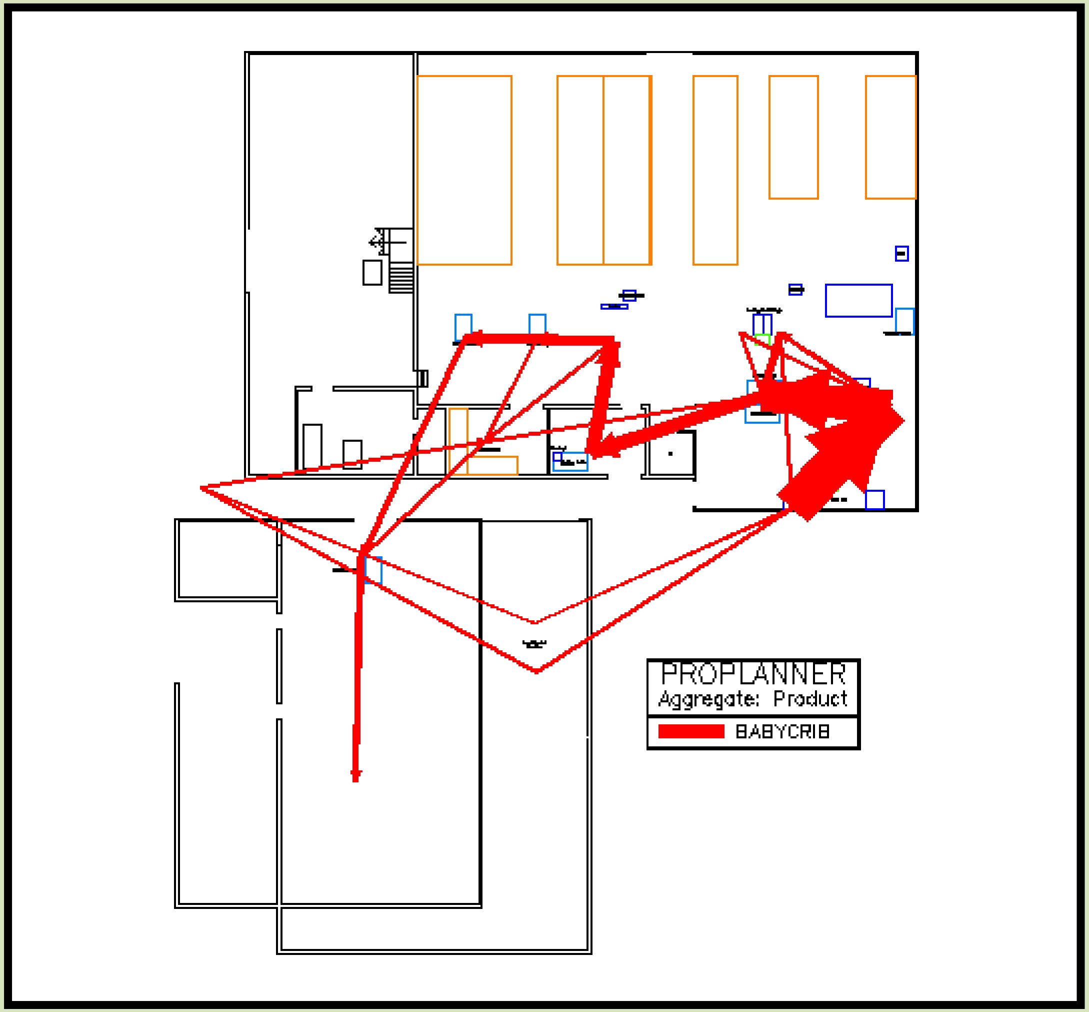
Factory Physics: Factory Layout

Future Layout



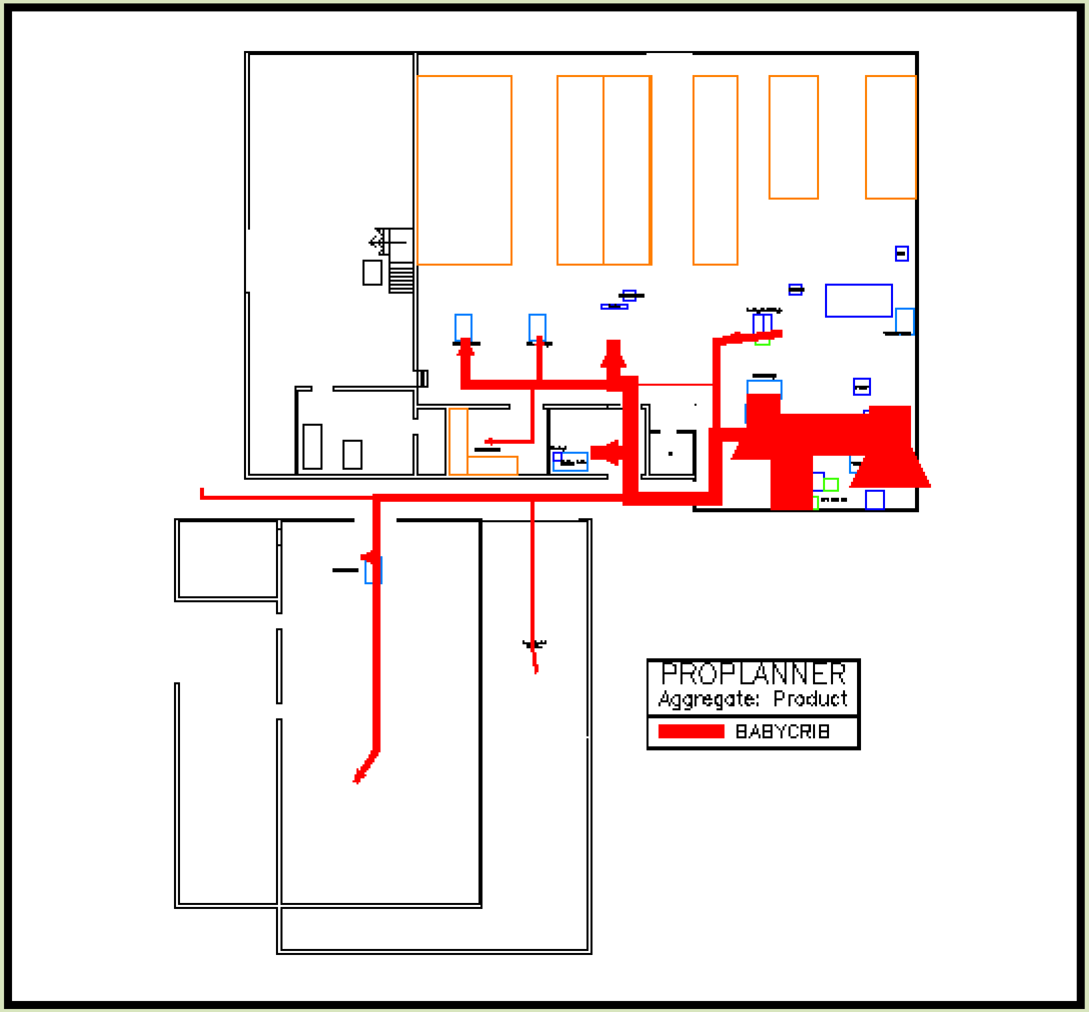
Factory Physics: Factory Layout

Future Layout – Material Flow



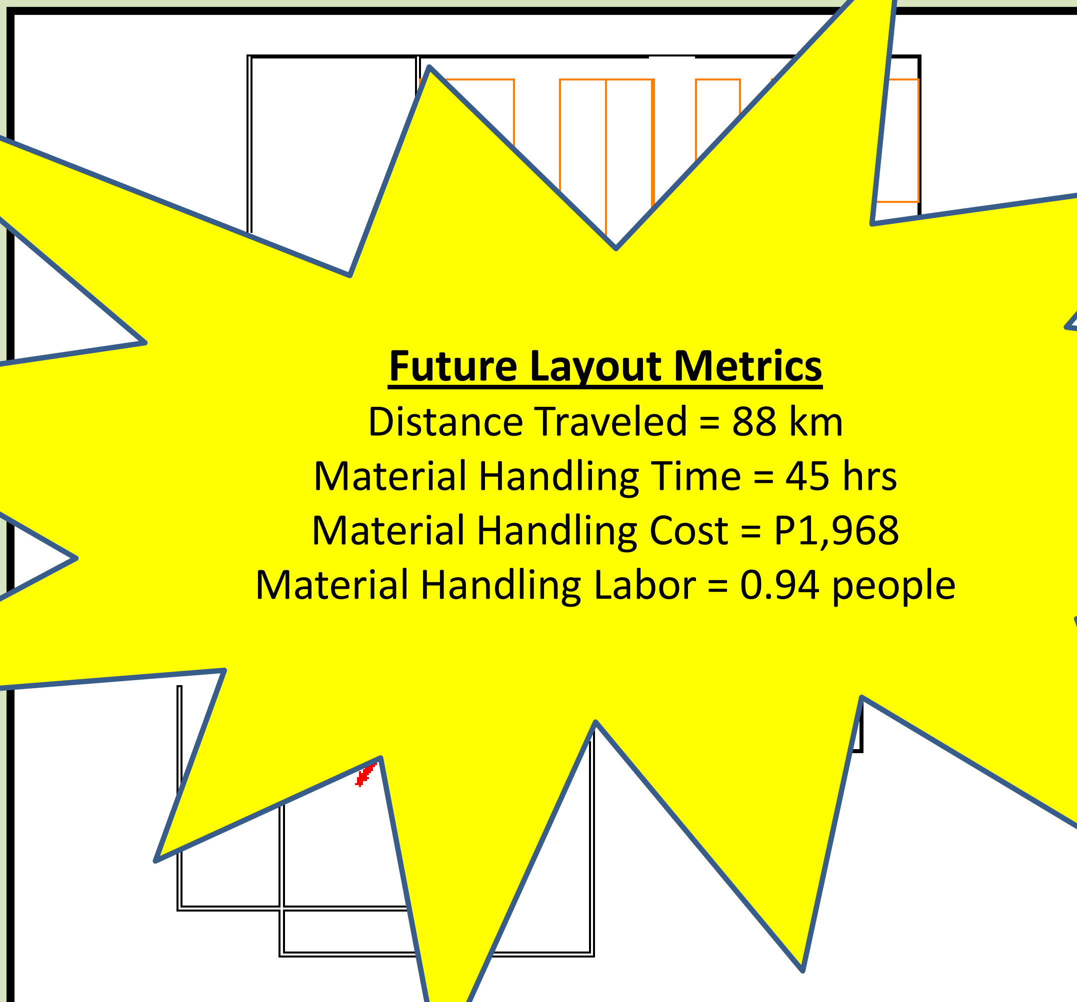
Factory Physics: Factory Layout

Future Layout – Material Flow



Factory Physics: Factory Layout

Future Layout – Metrics (per week)



