Critical Chain Enhancements for Complex Projects, Lessons Learned from the Real World

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CRITICAL CHAIN

Delivering MORE Projects - Better - Faster and at a Lower Cost

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Agenda

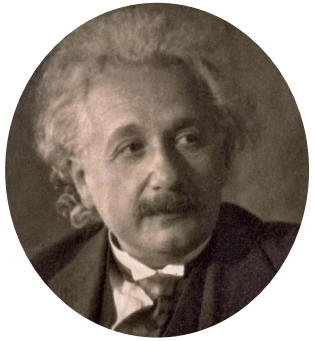
- Introduction
- Theory to real world
- Challenges
- What does this look like
- Solution
- What can you do

Introduction

Philosophy

All models are wrong, but some are useful

- George E. P. Box



Everything should be made as simple as possible, but not simpler

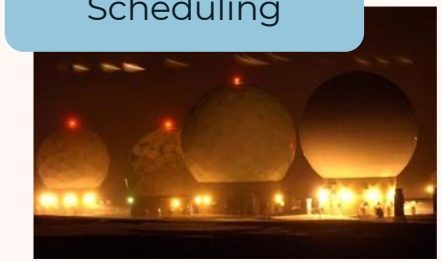
- Albert Einstein

Theory to real world

Real-world lessons learned from our clients

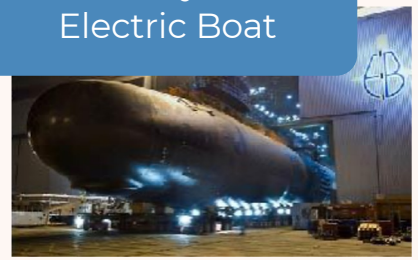
The Boeing Company

Air Force Satellite Scheduling



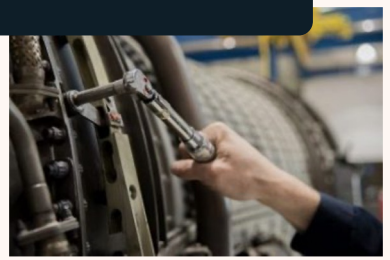
Mitsubishi Heavy Industries

General Dynamics Electric Boat



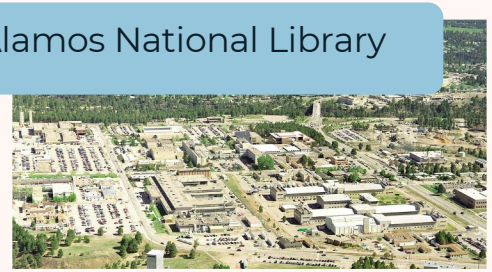
Siemens Integrated Program Planning & Execution

Camcar Textron



Spirit AeroSystems

Los Alamos National Library



Overview of Lessons Learned

- **Find the shortest Critical Chain**
- **Model to the level of detail required**
  - **Support real-world temporal constraints**
  - **Support resource types & details needed**
  - **Support real-world preferences for possible substitutions**
  - **Graphically explain the model**
  - **Provide analyses to research the model**
  - **Explain the how items were scheduled**
- **Execution dynamic critical chain updates that fully supports the model details**

Challenges

Challenges

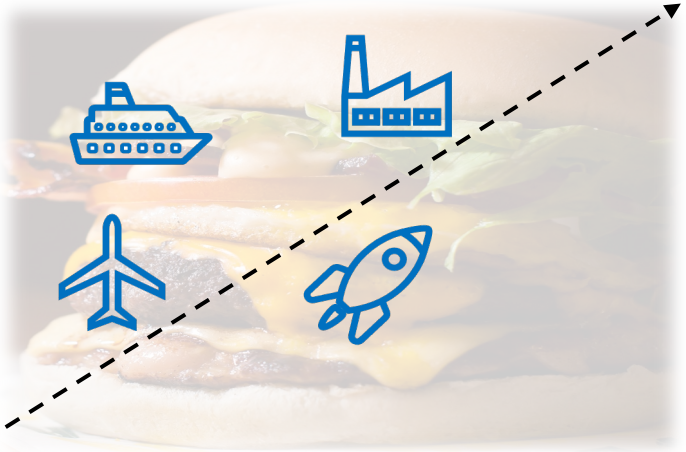
- Grizzled Veterans and Green Rookies
- Logistical Logjams
- Creeping Complexity

