A Modelling approach to Increasing Capacity through Plant Optimisation and Cycle Time Reduction in Industrial Scale Bio-Pharmaceutical Manufacturing

James Higgie

Introduction

- **Capacity expansion**
  - Cycle time vs batch size
- **Investigation**
  - Data gathering and interpretation
- **Design**
  - Process modelling
  - Scheduling and plant optimisation
- **Implementation and effectiveness review**

- **Overview**

Capacity Expansion in Existing Facilities

- **Batch size increase**
  - Large capital investment
    - Equipment
    - Validation
  - Regulatory submissions
  - Reduces operational costs

- **Cycle time reductions**
  - Low capital investment
    - Setup-times
    - Labour organisation
    - Batch type scheduling
  - Medium capital investment
    - Decoupling critical path process units
    - Testing improvements
    - New technology

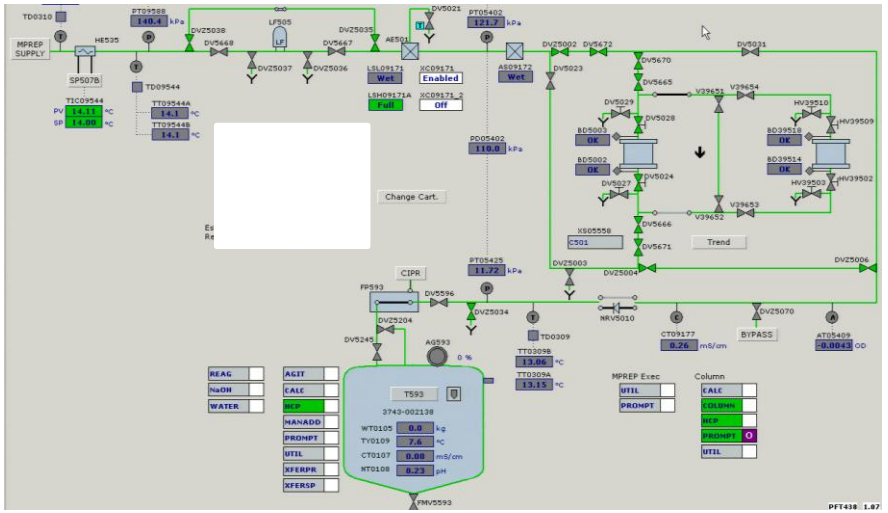
CSL Behring: Broadmeadows

- Toll manufacturing facility commissioned in 1994

- Main production streams
  - Chromatographic IVIG
  - Albumin 2VI

Initial Investigation: Big Data

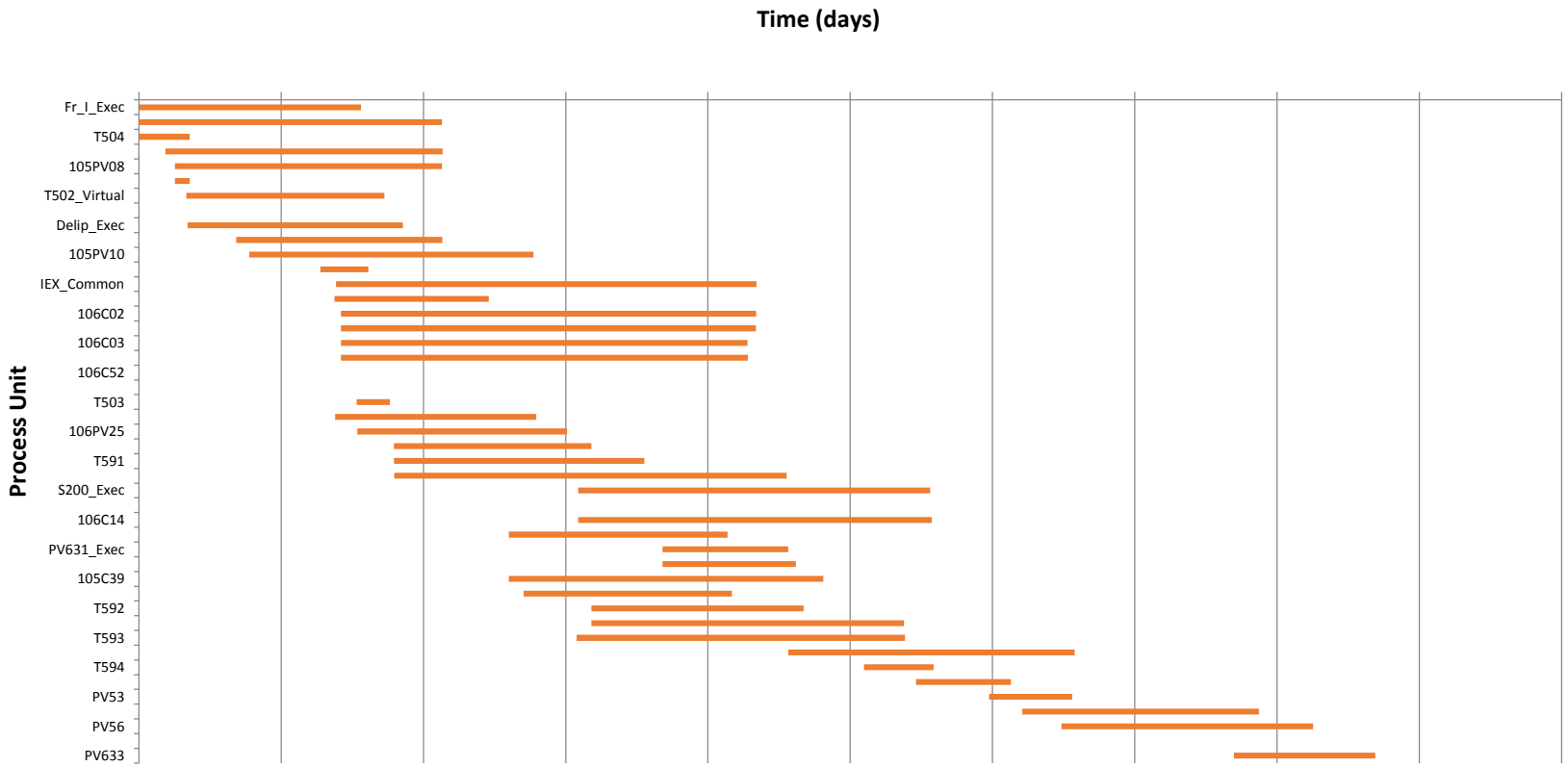
- **Data Collection**
  - Export data from SCADA System (Siemens PMCS 7) into raw csv files
    - Start and stop times of operations
      - 28,000 data/batch x 100 batches
        - 2.8 million data points