<u>Future Layout Metrics</u>

Distance Traveled = 88 km

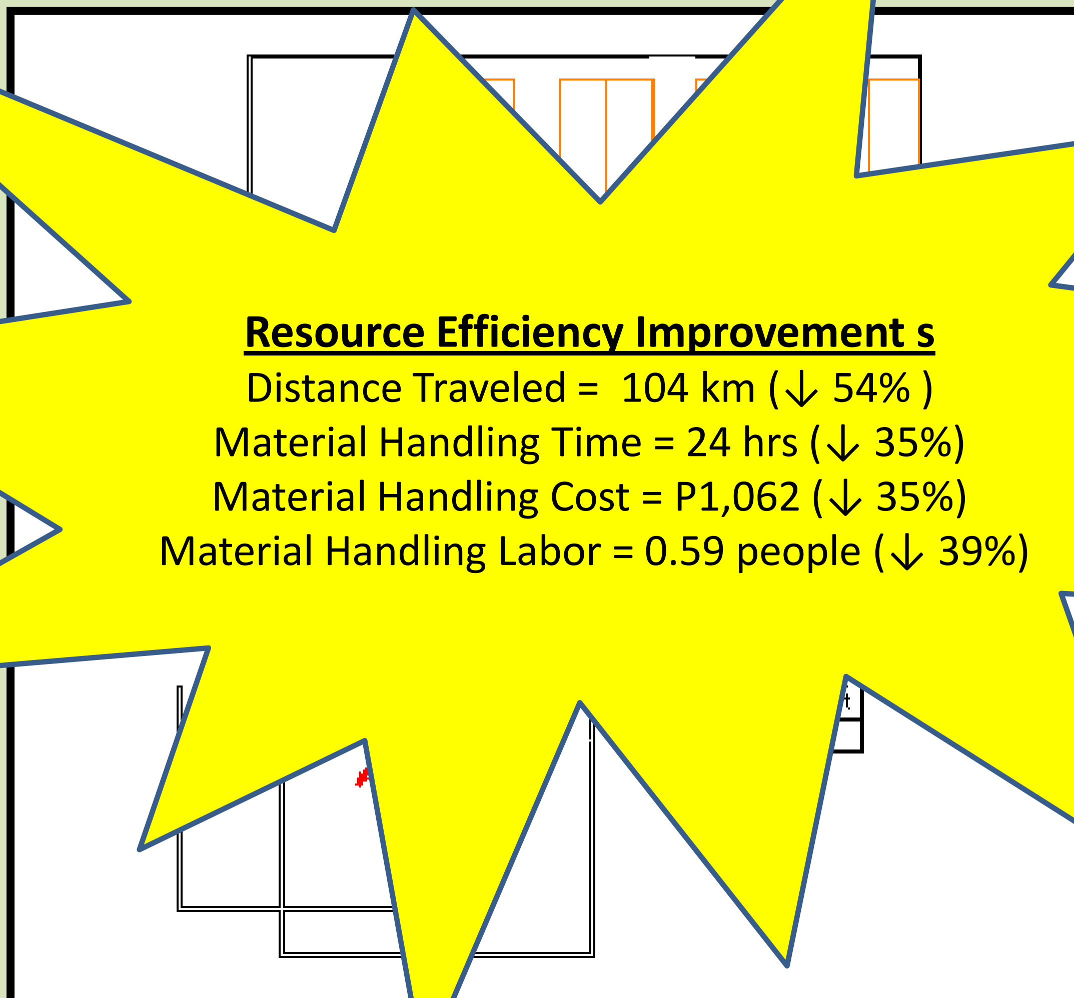
Material Handling Time = 45 hrs

Material Handling Cost = P1,968

Material Handling Labor = 0.94 people

Factory Physics: Factory Layout

Future Layout – Weekly Resource Savings



<u>Resource Efficiency Improvement s</u>