What does this look like

Defining Complexity

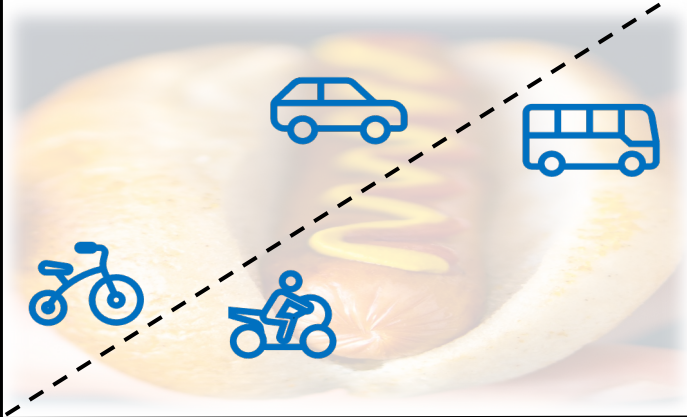
Number of Parallel Paths

Increasing Network Complexity



Hamburger Networks

- Thick with lots of ingredients
- Many integration/touch points
- Messy and Complicated
- Lots of variations
- Graph based solutions necessary to simplify this complexity BEFORE other solutions applied

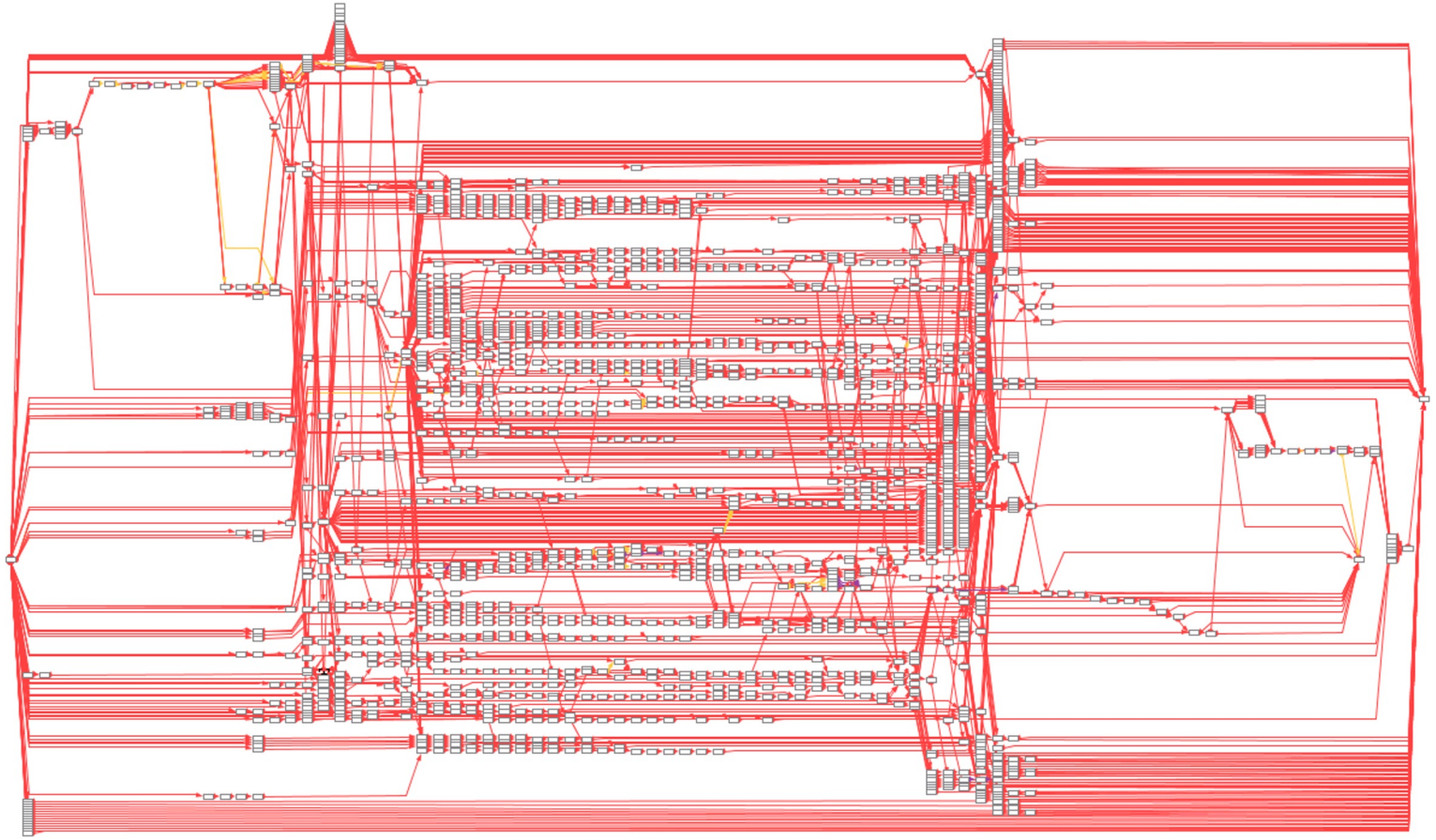


Hotdog Networks

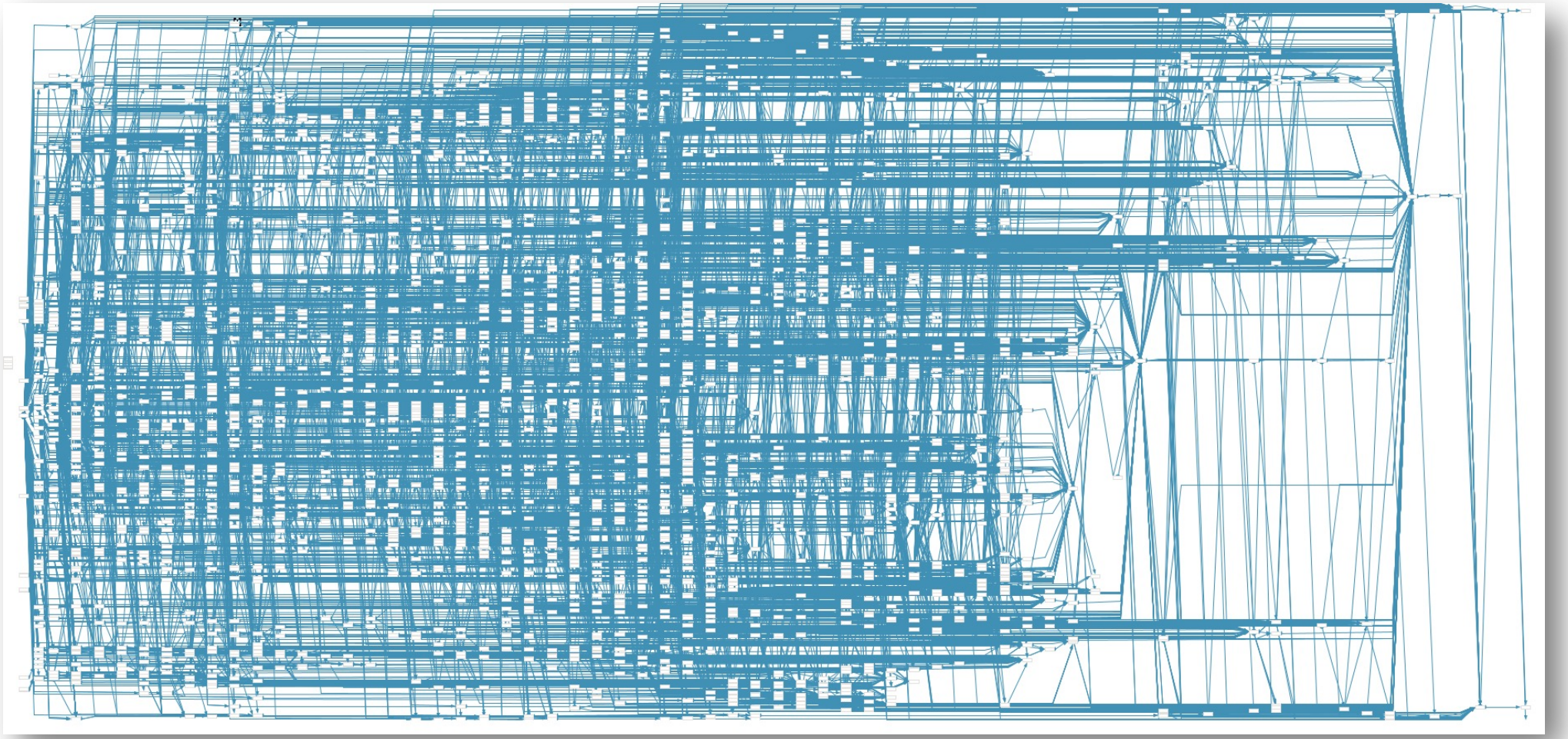
- Long and narrow
- Fewer parallel paths
- Straight forward and orderly
- Relatively few integration/interdependencies
- Lean, Six Sigma, and “Best Practice” methods work wonders

