Accelerating Project and Process Improvement using Advanced Software Simulation Technology: *From the Office to the Enterprise*

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Presentation Abstract

- **Simulation technology is at such a state that it is becoming increasingly risky not to use its capabilities in many of our project and process improvement activities.**
- **We are now able to create very realistic models that behave much like the actual system or processes that the system represents (whether current or future state). The need to accurately depict these processes and ensure valid decision making has increased.**
- **This presentation will demonstrate a number of computerized 3D models from actual aircraft maintenance programs, production lines, lean implementations, etc., and share the lessons learn from each.**
- **The overall purpose is to encourage attendees to adopt simulation technology into their programs and help visualize and realize its cost, schedule, quality, and culture-oriented benefits.**
- **As an industry best practice, simulations help improve communication of proposed implementation plans (thus accelerating approval) and increase understanding with those implementing the plan (thus accelerating acceptance and development).**

Modeling and Simulation

- **Simulation:**
  - *"The technique of imitating the behavior of some situation or system (economic, mechanical, etc.) by means of an analogous model, situation, or apparatus, either to gain information more conveniently or to train personnel."* (Oxford English Dictionary)
- **Modeling:**
  - The technique of a building a model of a real or proposed system so that the **behavior** of the system under specific conditions may be **studied**.
- **Power of simulation:**
  - The ability to model the **behavior** of a system as **time** progresses

Why use Modeling and Simulation?

- **Accurate (as possible) depiction of reality**
  - Information needed to make more accurate decisions and to apply more effective solutions to entire system.
- **Systems: Important to understand; complex**
  - Manual (paper) analysis burdensome
  - Simple tools (spreadsheets) good but unable to meaningfully represent reality (randomness, interdependence, simultaneous activity)
- **Advanced Optimization**
  - Simultaneous examination of multiple elements: Track overall system performance (i.e., activity time, arrival and exit rates, costs, revenues, and system utilization)
  - Scheduling capabilities and experiments (test multiple behaviors)
- **Insightful systems evaluations at real time or compressed time**
  - Tracks events as they occur and gather all time-related data
- **Animation**
  - Visual model performance verification
  - Tools for presentations and training

Accelerating Process Improvement

- **Purpose**
  - Utilize simulations (including advanced, computerized, 3-D simulations) to create “realistic” models that behave like the actual system and processes represented by the system (e.g., both current or future state)
  - Exploit the knowledge gained to augment and accelerate improvement plans
  - See the bigger picture for purposes of discussion, resolution, insight, brainstorming, testing, etc.
  - Make mistakes in prototype, virtual world where the costs of these mistakes are minimal.