Distance Traveled = 104 km (↓ 54%)

Material Handling Time = 24 hrs (↓ 35%)

Material Handling Cost = P1,062 (↓ 35%)

Material Handling Labor = 0.59 people (↓ 39%)

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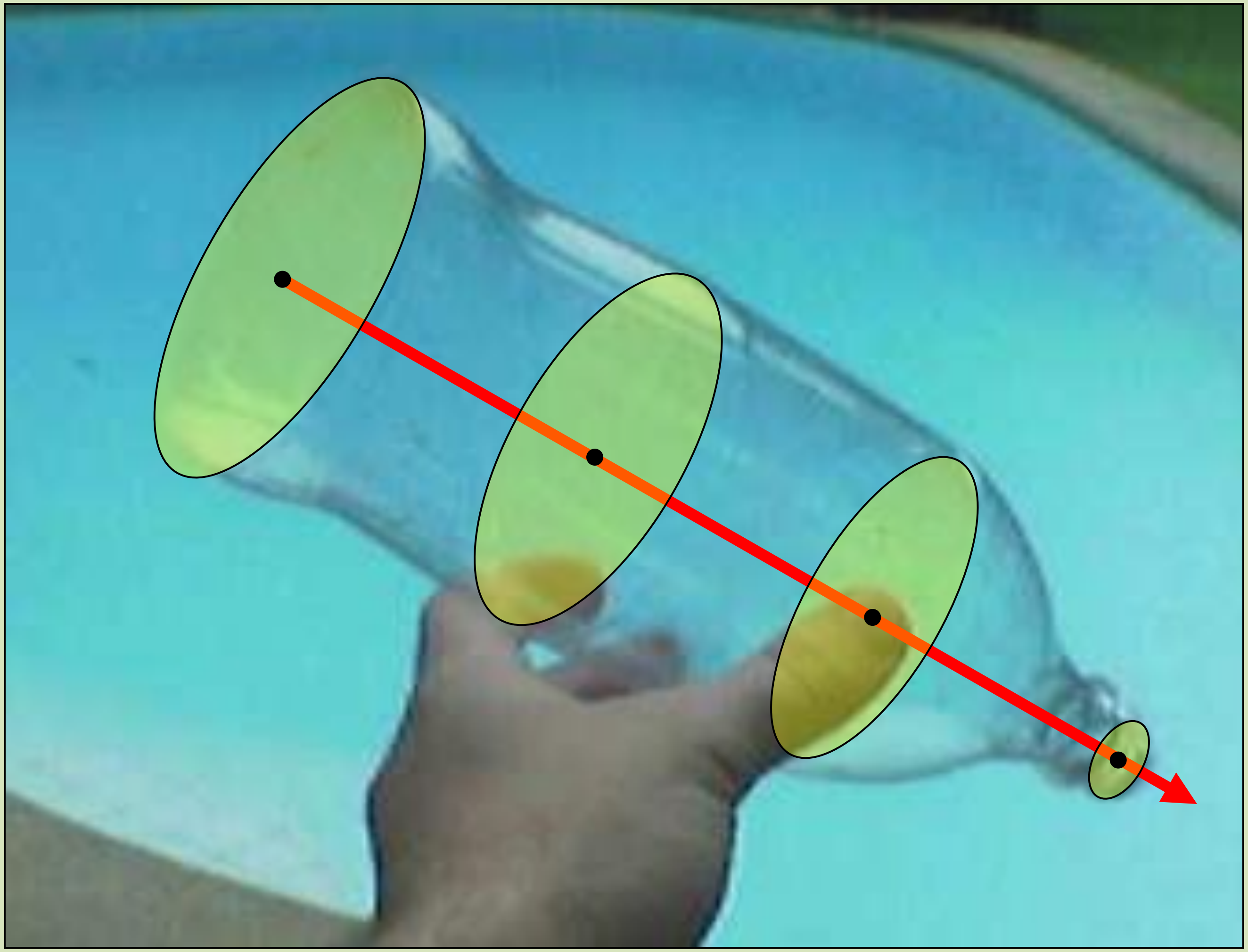
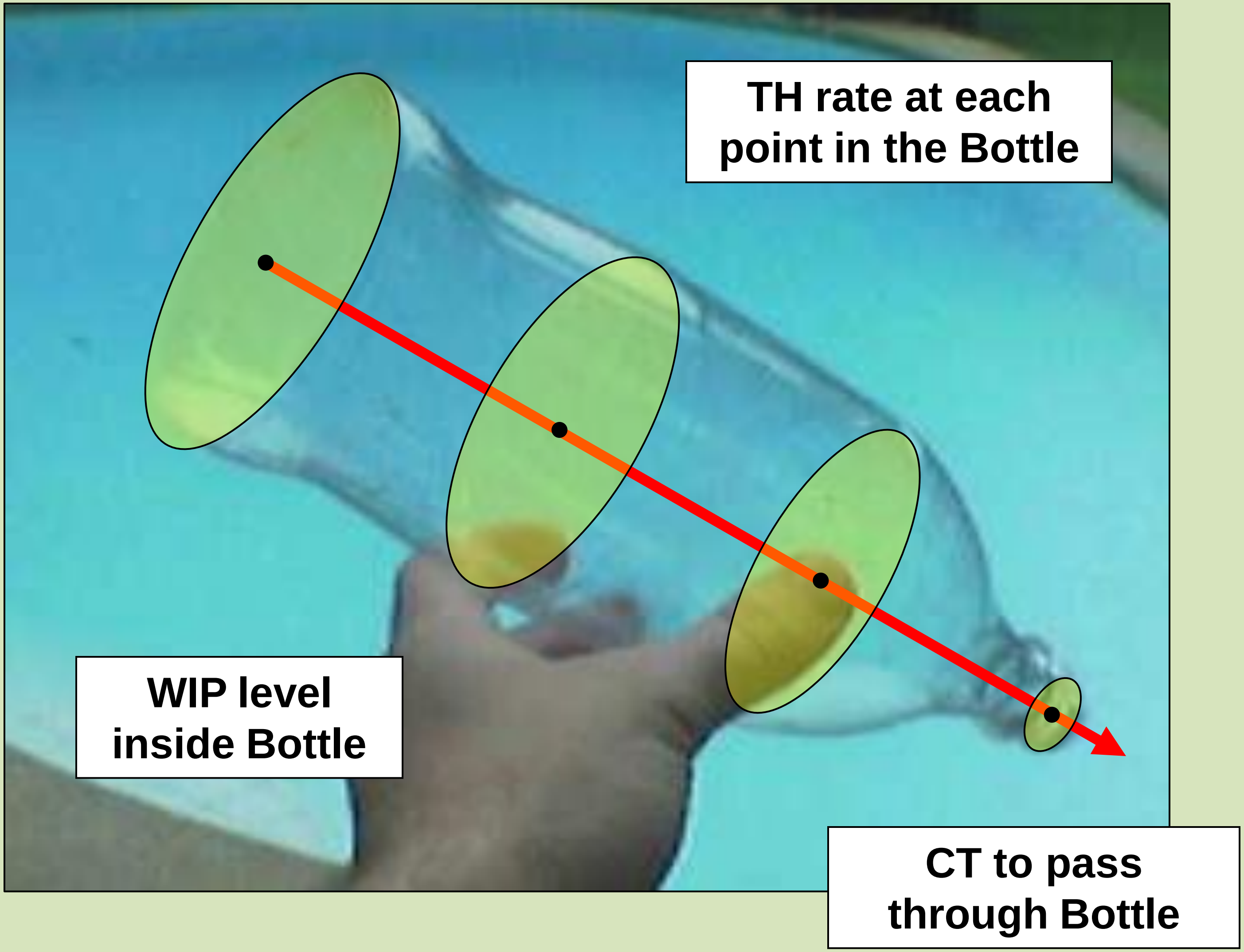
Factory Physics: Work Methods
Bottleneck Explanation