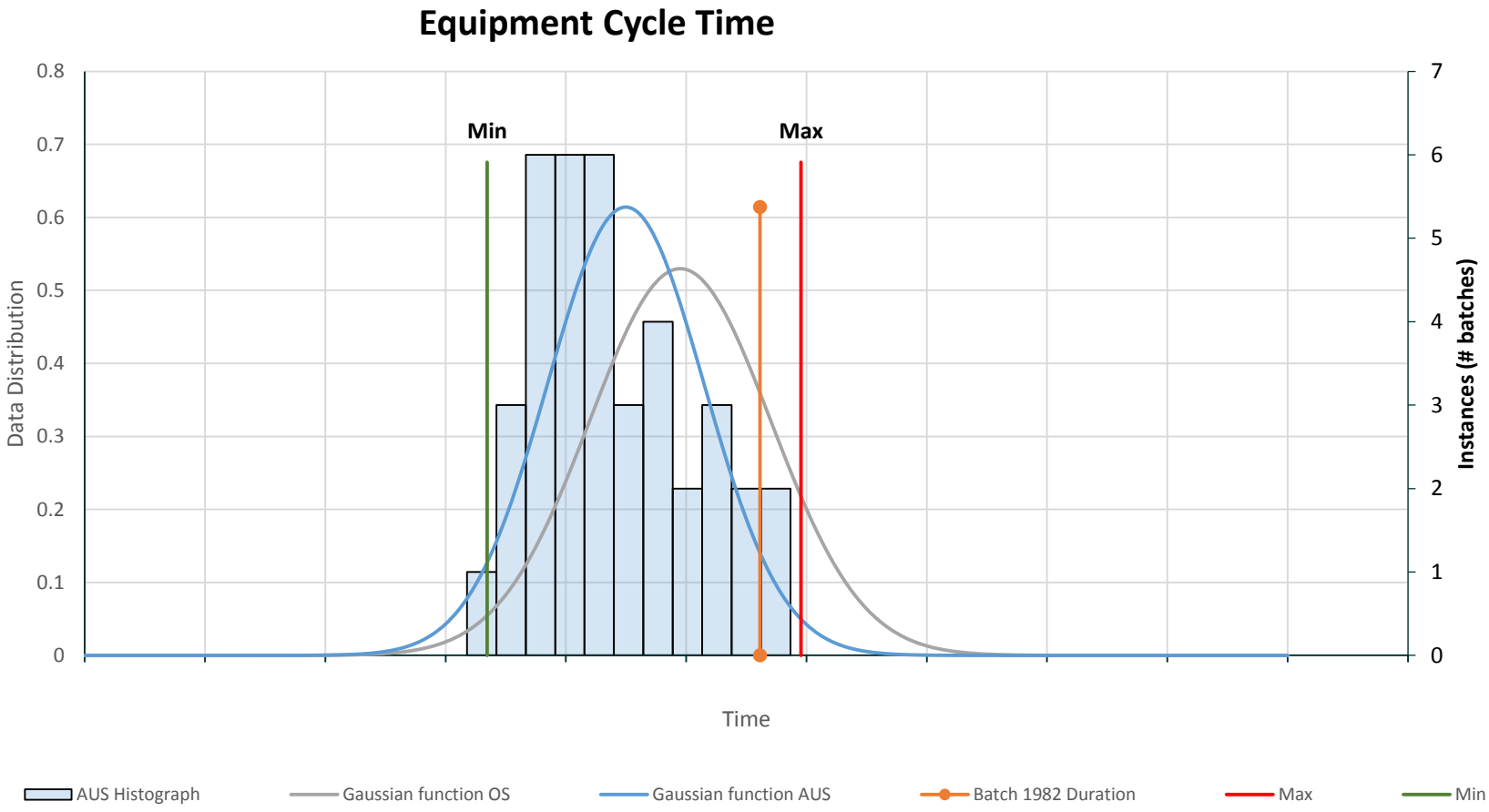
- **Data Manipulation**
  - Formatting into usable data
    - Equipment, batch and type categories
  - Align meaningful data points to calculate idle or hold times

