



From Legacy C2 Systems to Mission-Centered Design: Tactical Tomahawk Weapon Control System

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User-Centered Design Team

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Sponsors

■ Future Naval Capability (FNC) Programs

- ONR Code 31 Knowledge Superiority & Assurance (KSA)
 - LACS Decision Support Capabilities
- ONR Code 34 Capable Manpower (CM)
 - Task-Centered HSI & Training Capabilities



■ Transition Program Offices

- PMA-282 Tactical Tomahawk Weapon Control System (TTWCS)
- IWS3C Naval Guns





Mission-Centered Design Distinctions

- Like UCD, MCD is an iterative process of Analysis, Design, Implementation, Deployment
- Focuses on mission products
 - Less focus on user characteristics or responsibilities
 - Focus on tasks as a by-product of the products
- Early and frequent user involvement throughout the process



Why TTWCS Needed MCD

- Crew Size Reduction
- Workload Reduction
- Training Reduction
- Better and more consistent performance
- Increasing mission requirements
- Increasing system complexity and functionality



Some MCD Design Axioms

1. *Focus on mission products to bound the task analysis.*
2. *Focus on task goals and products, NOT on current methods.*
3. *Do NOT allow task allocation to impact task analysis.*
4. *Explicitly represent the mission process within the interface.*
5. *Allow for variable levels of automation.*
6. *Avoid function based decomposition and analysis.*



Mission Products Bound the Task Analysis

- Analyze down to the level of tasks having products.
- What is a product?
 - Something of value to a customer with little or no additional work required from the producer.
 - Product should be tangible.
 - Intangible products lead back to a functional based design



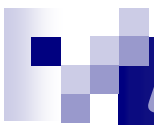
Example TTWCS Products

- Validation Report
- Strike Coordination Overlay
- Line Item Reports
- Post-Launch Report
- Missile Message
- Post-Strike Report



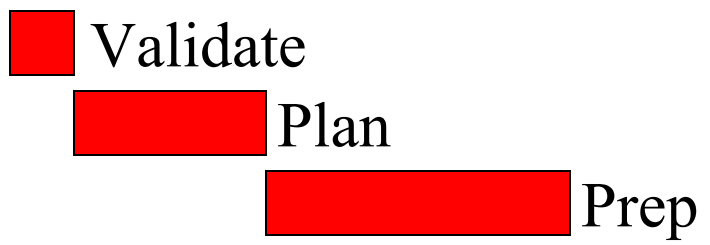
Focus on Goals Not on Current Methods

- Current method normally a by-product of previous constraints
- Want revolutionary not evolutionary improvements
 - Normative - how it was designed
 - Descriptive - how it is used
 - Formative - how it should be designed and used
- Must find ways to develop alternatives or you get stuck in local maximums

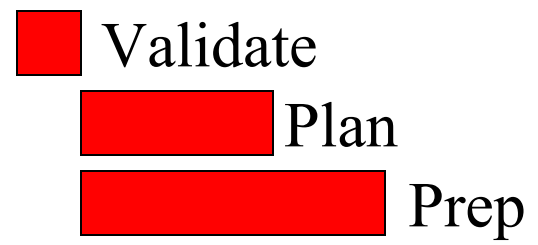


Example - Prep Missiles First

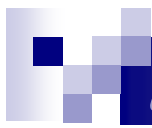
- Prepping of missiles is on the critical path.
- Historically waited until planning was completed to prepare missiles.
- Recommending once the strike is validated that missiles are prepped while planning is being done.



Serial

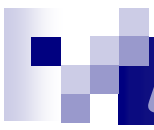


Parallel



Goal Explicit Interface

- Tasks
- Processes
- Products
- Responsibilities
- Automation
 - Domain Consistency
 - Reliability
 - Time Availability



Goals, Tasks, & Steps

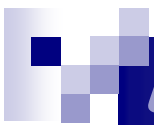
Task Manager > TLAM Taskings 08:05:29Z 1

| Task Manager > TLAM Taskings | | | | | | | | | | | | |
|------------------------------|----------|--------------------|------------------|--------------------|----------------|------------------|------------------|---------------|---------|------------------|---------|-------------------|
| Ship Readiness | | Battlespace SA | | Conduct IS&R | | Prepare Taskings | | TLAM Taskings | | Gun Taskings | | Rehearse Taskings |
| 0/0 | | 0/0 | | 0/0 | | 0/0 | | 1/4 | | 0/0 | | 0/0 |
| ESP Taskings | Priority | Validate Engmnts | Plan Routes | Allocate Missiles | Power Missiles | Execute Engmnts | Monitor Missiles | Tasker | Engmnts | Missiles | Comment | TOL |
| Powering Exec 0007B | High | Validated 3 / 3 | Planned 3 / 3 | Allocated 5 / 5 | Powering 5 | | | TSC | 3 | 5 - 3C | None | -00:15:31 |
| Planning Exec 0008A | High | Validated 3 / 3 | Planning 3 | Allocated 5 / 5 | | | | TSC | 3 | 2 - 3C 3 - 4E | None | -00:21:15 |
| Validate Exec 0009A | High | Validate 1 / 1 | Planning 1 | Allocating 1 | | | | SLT 1 | 1 | 1 - 4E | None | -00:16:31 |
| MDU Plan 0010A | High | MDU 1 / 1 | | | | | | TSC | 1 | 1 - 3C | None | --- |