Factory Physics: Work Methods
Bottleneck Explanation



Factory Physics: Work Methods

Bottleneck Explanation



Factory Physics: Work Methods
Laws of Factory Physics

1 $TH_{\text{System}} = TH_{\text{Bottleneck Station}}$

Factory Physics: Work Methods

Laws of Factory Physics

1. $TH_{System} = TH_{Bottleneck\ Station}$

2. $CT_{System} = WIP_{System} / TH_{System}$

Factory Physics: Work Methods

Laws of Factory Physics

1 $TH_{\text{System}} = TH_{\text{Bottleneck Station}}$

2 $CT_{\text{System}} = WIP_{\text{System}} \,/\, TH_{\text{Bottleneck Station}}$

Factory Physics: Work Methods

Laws of Factory Physics

1. $TH_{\text{System}} = TH_{\text{Bottleneck Station}}$

2. $CT_{\text{System}} = WIP_{\text{System}} / TH_{\text{Bottleneck Station}}$

3. Find Bottleneck Station & Increase Its Output (TH)

$\uparrow TH_{\text{Bottleneck Station}}$ $\downarrow CT_{\text{System}}$

Factory Physics: Work Methods

Laws of Factory Physics

1 TH System … Bottlene…

2 CT Sy…

3 Fin… …ut (TH)

↑ TH Bottleneck S…ation … CT …n

Factory Management identified the Drilling Operation as the Bottleneck of the process.

The expected time (standard time) for this operation was unknown.

Factory Physics: Work Methods

Laws of Factory Physics

1 TH_{System} =

We could purchase another Drilling Station to increase output (add more resources).

Better yet, we could eliminate wasted time (Non-Value Added) at the Drilling Station.