Data Interpretation: Primary level
Single Batch

- **Individual equipment cycle time for a single batch**



Data Interpretation: Primary level
Multiple Batches

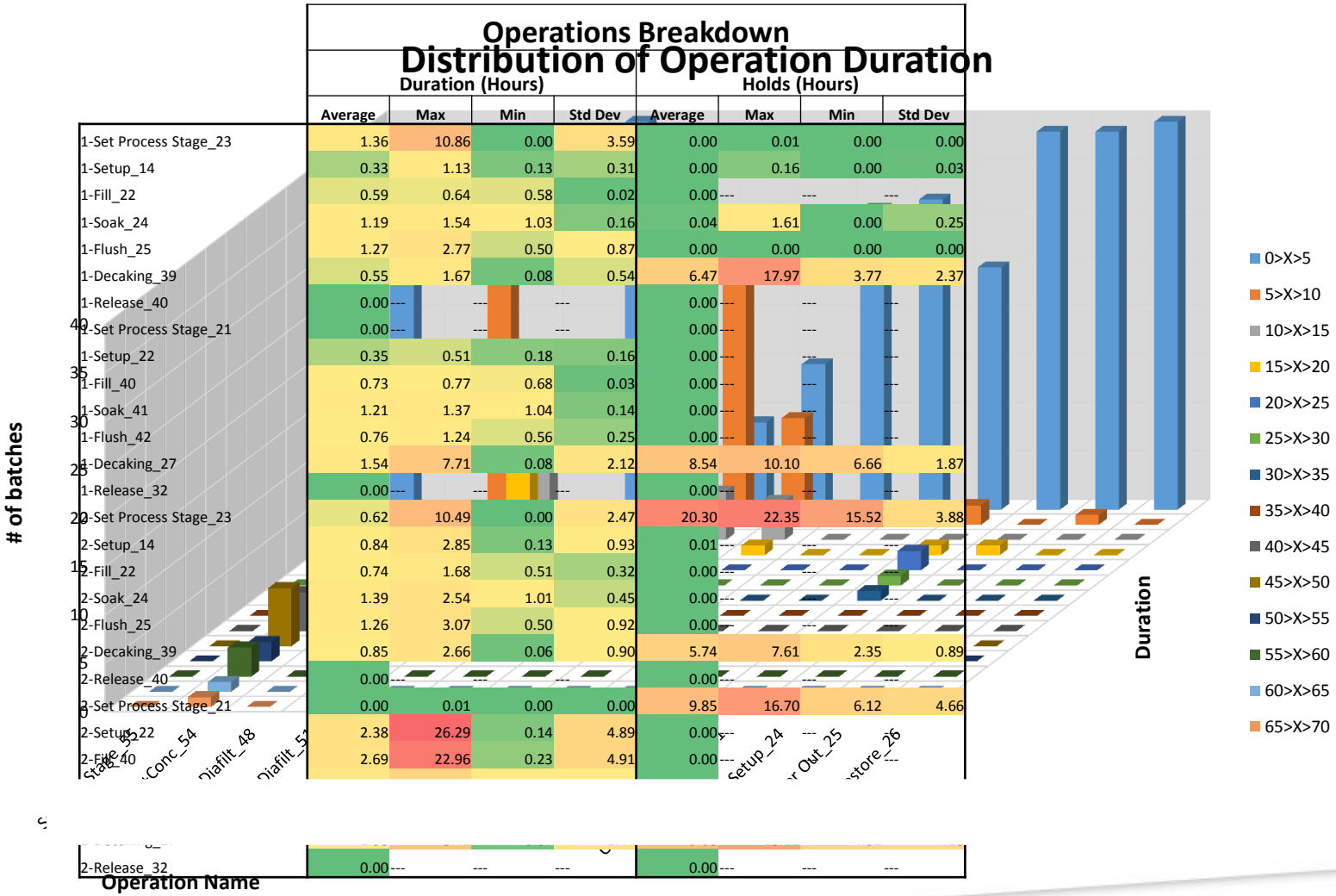


Data Interpretation: Secondary level
Operations within a Single Batch

Batch 0000				
Operation	Start	Finish	Duration	Hold time
3452-001982/Collection Tank._6/Set Proc Stage_55	22/07/2012 7:36	22/07/2012 7:36	0.000	0
3452-001982/Collection Tank._6/Receive+Conc_54	22/07/2012 7:36	24/07/2012 1:42	1.754	0
3452-001982/Collection Tank._6/ Diafilt_48	24/07/2012 1:42	24/07/2012 8:15	0.272	0
3452-001982/Collection Tank._6/ Diafilt_51	24/07/2012 8:15	25/07/2012 5:54	0.902	0
3452-001982/Collection Tank._6/Further Conc_52	25/07/2012 5:54	25/07/2012 7:04	0.0487	0
3452-001982/Collection Tank._6/Recover UF_53	25/07/2012 7:04	25/07/2012 11:30	0.184	0
3452-001982/Collection Tank._6/Addition_57	25/07/2012 11:30	25/07/2012 16:59	0.228	0
3452-001982/Collection Tank._6/Adjust_66	25/07/2012 16:59	25/07/2012 18:46	0.074	0
3452-001982/Collection Tank._6/Release_10	25/07/2012 18:46	25/07/2012 18:48	0.001	0
3451-001982/Transfer PV631 to PV635_31/Set Process Stage_38	25/07/2012 21:35	25/07/2012 21:35	0.000	0.116
3451-001982/Transfer PV631 to PV635_31/OP187 Calculations_21	25/07/2012 21:35	25/07/2012 22:34	0.040	0
3451-001982/Transfer PV631 to PV635_31/Transfer Setup_24	25/07/2012 22:36	25/07/2012 22:53	0.011	0.001
3451-001982/Transfer PV631 to PV635_31/Transfer Out_25	25/07/2012 22:53	26/07/2012 1:39	0.115	0
3451-001982/Transfer PV631 to PV635_31/Restore_26	26/07/2012 1:39	26/07/2012 1:54	0.010	0