Allow for Variable Task Allocation and Levels of Automation

- Users will decide how to employ automation.
- Users will decide how to allocate tasks.
- If you do not support this they will find a work around (increasing workload) or your system will be seen as inflexible and will meet resistance.
- Everyone has an opinion on organization, don't get wrapped up arguing about this instead of analyzing tasks.
- Automation availability and reliability will continue to change beyond your control.
- Important to show the current automation settings and allocations, especially if dynamic.



Automation Level Coding

Task Manager > TLAM Taskings 08:05:29Z 1

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Mission vs. Function Based Design

- *Functional Design breaks the task procedure down into the engineers mental model -- HCI = SW Architecture*
- *Mission-Centered Design presents the goals and intent in the user's mental model -- HCI = Goals & Products*

VCR Example - Decide to record a specific program

Function Oriented

Press "Menu"
 Tab down 3
 Press "timer set REC lock"
 Tab down 2
 Select "Enter program"
 Move cursor to start time
 Press "Enter key" etc....

Task Oriented

Select "Record football game"
 See Today's Options
 Select Desired Date
 See Options
 Select Desired Game



TTWCS HCI Design Evolutions

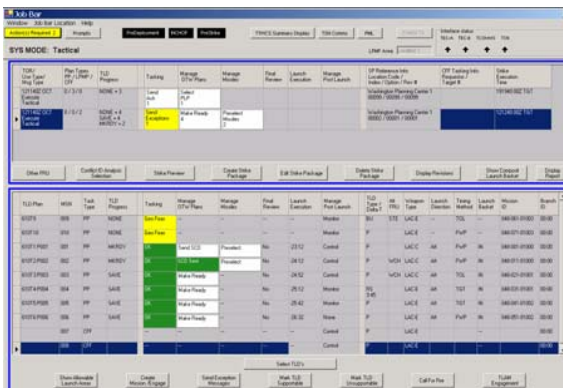
Current

Menu (function based)

Window System Chart Views Comms Support Misc Help

V5 2006

Task (goal based)

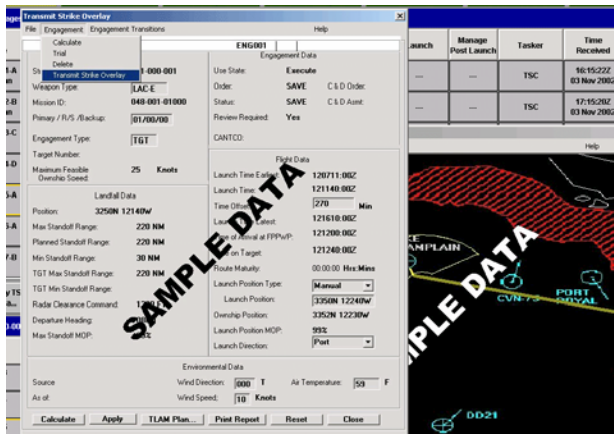


V6 2008

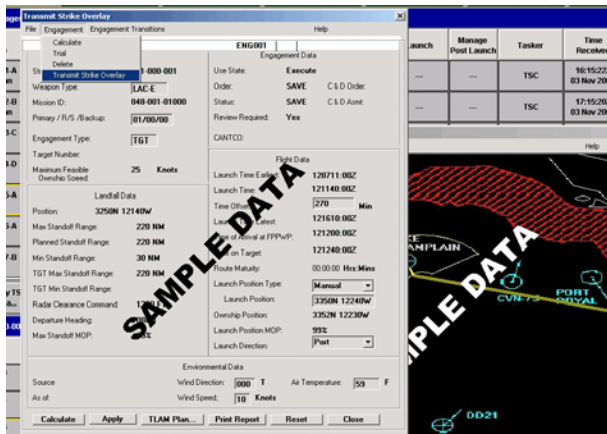
Task (goal based)