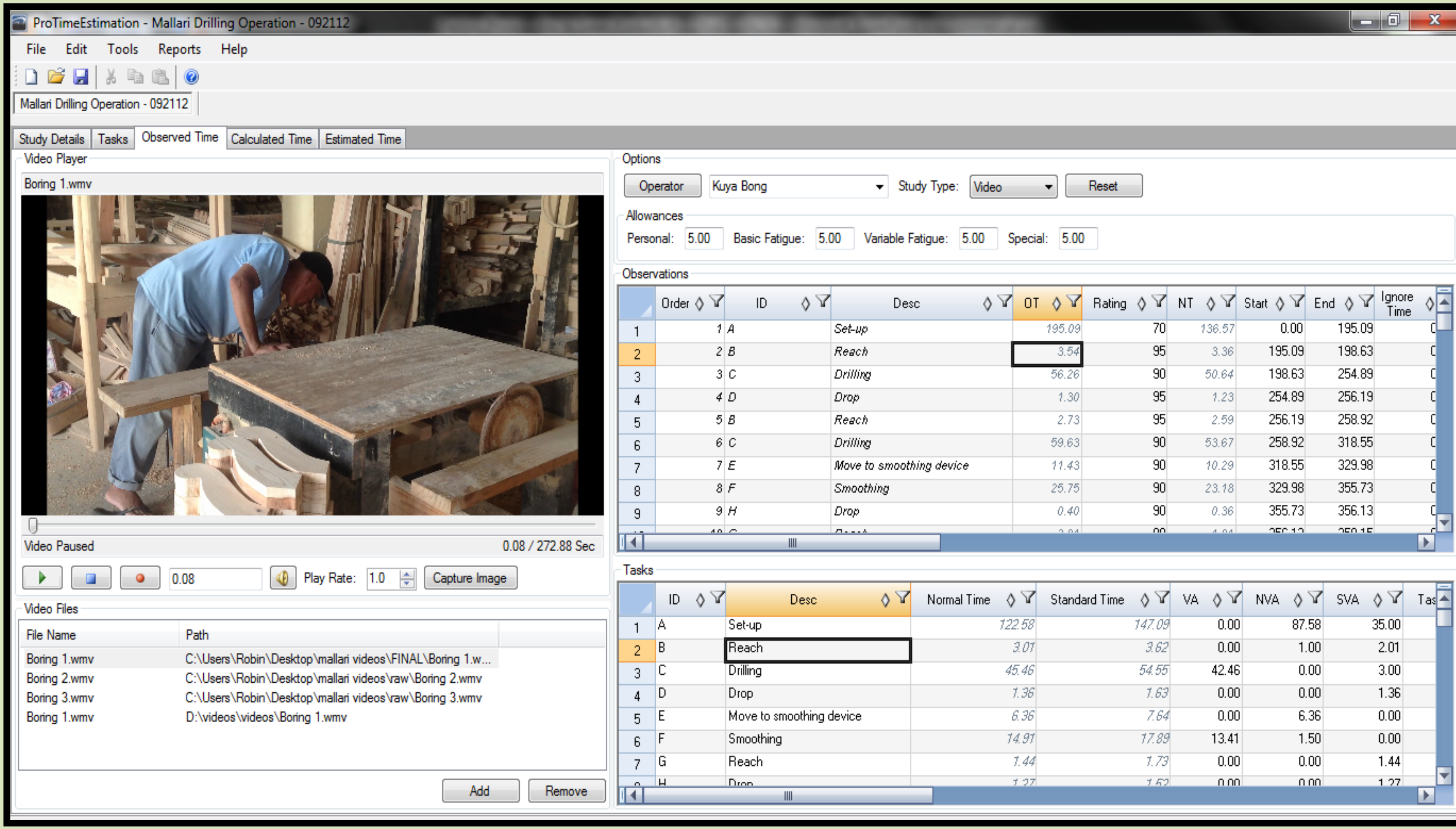
2 CT_{System}

3 Find Bottlenec ... (TH)

↑ $TH_{Bottleneck\ Station}$ ↓ CT_{System}

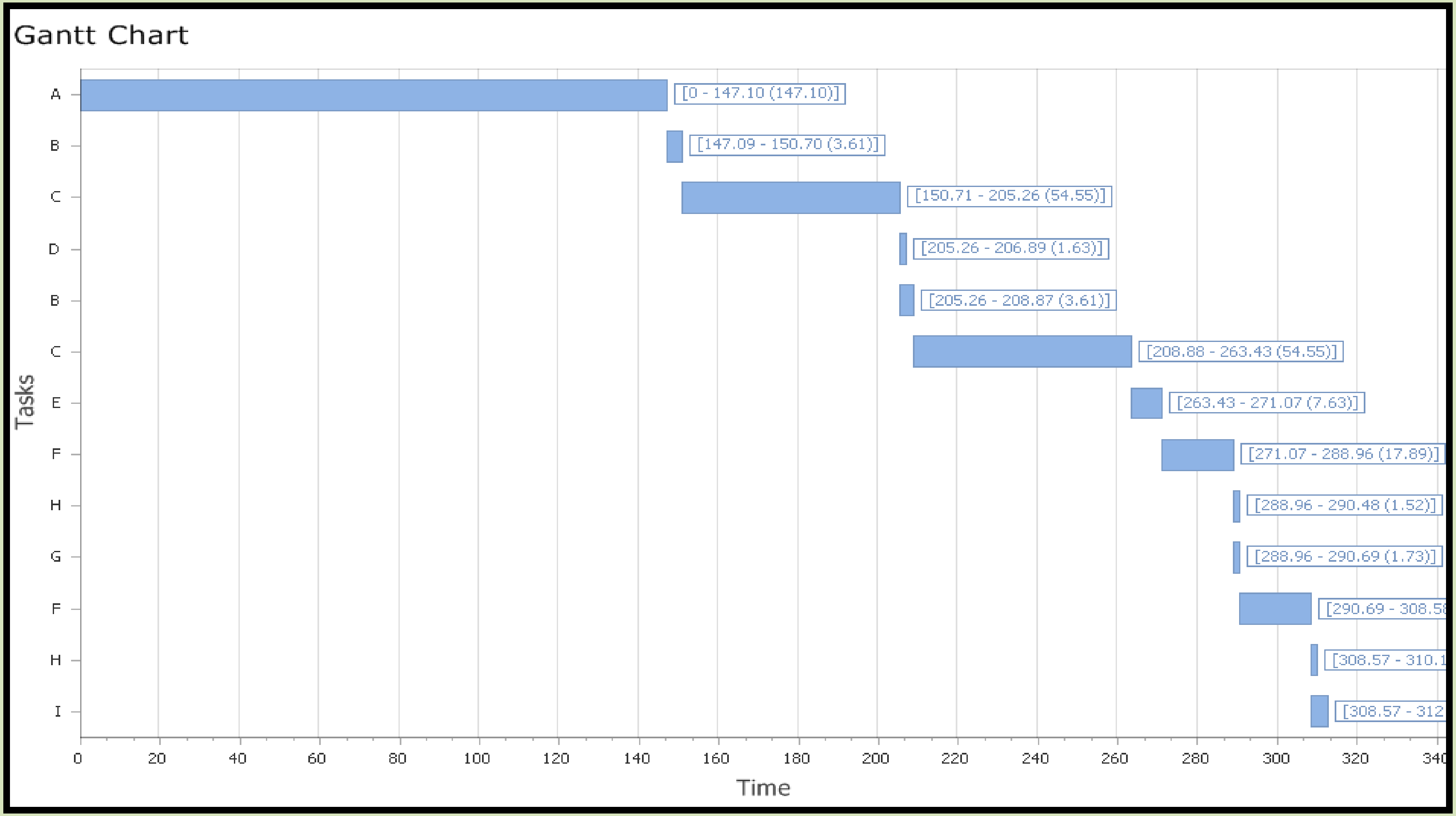
Factory Physics: Work Methods

Video Time Study – Drilling Operation



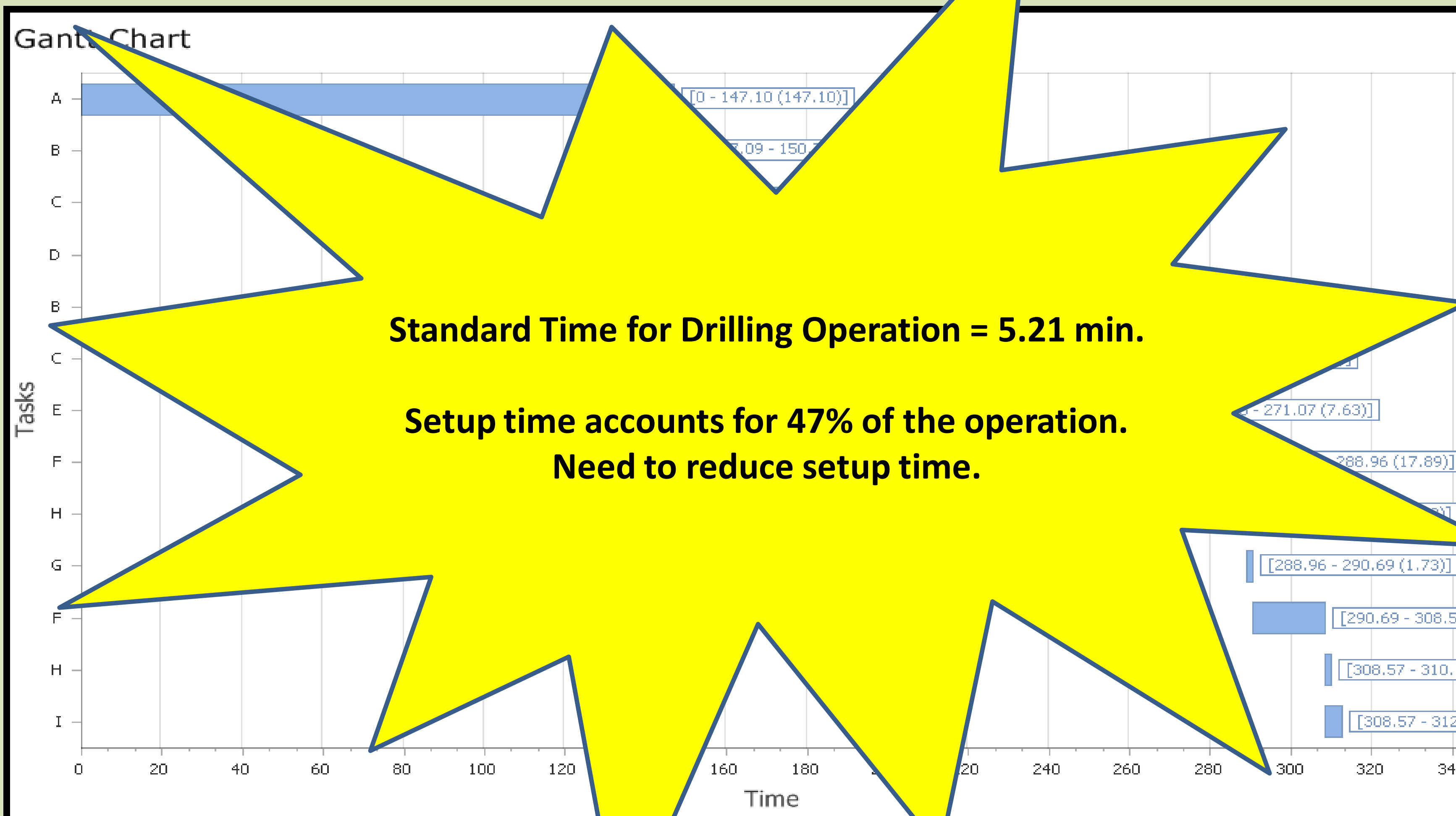
Factory Physics: Work Methods