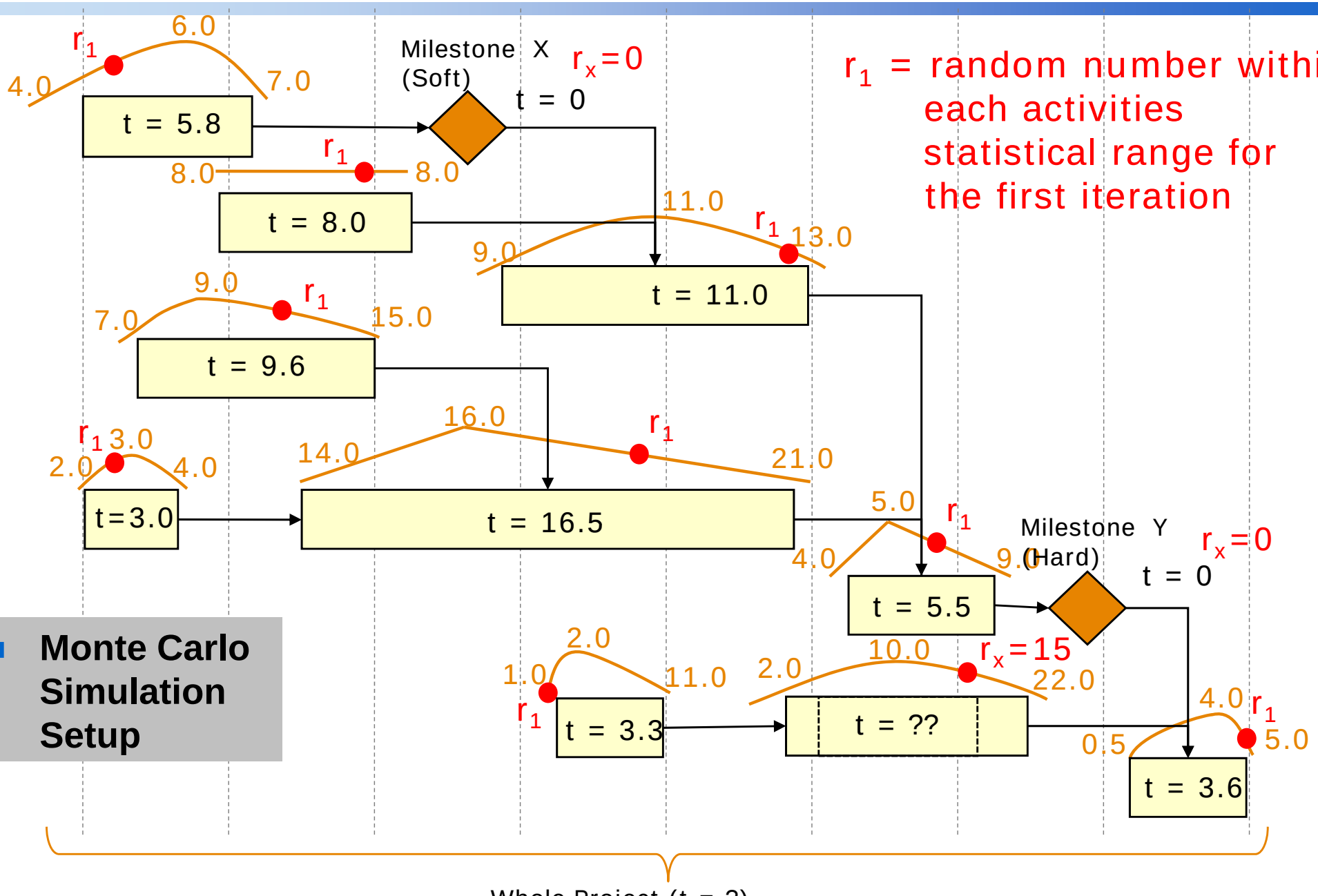
Basic Activities of Model Development

- **Facilitate the modeling and simulation effort by:**
  - Work with teams and individuals at all levels to set objectives
  - Determine and collect required data
  - Review and validate processes
  - Assimilate all relevant information into the model and simulate
- **Models could include:**
  - People, processes, equipment, machinery, etc.
  - If desired, designed to floor plan with important elements (i.e., critical product lines, parts, process, shifts, etc.) highlighted to generate accelerated analysis and subsequent improvement
  - Tool specific capabilities and elements (Excel interfaces, swim lanes, 3D images, etc.)

Types of Simulations

- **Physical**
  - Characteristics designed to resemble the things being modeled (i.e., “looks” and “feels” like the real thing).
- **Mathematical**
  - Uses symbols, equations, functions, relationships, etc., (accompanied by graphs, charts, formulas, statistics, etc.,) to describe something
- **Process**
  - Describes the steps that need to be followed to get something done (to do lists, work tasks, flowcharts, etc.)
- **With these types and elements almost anything can be simulated**

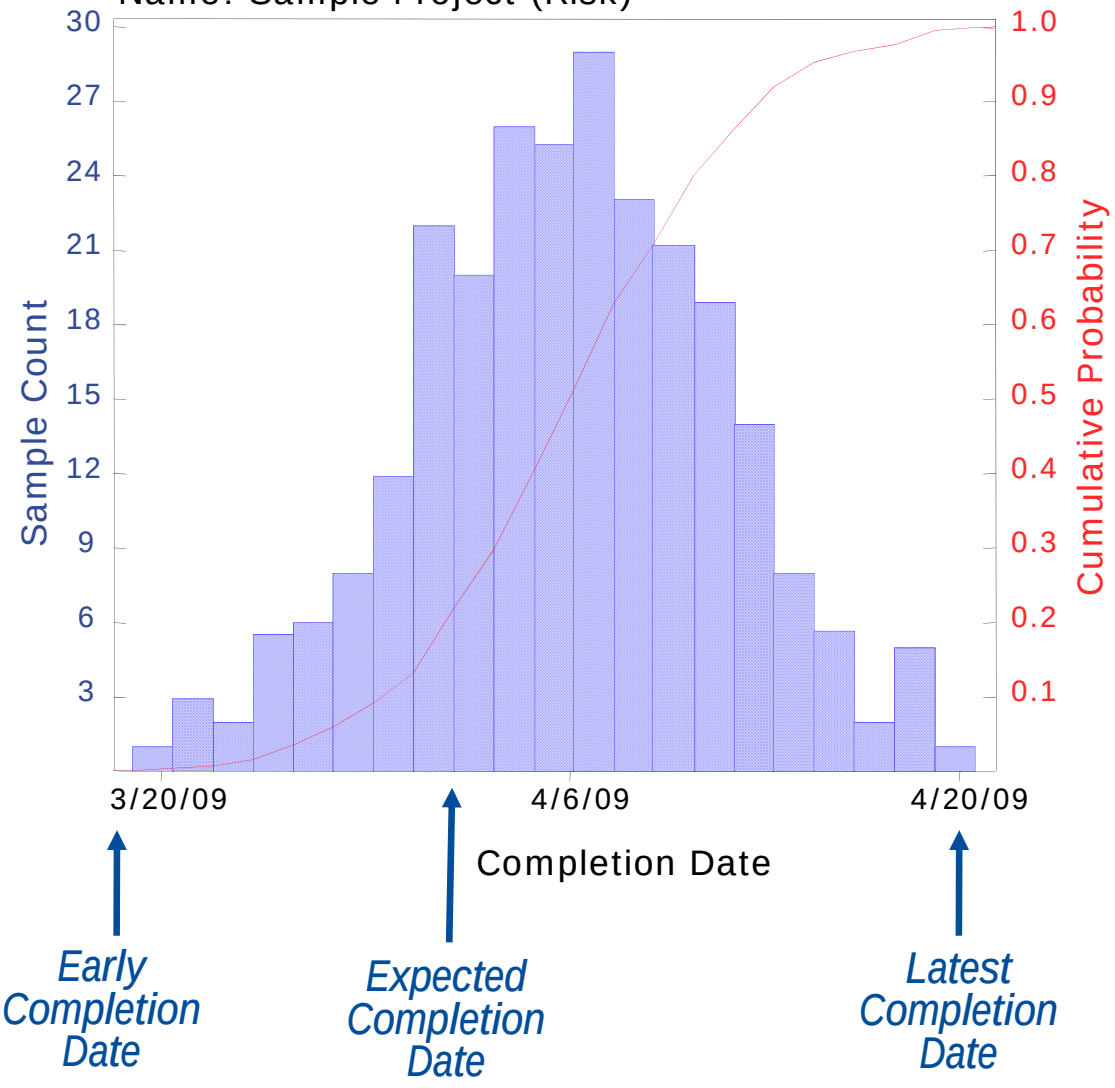
Project Management Example



- **Monte Carlo Simulation Setup**

Monte Carlo Simulation: *Using Risk+®*

Date: 3/20/09 12:47:23 PM
Number of Samples: 200
Unique ID: 1
Name: Sample Project (Risk)