Number of constraints per Task

What does complexity look like



What does complexity look like



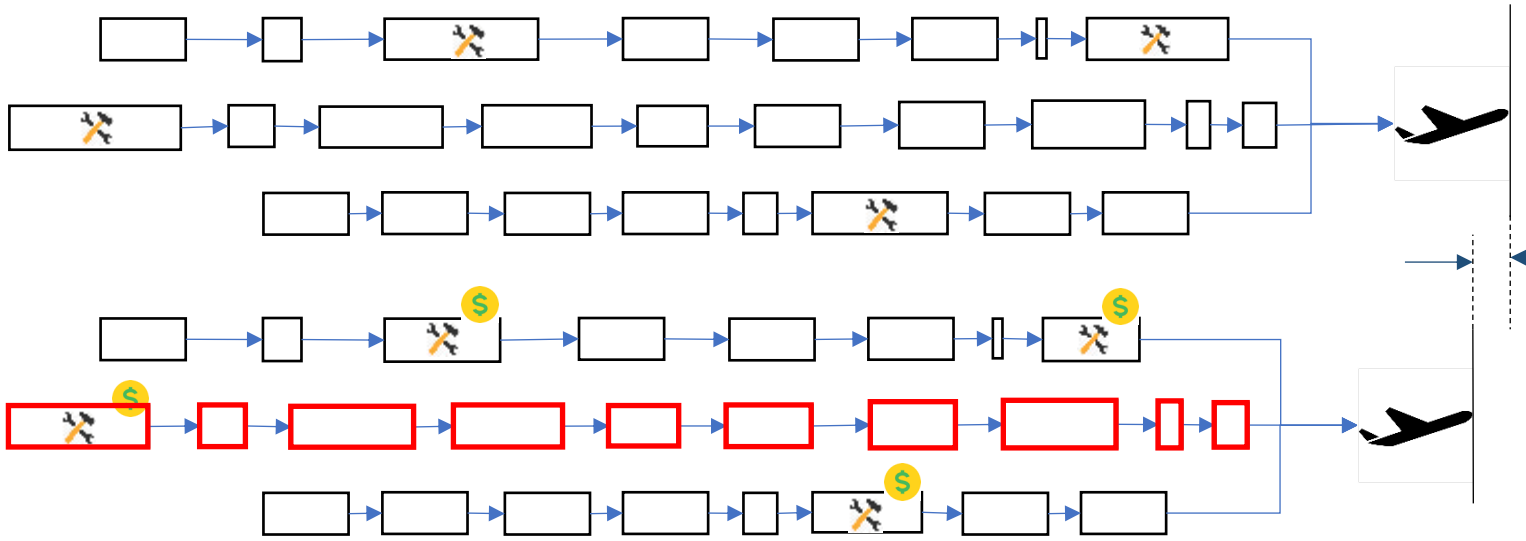
Mental Model / How to Implement ToC Mgmt System

- Step 0- Understanding
- Step 1- Model Building
  - Better CC scheduling short-term benefit
- Step 2- Priority Board
  - Work to global priority
- Step 3- Soft Roll Out
  - Building confidence in the model and method
- Step 4- Refine the Model
  - More benefits as you add more realistic modeling
- Step 5- Full Implementation
  - Everyone including management sees benefits
- Step 6- Improve the System
  - POGI

Solution

Which approach helps us deliver faster ?