Gantt Chart – Drilling Operation



Factory Physics: Work Methods

Time Study Results

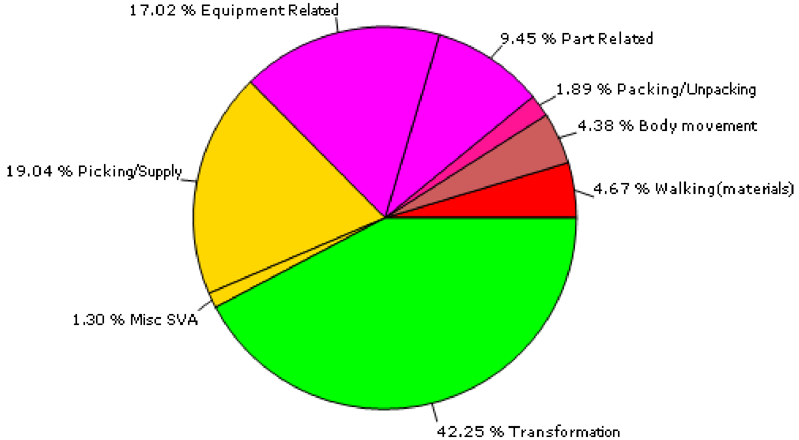


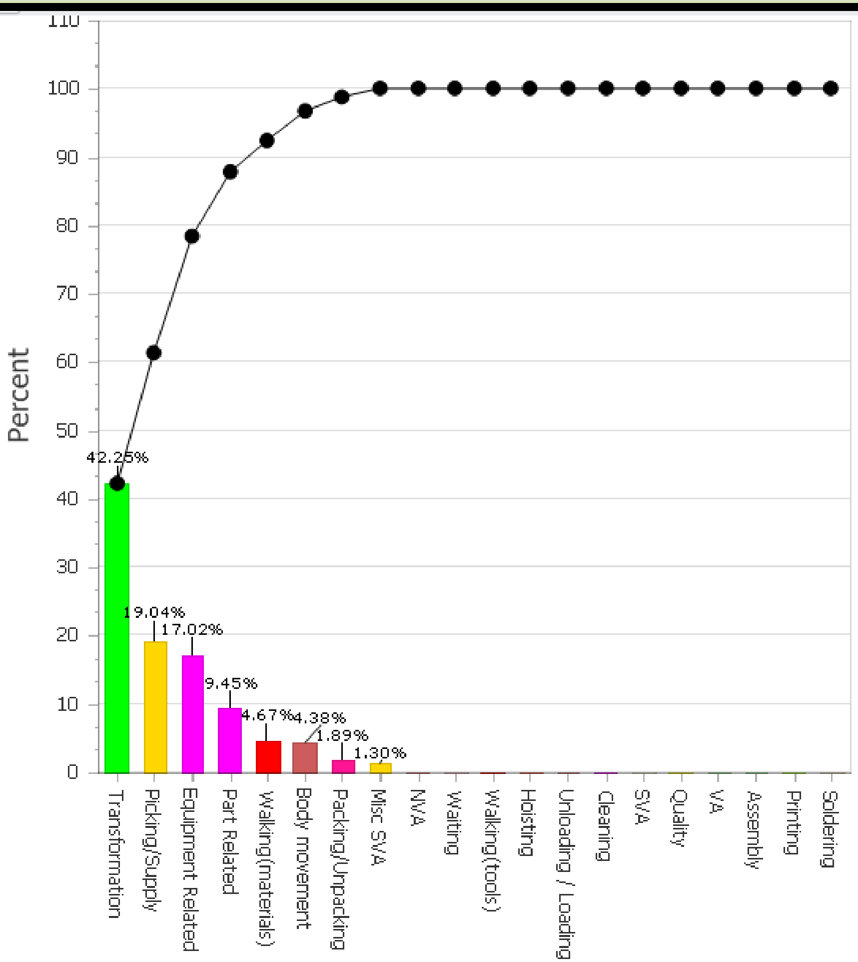
Standard Time for Drilling Operation = 5.21 min.

Setup time accounts for 47% of the operation.
Need to reduce setup time.