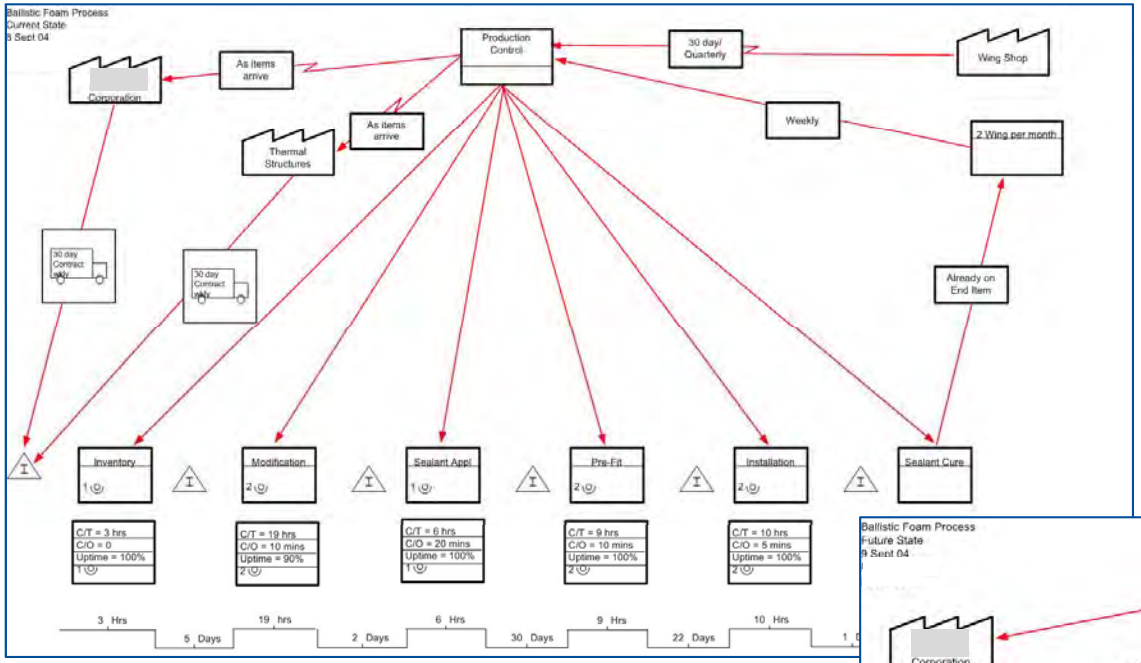
Completion Std Deviation: 3.7d
95% Confidence Interval: 0.5d
Each bar represents 1d.

Completion Probability Table

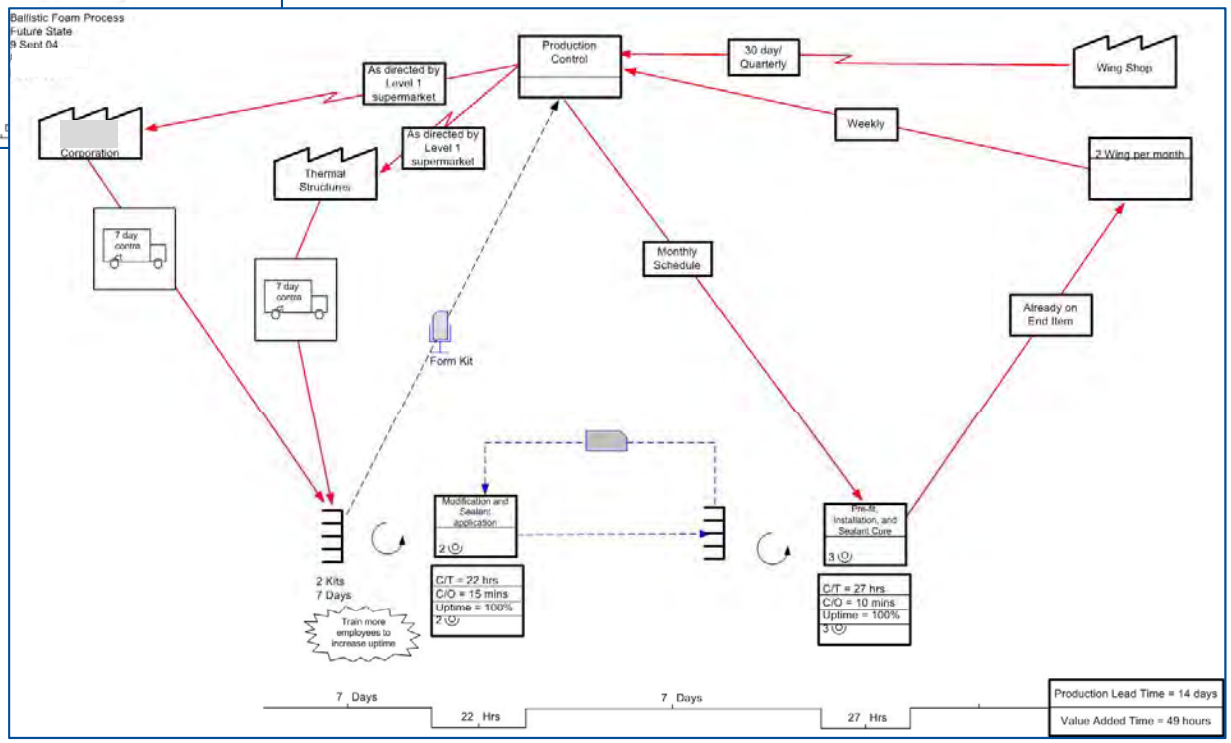
Prob	Date	Prob	Date
0.05	3/26/09	0.66	4/7/09
0.10	3/28/09	0.60	4/7/09
0.15	4/3/09	0.65	4/10/09
0.20	4/3/09	0.70	4/10/09
0.25	4/4/09	0.75	4/11/09
0.30	4/4/09	0.80	4/11/09
0.35	4/5/09	0.85	4/12/09
0.40	4/5/09	0.90	4/13/09
0.45	4/6/09	0.95	4/14/09
0.50	4/6/09	1.00	4/20/09