CC3 & CC4
Gaps
As Targeting
Mechanism

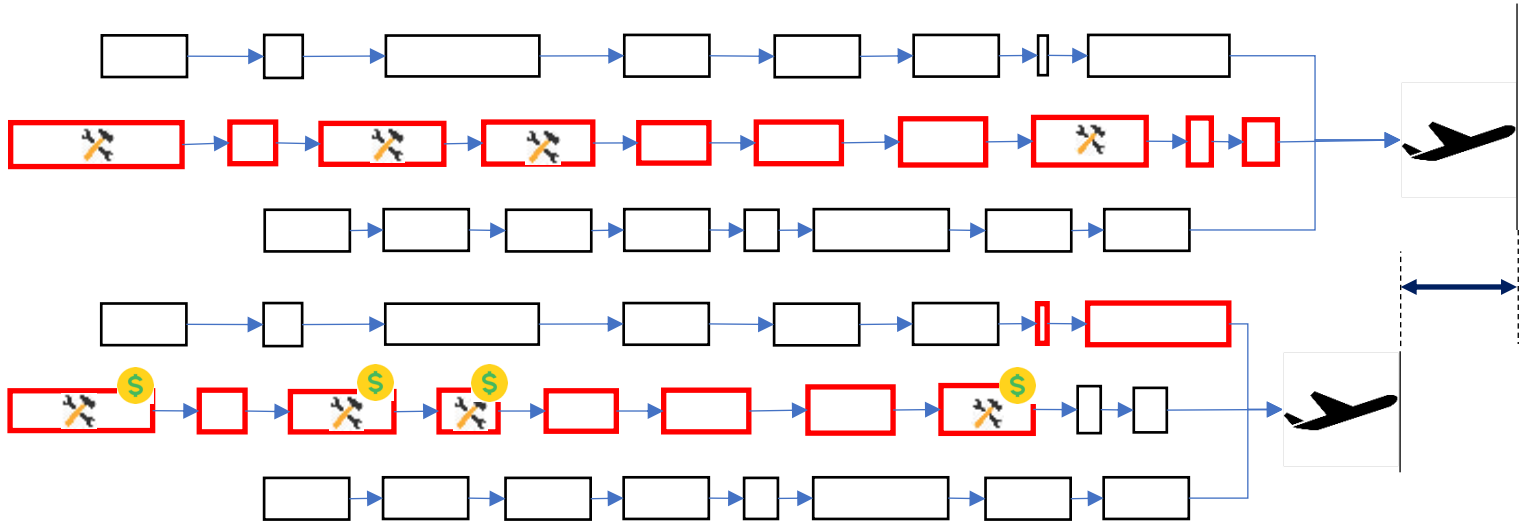


Flow reduction by
Local optimizations

Benefits of reducing critical chain

- Reduce costs
- Create capacity and move jobs from Field to factory
- Deliver as soon as possible (Faster Revenue)

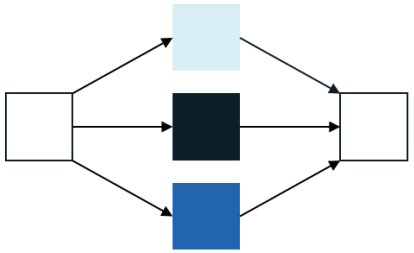
Critical Path Constraint,
then
CC3 & CC4



Flow reduction by
System-wide optimization

Scheduling is Difficult

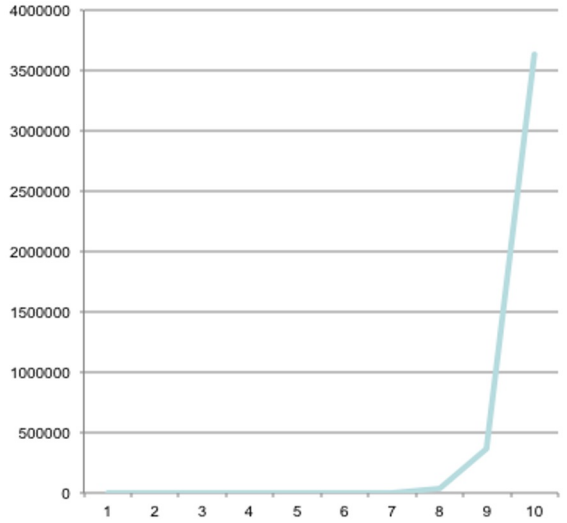
Three tasks that can occur in any order (one at a time)