Factory Physics: Work Methods

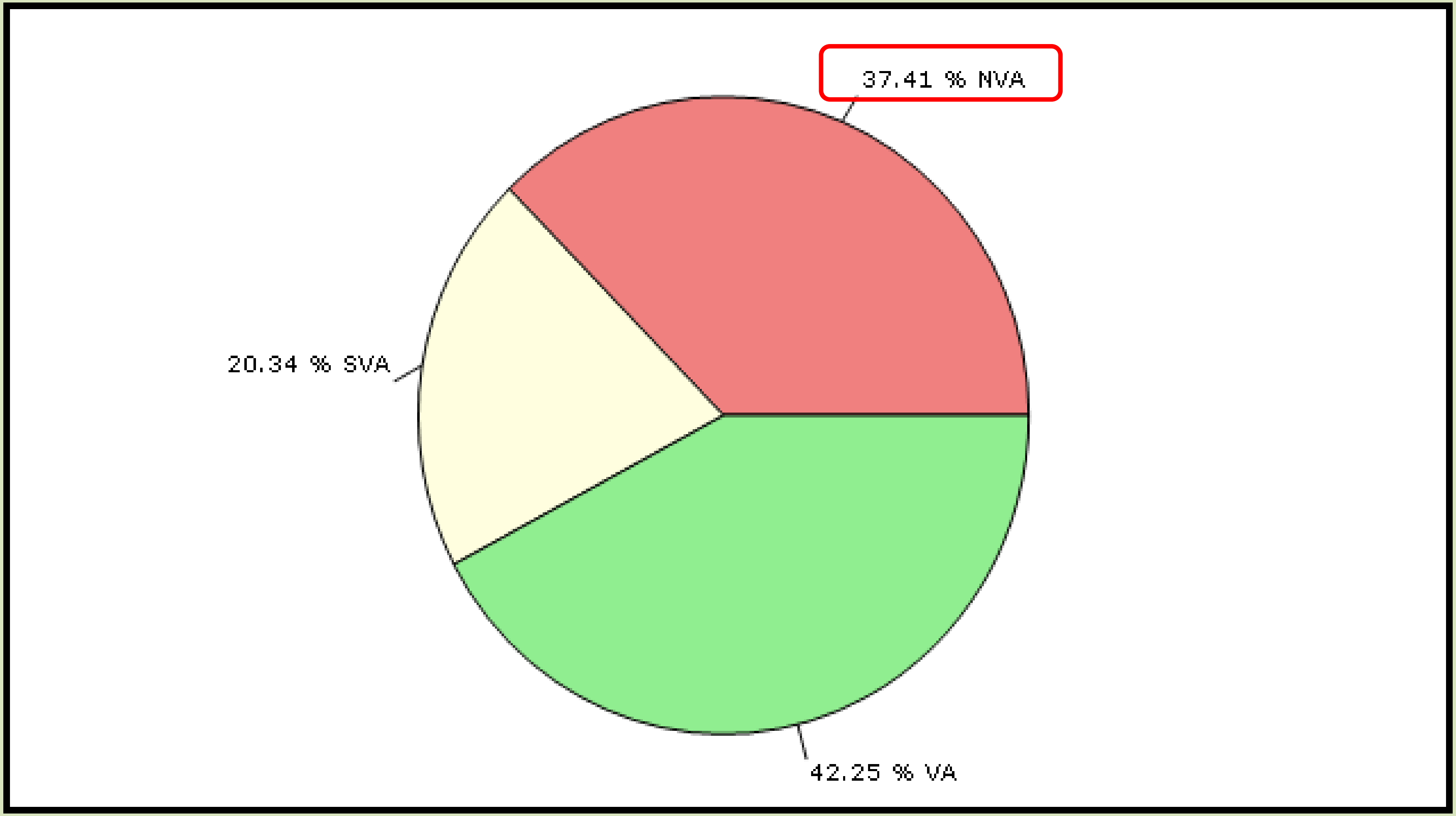
Distribution of Time - Drilling Operation