Only a 20% probability of completing the project as expected on 4/3/09

Static vs. Dynamic Value Stream Maps



- **Static Future State VSM**
  - **"That's fine, but…"**
  - **Unable to check basic validity of ideas**
  - **Buy-in reduced**

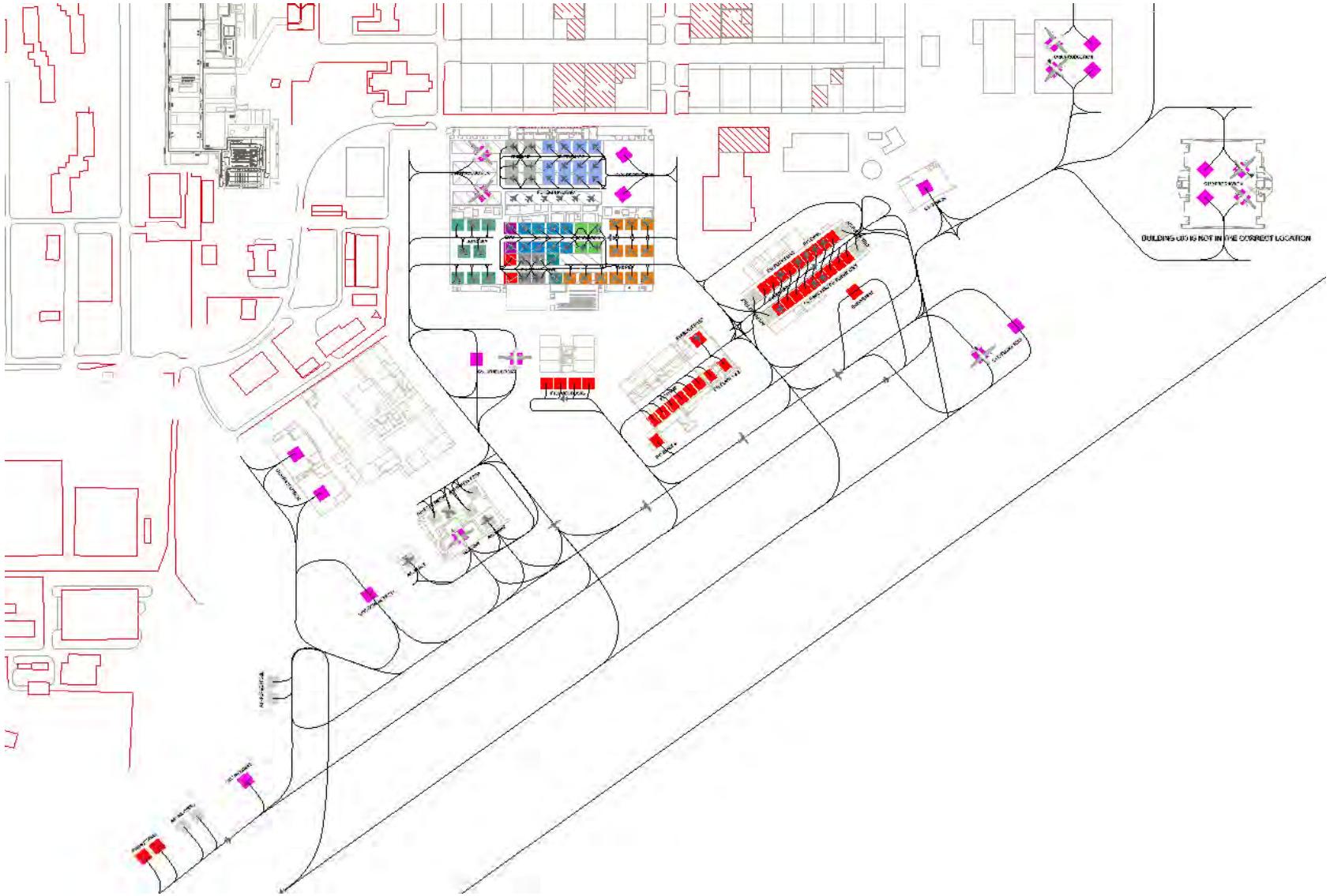


- **Static Current State VSM**
  - **"Boring!"**
  - **Unable to assess, verify, make adjustments quickly**
  - **Unable to envision and consider more useful Future State**