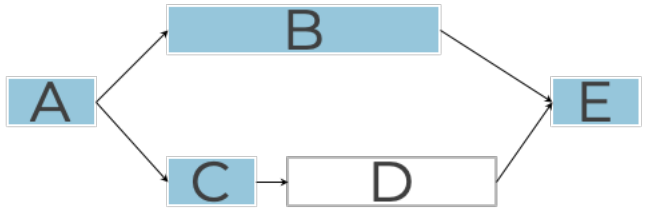
results in six options

- Ordering options scale as N!

1	1
2	2
3	6
4	24
5	120
6	720
7	5040
8	40320
9	362880
10	3628800



The example below involves jobs using two resources, light blue and white

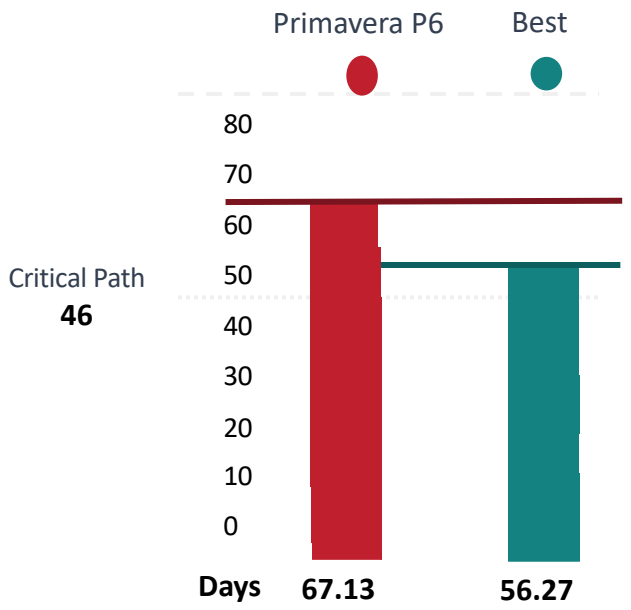


Schedule 1: B before C

Schedule 2: C before B

- Resource-Constrained Scheduling is NP-Complete, takes factorial time for optimal solution. Incredibly hard problem
  - Approximate methods and heuristics are needed
- Most critical chain project management systems use simple algorithms