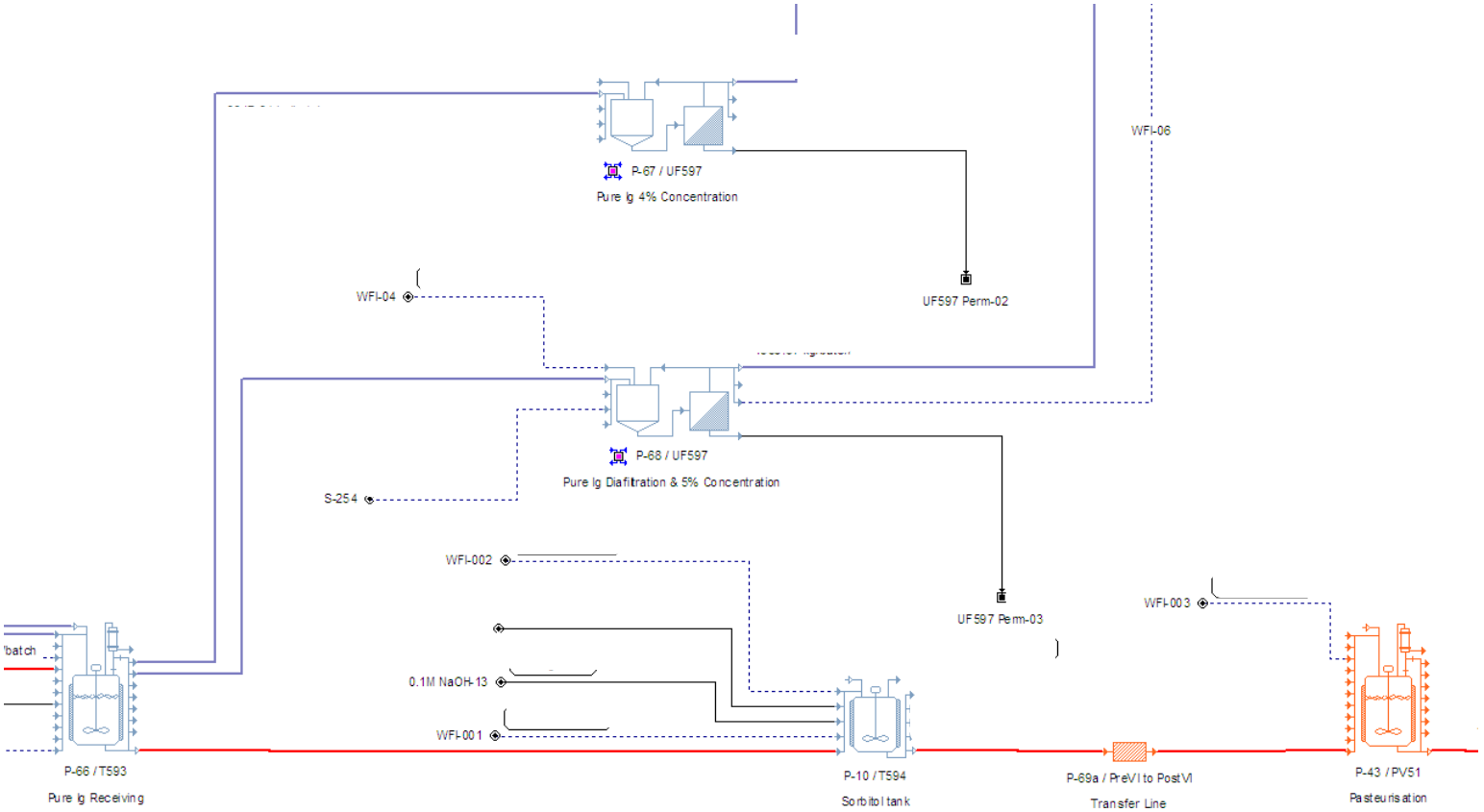
Data Interpretation: Secondary level

Operations within a Multiple Batches



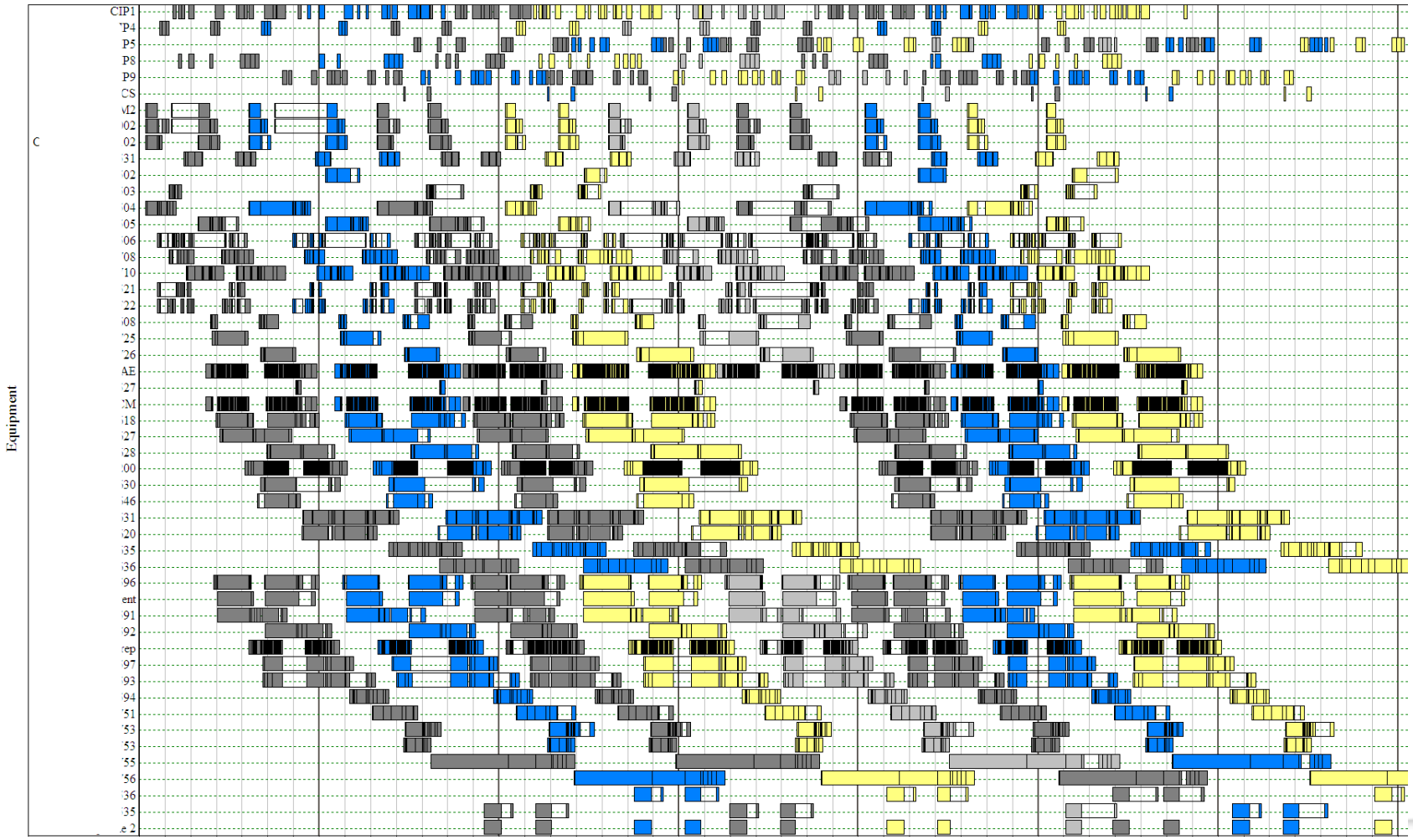
Computational Modelling

SuperPro Designer



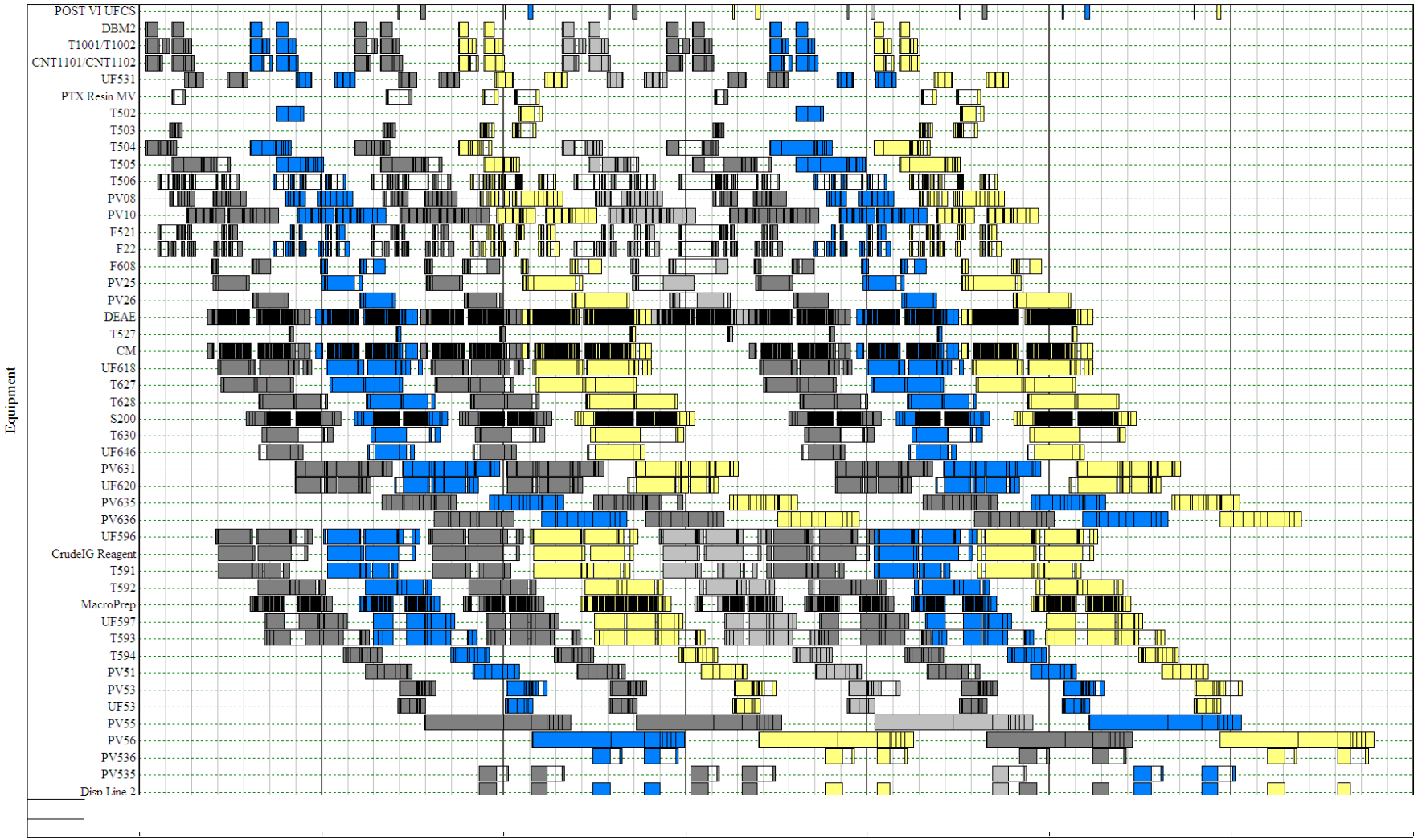
Plant Scheduling: Current

SchedulePro



Biotherapies for Life™ CSL Behring

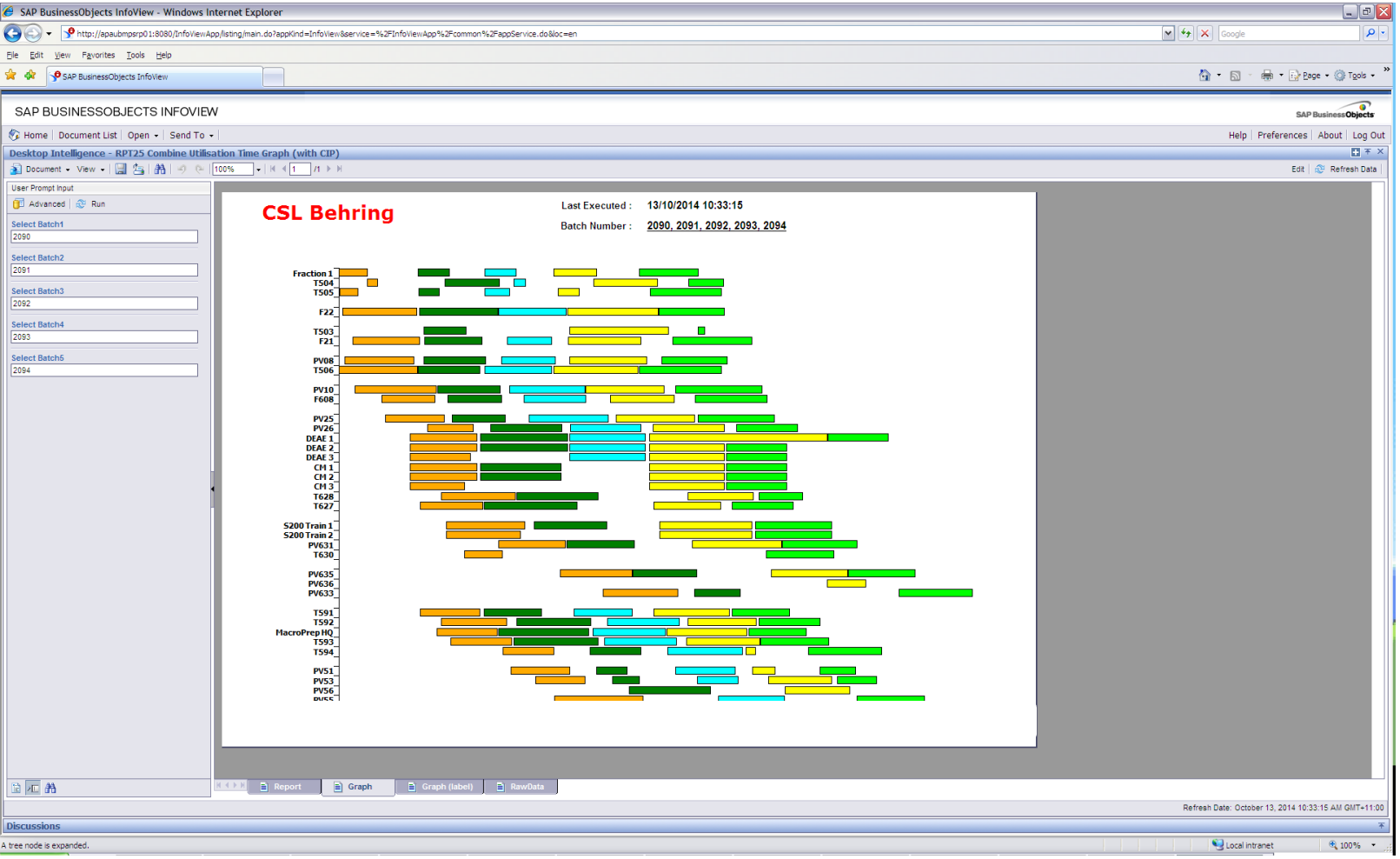
Plant Scheduling: Design Solution



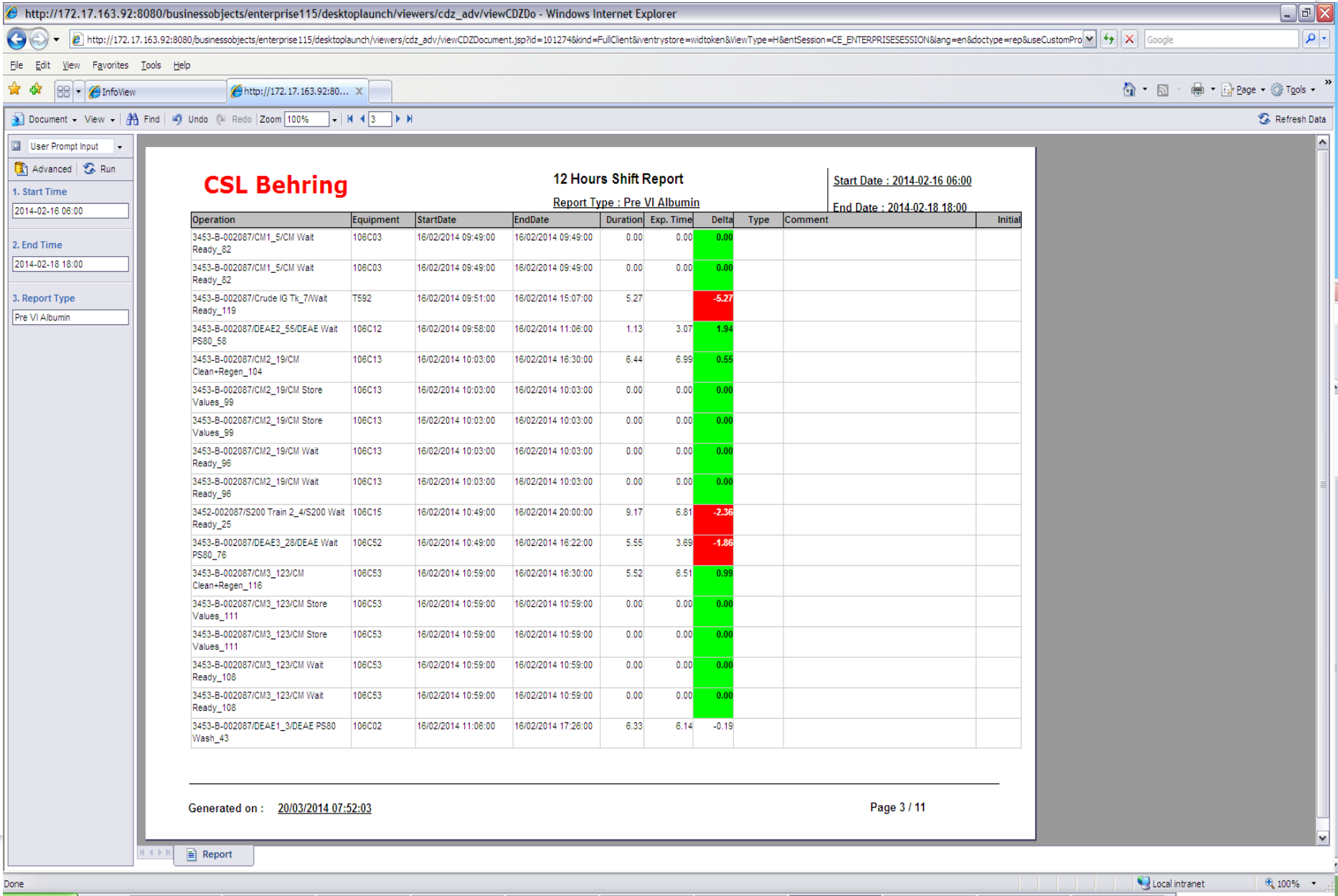
Implementation

- Communicate a clear vision of changes required and accountabilities
  - Educate and empower staff to achieve
  - **Data is king**
    - Presenting new scheduling patterns and work plans quantitatively to mangers, shift supervisors and operators
- Constant review
  - Daily meeting to track batch progress with management stake holders
    - Review hits and misses
  - Follow and communicate operation by operation with shift supervisors in real time
    - Critical path decisions (eg CIP prioritisation)
      - Informed by the model (adjusted for actual conditions)
- Allow failures: **F**irst **A**ttempt **I**n **L**earning
  - Review and record operation level data (shift report)
  - Staff learn new work day over time
- Use lessons learnt to priorities continuous improvement projects to ensure a robust and lasting change

Effectiveness Review: Cycle time reporter



Shift reporter



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Overview

- Data is king!
  - Shift away from anecdotal, from n=10 to big data
- Computer modelling allows visualisation of complex problems
- Informs the right amount and type of resources applied to the areas of highest return

- Implementation requires
  - Teamwork
  - Education
  - Tools that empower staff to make informed real time decisions

Thank you

- Questions?