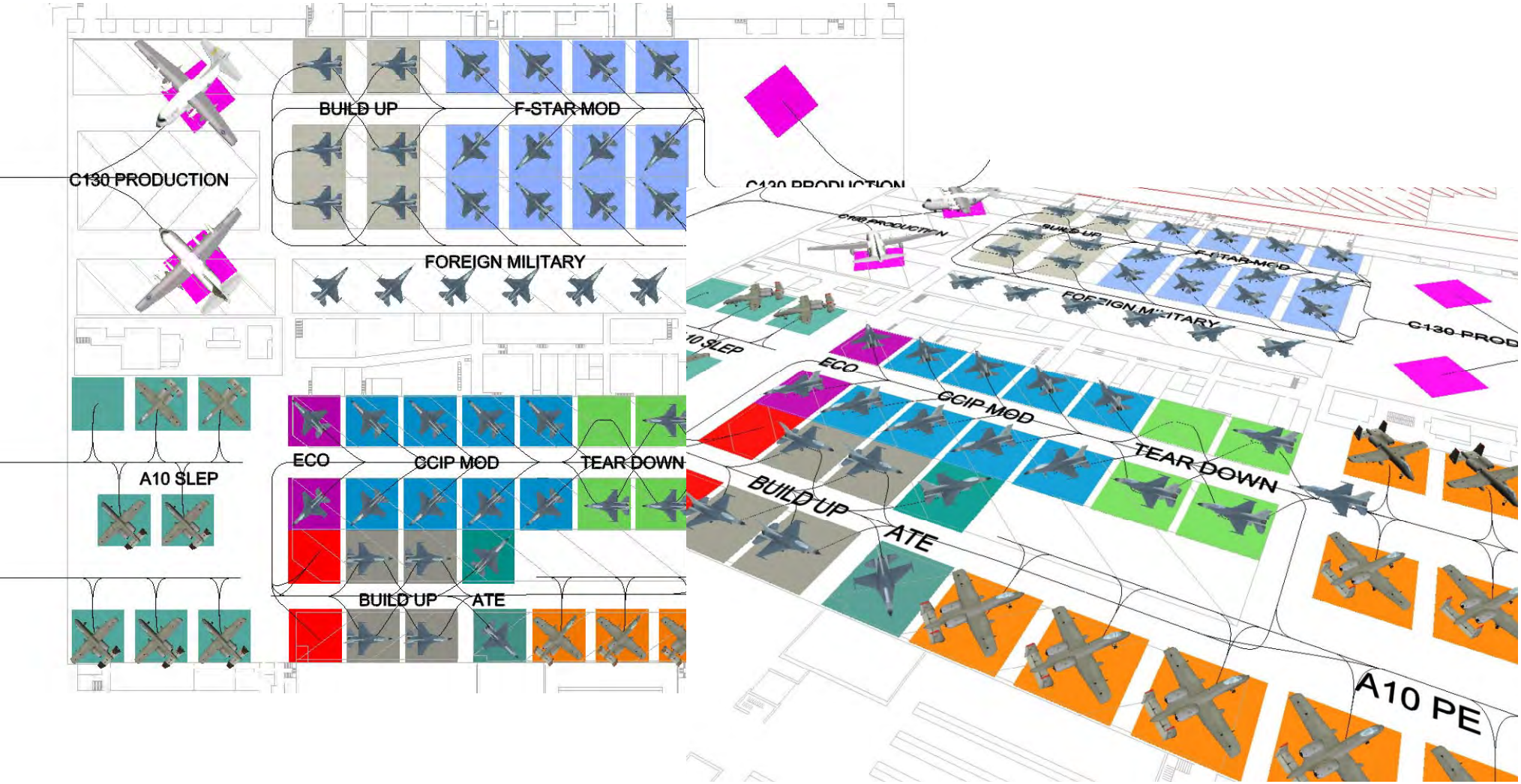
Enterprise Aircraft

- **Purpose**
  - **To provide proof of concept for proposed changes in aircraft (F-16, A-10, C-130, F-22) building utilization and aircraft flow**
- **Benefits**
  - **Provide a 3D motion video of the future state to scale.**
  - **Reduce the time required to communicate the plan to upper management.**
  - **Provide a forum for thorough debate and hence a quicker resolution of key issues.**
  - **Show problems that will occur and outline potential problems that may occur during the transition from current to future state.**
  - **Reduce the overall time to implementation.**
  - **Highlight opportunities for back shops and other supporting functions to sustain overall changes.**

Enterprise Aircraft View



Enterprise Aircraft (Building xx1)



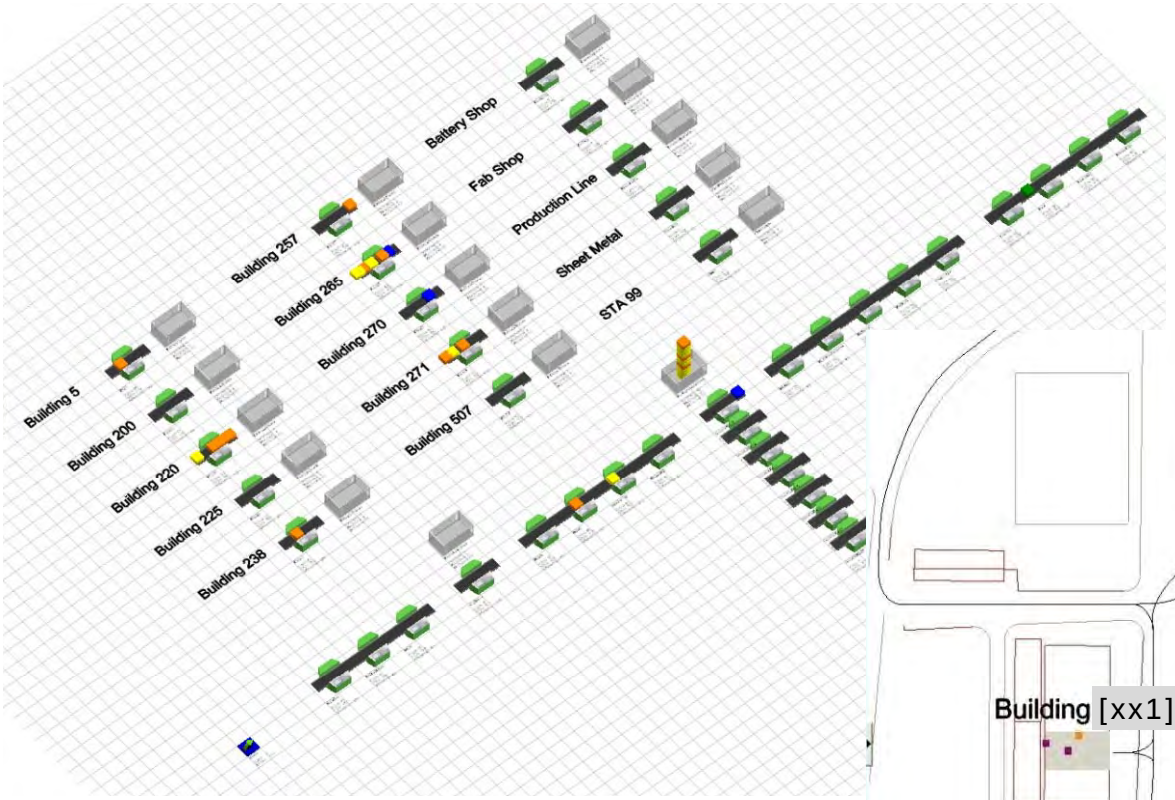
Enterprise Aircraft (Building xx2)