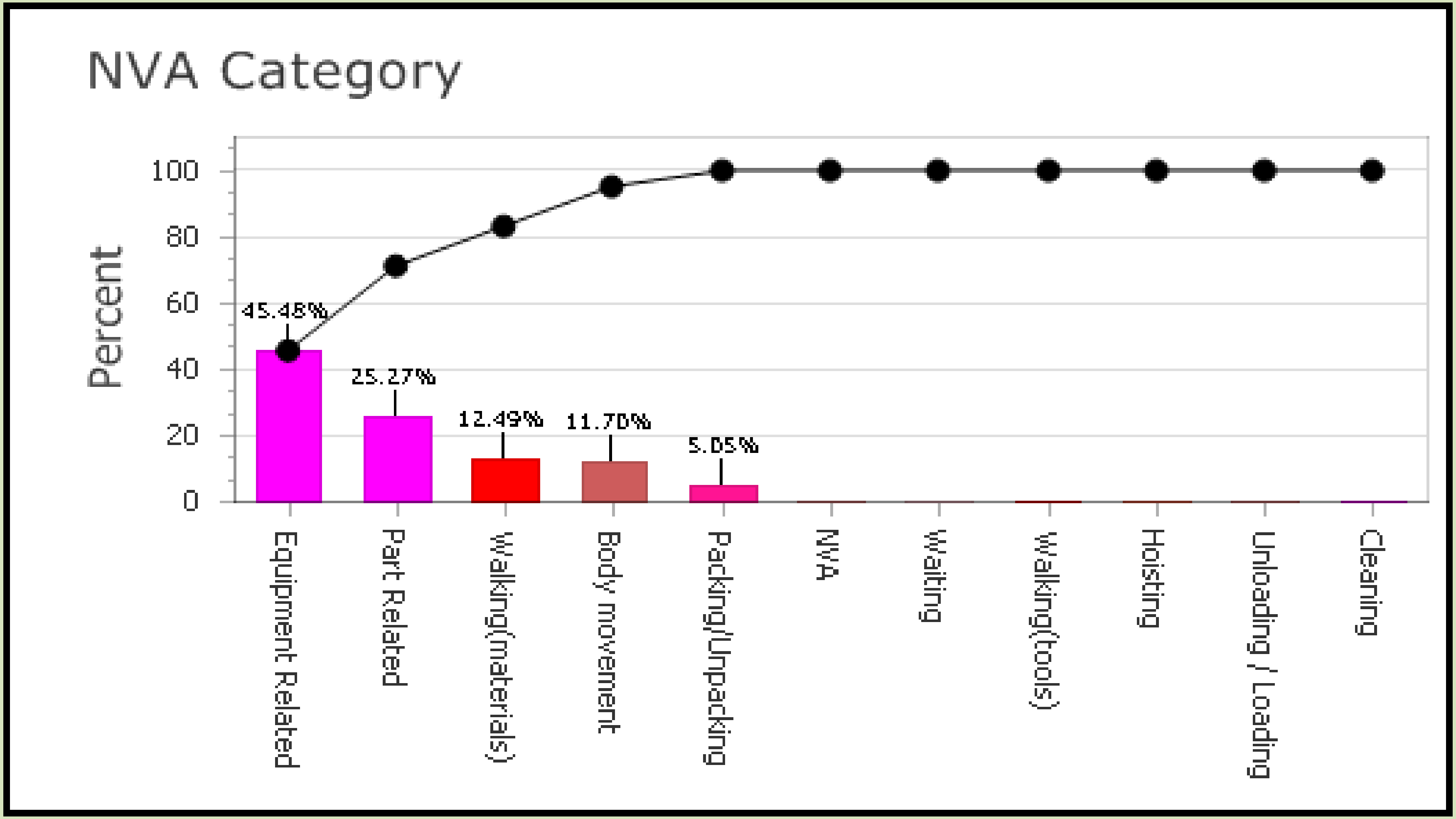


Factory Physics: Work Methods

Non-Value Added Time - Drilling Operation

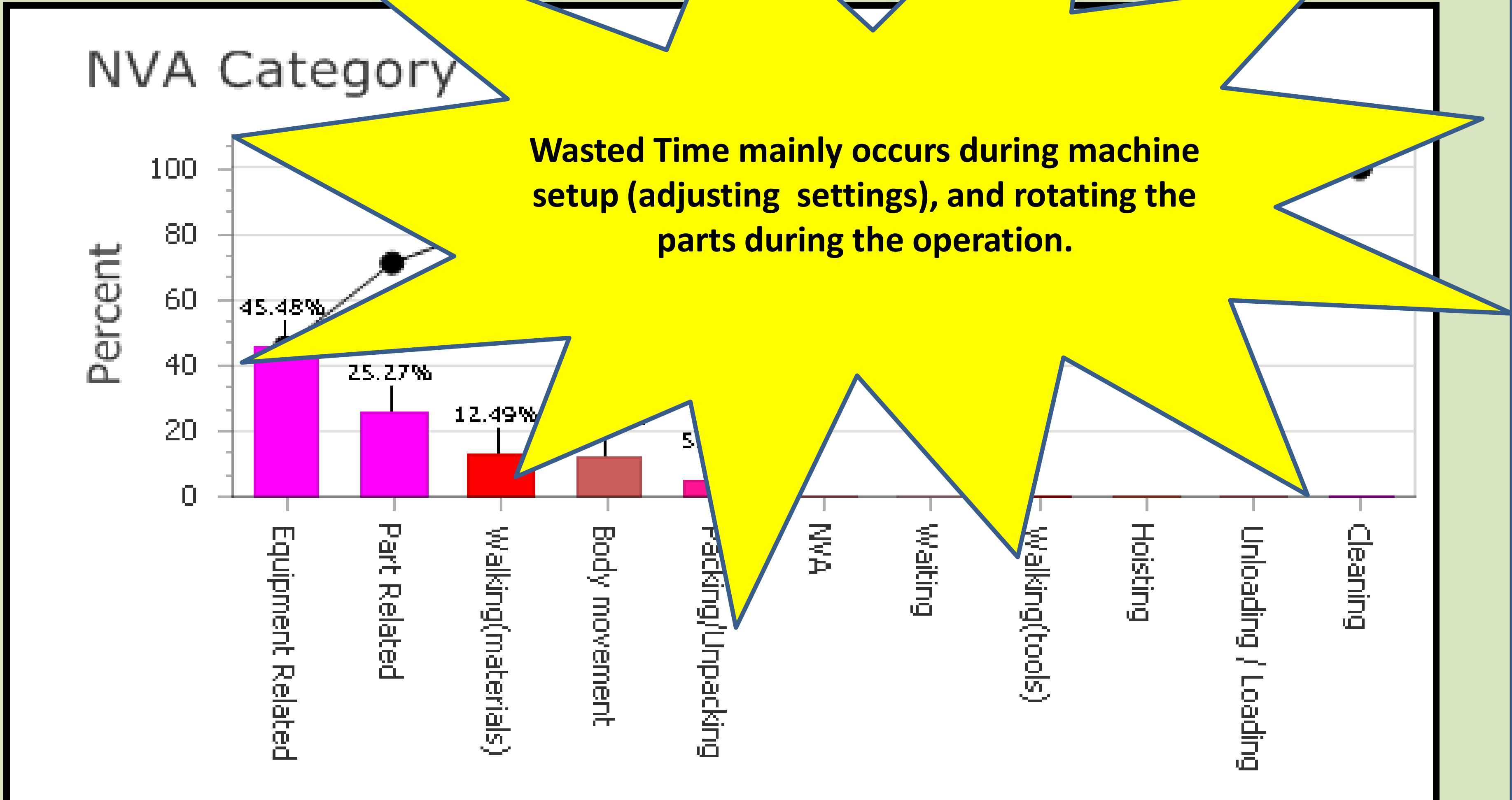


Factory Physics: Work Methods
Distribution of Non-Value Added Time



Factory Physics: Work Methods

Distribution of Non-Value Added Time



Factory Physics: Work Methods

Recommendations to Reduce NVA Time

- Plastic bins for nails, arranged within reaching distance of the operator.

- Fixtures such as quick clamps for the table and work surface.

- Re-design the Drilling machine to eliminate manual part rotation.

Factory Physics: Work Methods

Recommendations to Reduce NVA Time

- Plastic bins for nails, arranged within reaching distance of the operator.
- Fixtures such as quick clamps for the table and work surface.
- Re-design the Drilling machine to eliminate manual part rotation.
- These recommendations would save 0.8 minutes per product at the Bottleneck station.
- This reduces Drilling time by 17%, and allows more products to flow through the factory, with the same amount of resources.

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Factory Physics: Energy Observation

Current Issue

- The factory experiences frequent brownouts, and the company has no alternative energy source.
- During brownouts, equipment cannot run, including the critical bottleneck operation.

Factory Physics: Energy Observation
Current Issue

- The factory experiences frequent brownouts, and the company has no alternative energy source.
- During brownouts, equipment cannot run, including the critical bottleneck operation.
- This significantly affects the company's efficient use of its resources.
- Most would suggest purchasing a back-up generator, which is not a cost effective, clean, green source of energy.

Factory Physics: Energy Observation

Recommendation

- The Philippines experiences a great amount of solar energy. Mallari should consider purchasing solar panels to capture and utilize this free, green source of energy.
- A secondary benefit is to have an alternative power supply during brownouts, in order to keep operations running.

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