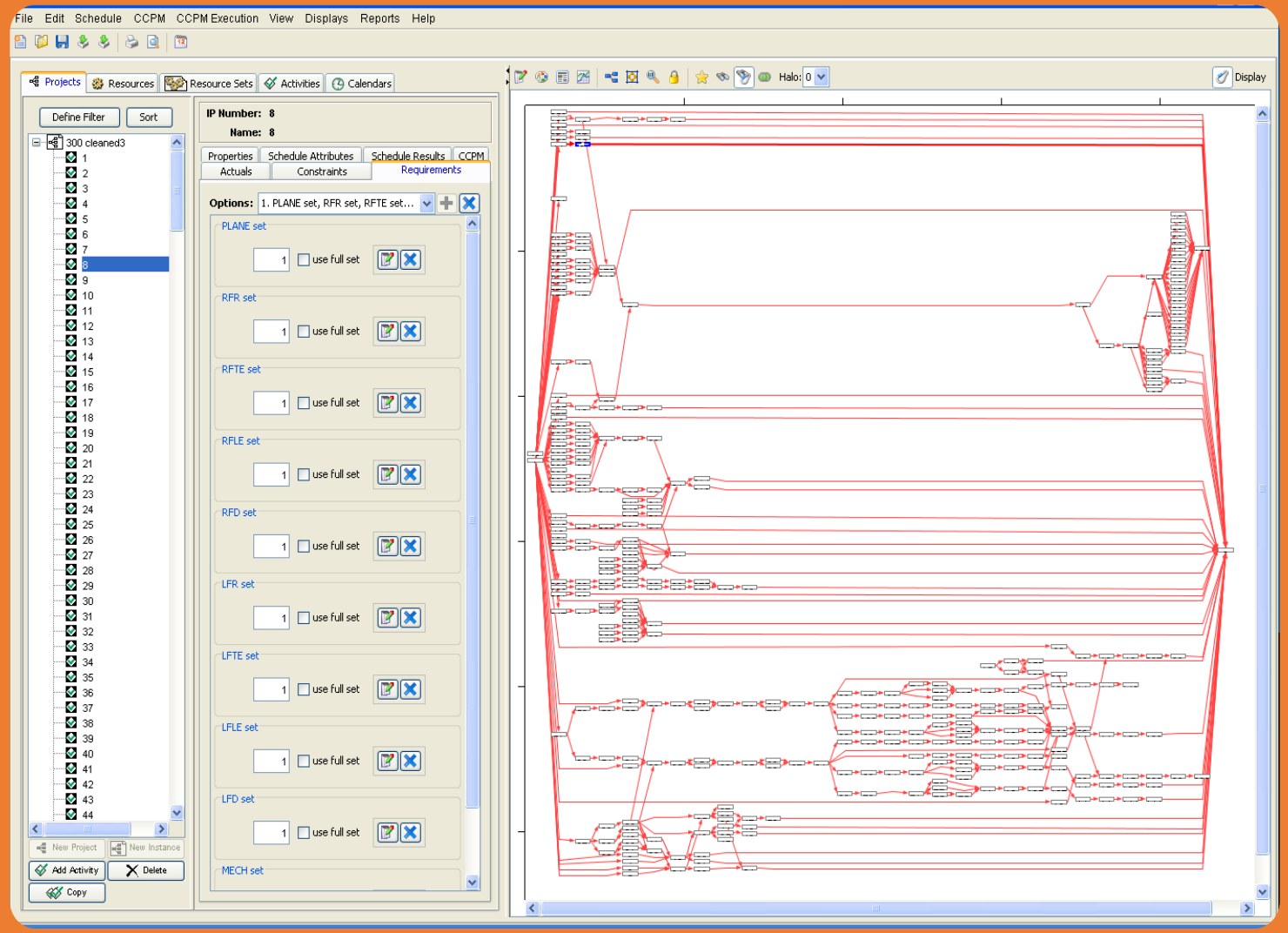
Results: 2,500+ Turnaround



Best saves over

10 days

versus Primavera P6

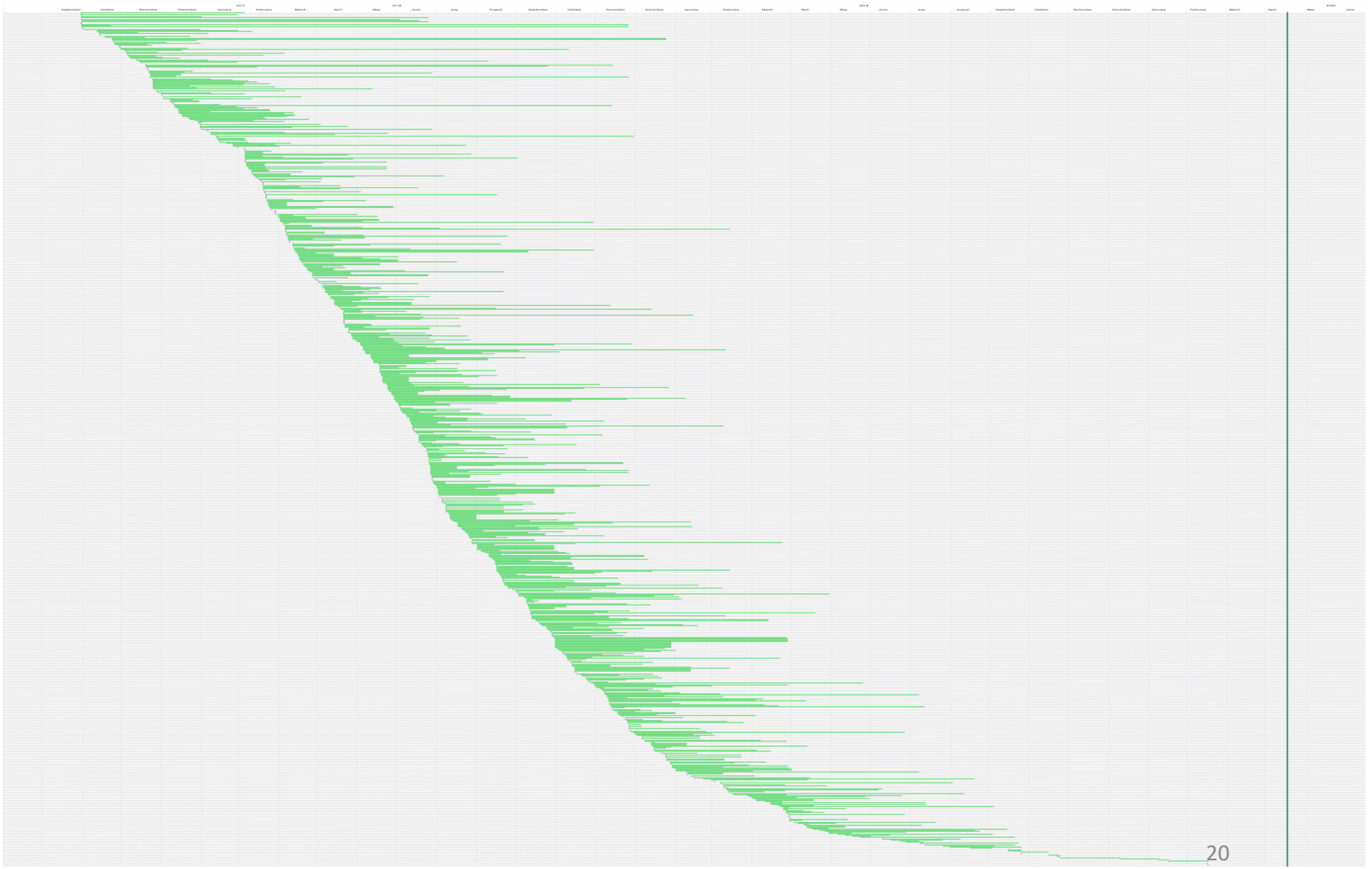


300 Task Example: Network

- MS Project **145** days
- Best **102** days

Multiple resource types needed for most tasks

Animation: Resource leveling at start vs Best option at the end



Model to the level of detail required

- **Specify a preference order when defining a set of resources that are mostly interchangeable.**
  - **Prefer work in default shop**
  - **Prefer work by tech, but supervisor can substitute**
  - **Prefer certain equipment**
  - **Prefer certain lab space**
  - **Use consistent auditors for a client**
- **Concurrent & Non-Concurrent Constraints**
- **Ergonomic constraints – individual limitations on work conditions**
- **Spatial / physical space constraints**
  - **Job requires a certain location or type of space**
  - **Including the creation and elimination of the space during the project**
- **Shift related constraints**
  - **Only start a task if it can finish during the same shift**
  - **Task can only be performed during the day shift**
  - **Task can take multiple shifts, but requires same resource constraints**

What can you do

Key Takeaways

- When jobs are worked in the sequence and position they were designed, then safety, quality and morale improve significantly

- No matter how good you think your precedence network is…the mechanics will help you make it much better

- Until leadership asks different questions, people will still act to optimize their support based on previous paradigms & goals
  - "*First in, first out"* has to be replaced by "*Impact to critical chain flow*"
  - Shift from "*daily commits*" to "*next impediment to help resolve*"

- Training and preparation go only so far….
  - Do not switch from a "soft roll-out" to a "hard roll-out" prior to the precedence network update volume starting to taper down

Ask your team

If you asked 10 people on your team the same question, would you get the same answer?

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Call to action

Email a project and we will see if there is a shorter critical chain!

Robert Richards, Ph.D. is a Principal Scientist and Head of Strategy at Stottler Henke. Robert Richards received his Ph.D. in Mechanical Engineering from Stanford University. Dr. Richards is managing and has managed multiple critical chain and intelligent scheduling implementations leveraging Stottler Henke's Aurora-CCPM AI-based critical chain scheduling and project management software. Current clients include General Dynamics Electric Boat per submarine construction and the Los Alamos National Laboratory. Dr. Richards established and manages the Siemens relationship which incorporates Stottler Henke's Aurora-CCPM software into Siemens IPP&E Xcelerator product. Dr. Richards has published many Critical Chain related papers and presentations.

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Call to action

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