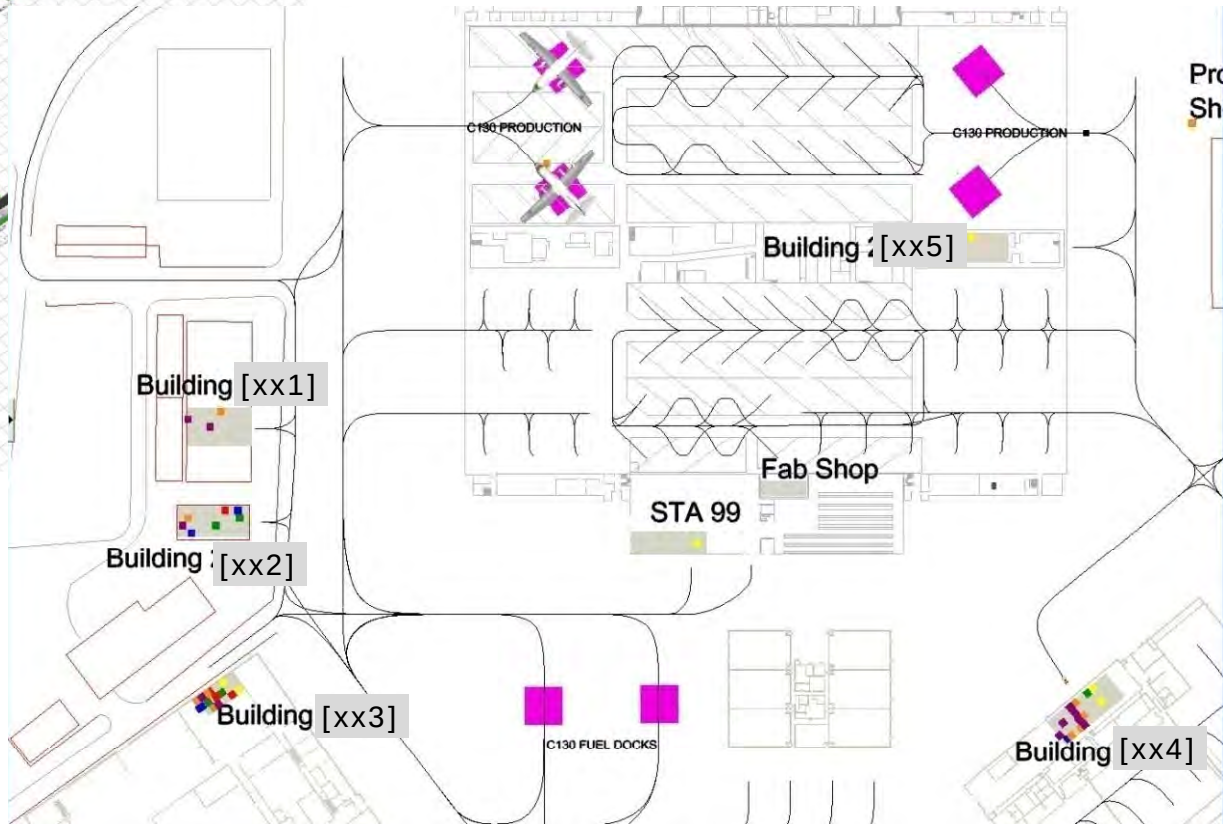
- **Purpose**
  - **To simulate how all processes are working in relation to each other and how they are affected by key changes within the entire enterprise.**
- **Benefits**
  - **To help prepare Building xx2 for increase in future workload.**
  - **Provided a 3D motion video of the future state to scale for assistance in preparing for International award and inspections.**
  - **Provided a forum for thorough debate and hence a quicker resolution of key issues.**
  - **Showed problems that will occur and outline potential problems that may occur during the transition from current to future state.**
  - **Highlight opportunities for improvements and to assist in sustainment of overall changes.**

C-130 Routed Parts (Back Shops)

- **Purpose**
  - **To animate, visualize, and provide variability to the value stream map in order to clearly demonstrate which routed parts are arriving early or late for installation on the plane**
- **Benefits**
  - **Visually shows massive amount of travel of C-130 parts.**
  - **Shows which parts are delayed, and which back shops are causing the delay.**
  - **Provides means of demonstration to back shops why they need to improve.**
  - **Help reduce the back shops' resistance to change.**
  - **Improve use of process improvement funds ("Planes waiting on parts" <Great Than> "Parts waiting on planes")**
  - **Commercially viable DVD on VSM implementation**

C-130 Routed Parts (Back Shops)





[Aircraft] Wing Cell and Shop

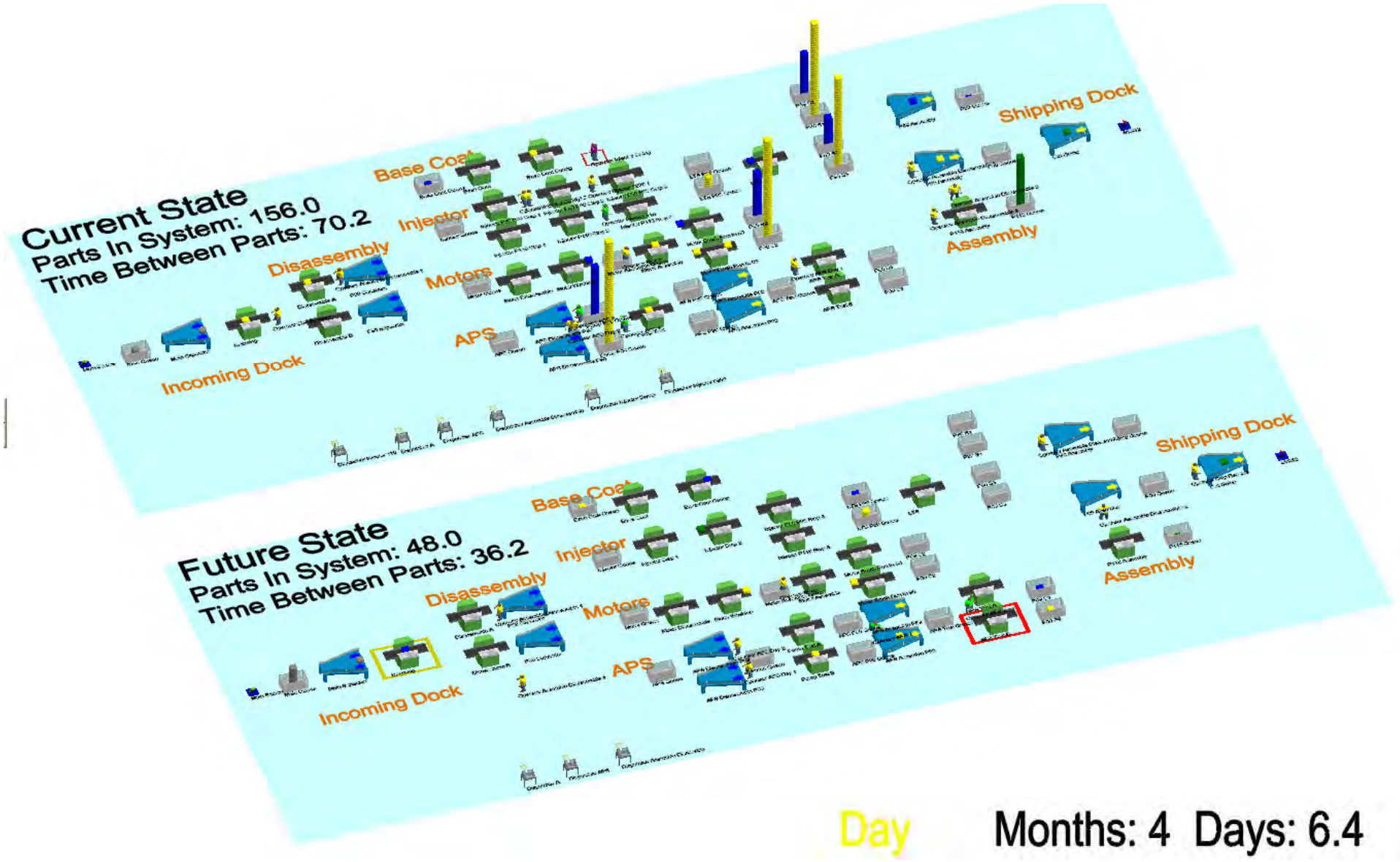
- **Purpose**
  - To determine the effectiveness of proposed changes to the wing shop.
  - To determine the intricacies of the interaction between the wing cell and the wing shop.
  - To highlight possible problem areas in the proposed changes.
- **Benefits**
  - Determined that keeping the wing in one station was more effective than moving the wing through a series of stations.
  - Exposed the scale of the problems with complex and typical wings meeting time requirements.
  - Provided a tool to determine if the future wing shop will be capable of meeting future demand.

[Aircraft] Wing Cell and Shop

[System X] Flight Controls

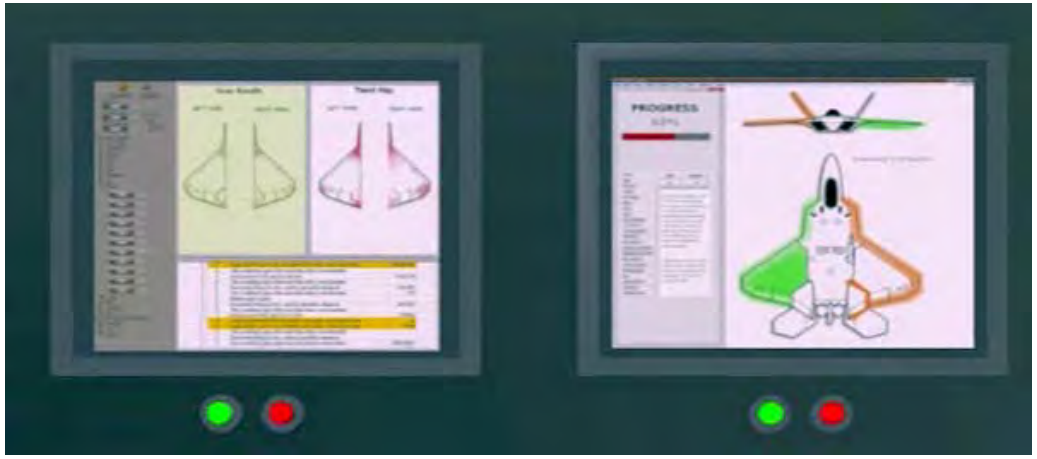
- **Purposes**
  - **To compare the current and future states of flight control repair. To ensure that the future state will work according to plan.**
- **Benefits**
  - **[System X] Lean Team Members:**
    - **Were able to determine the key components necessary for the success of the future state.**
    - **Were able to confirm the productivity rate of the future state. Have been supplied with the means to clearly communicate what the key components are and why they are critical to the success of the future state.**

[xx6] Refurbishment Process Analysis



Visual Simulation: Conceptualization

- **Purpose**
  - **To support new workload and conceptualization of buildings, processes, tradeoffs, and overall approach**
- **Benefits**
  - **Provide vision of yet-to-be created concept**
  - **Marketing**
  - **Advance consideration of issues, concerns, challenges, etc.**



Estimated Savings and Payback Period

- Project [X]
- Estimated Project Savings
  - Estimated 3:1 as determined from FY 200x-200y projects
- Payback Project Period
  - Each simulation project – dependant on project team (3-6 months)
  - Overall – estimated two years
  - Maintain cultural momentum in lean investment (buy-in)

Note: If you don't plan for the ROI and payback period data in the simulation, you won't have it at the end of the project and you won't have the buy-in for the next project or project phase.

Why Transformational

"A process that sustains the Wing goals through new combinations of concepts, capabilities, people and organizations that exploit to sustain our strategic planning."

- Dynamic and continuous event simulation that includes historical and probabilistic data
- Visible results: Cost, schedule, and quality with ability to quickly modify future state
- Advanced technology
- Processes, people, parts, plant, etc. (in flyby 3D)
- Dynamic rather that static value stream maps
- Current/future state captured, including variation
- Creative and inclusive buy-in (data/visual view)
- Enterprise-wide view (multiple groups)
- Capitalize on knowledge of systems variation
- Confirm, corroborate, and validate ideas, concerns, barriers, etc.
- Validate large-scale, long-range planning and deployment (while increasing trust and reducing blame)

Additional Simulations Envisioned

- **Building [xx1] and [xx2] Enterprise Follow-up**
  - Take advantage of models completed to date to highlight and implement advanced lean improvements.
- **Building [xx3] and [xx4] Enterprise**
  - Simulate how all processes are working in relations to each other and how they are affected by key changes within the entire enterprise.
- **[Missile] Flight Controls Follow-up**
  - Take the future state to the next level of efficiency
- **[Equipment] Laboratory**
  - Simulate processes surrounding complex calibration equipment
- **[Work group] Simulation**
  - Improved efficiency of current processes; simulate elimination of waste
- **Building [xx5] Paint and Blast Follow-up**
  - Assist with implementation planning of expanded paint and blast rqmts.
- **Enterprise Maintenance Scheduling System**
  - Assist with manpower planning and scheduling improvements

Accelerating Learning & Improvement

- **Sample Benefits Realized**
  - Improved communication of the implementation plan with “workers” thus accelerating acceptance
  - Improved communication of the implementation plan with upper management thus accelerating approval
  - Decreased planning and implementation time by validating future state and gaining buy-in
  - Facilitated learning (customizable allows “what-ifs”, tradeoff analysis)
  - Assisted management and practitioners to build additional skills and recognize new opportunities
  - Helped teams visualize future implementation options and reduce implementation planning and development time
  - Accelerated lean and process improvement events by increasing trust within systems processes and decreasing blame
  - Maintained motivation and momentum of improvement and skills
  - Increased discovery of triple-constraint (cost, schedule, quality) solutions

Key Corporate Benefits

- **Schedule**
  - More effectively validate that designs (e.g., Lean Cells) will work thus decreasing implementation schedule.
  - Increase the buy-in time for proposed ideas, processes, layouts, etc., with all levels within the organizational hierarchy (particularly management).
  - Prototype a process schedule and simulate it in compressed time to highlight issues, opportunities, barriers, etc.
- **Cost**
  - Create a valid future state that will work according to available and planned budgets.
  - Compare the effectiveness of one design over another in virtual space without having to move equipment, utilities, personal, work units, etc.

Key Corporate Benefits

- **Culture**
  - Improve the communication of workplace process between all levels of hierarchy
  - Improve the learning of workplace processes among all who touch the process.
  - Change the approach for conducting process improvement with visual elements, quantitative data, stochastic processes, etc.
  - New technique for training personnel on business, product lines, processes, etc.
  - Highlight opportunities for support functions to sustain overall changes without blaming.
  - Reduce resistant to change - visual model's "reality" modified before implementation.
  - Continue ground-swell of culture change in improvement initiatives.
- **Quality**
  - Create proof-of-concepts for proposed changes that can be readily reviewed for impact to product line, team, customer, etc.
  - Confirm the key quality issues and required productivity rate of the future state prior to implementation.
  - Highlight problems that will occur and outline potential problems that may occur during the transition from the current state to the future.

Sample Resources

- **Books and Articles**
  - Stuart Robinson, “Successful Simulation: A Practical Approach to Simulation Projects.” McGraw-Hill Book Company. 1994.
  - Law, A.M., “Introduction to Simulation”, *Industrial Engineering*, May 1986.
  - “Simulation Software Survey”, OR/MS Today, Institute for Operations Research and the Management Sciences (December 2005; updated on-line May 2006), Lionheart Publishing, Inc. Marietta, GA 30060, USA
- **Other: Web sites and tools**
  - Proceedings of the Winter Simulation Conference (www.wintersim.org).
  - IITSEC Modeling and Simulation Conference (www.iitsec.org)
  - Simio, Inc. (www.simio.biz)
  - Flexsim, Inc. (www.flexsim.com)