Data-driven windows

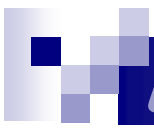


Data-driven windows



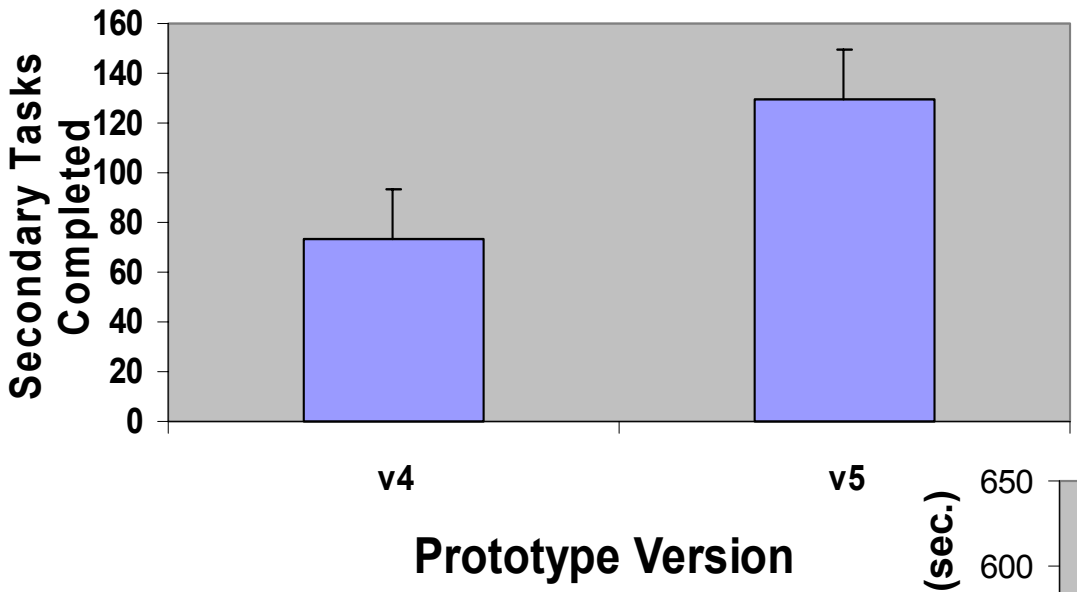
Task Decision-support



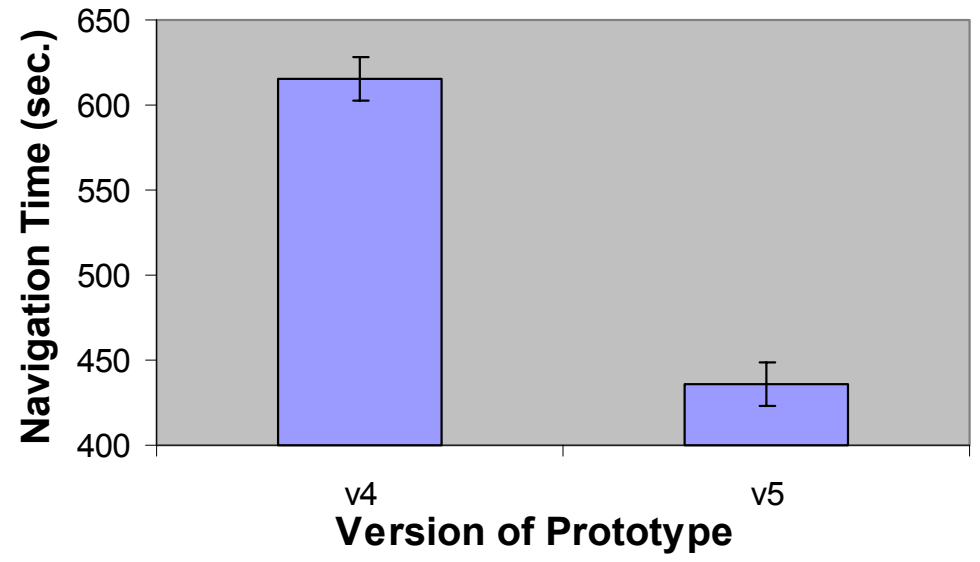


Lockheed-Martin Usability Testing

Cognitive Workload Results



Navigation Times





Fleet Operability Test

■ Performance

- HCI supported a single operator performing a complex scenario with accurate, timely performance of tasks and reporting
 - 99.0% on time launches (309/312)
 - Still room to improve on alerting during simultaneous task processing

■ Situation Awareness

- Performed better on higher level SA questions
 - Often anticipated upcoming events
 - Least effective in locating requested information

■ Workload

- Participant ratings indicated manageable workload across the scenario
 - Ratings were correlated with SME-rated taskload, indicating an understanding of the situation



Land Attack Combat System FNC Team

■ Government Labs

- SPAWAR Systems Center - San Diego, CA
- NAVSEA - Dahlgren, VA
- NAVAIR - Orlando, FL
- Naval Submarine & Medical Research Lab, Groton, CT



■ Industry & Federally Funded Labs

- Johns Hopkins Applied Physics Laboratory, MD
- Pacific Science & Engineering Group Inc., CA
- Southeastern Computing Consultants Inc., VA
- Lockheed Martin Advanced Technology Labs, NJ
- Lockheed Martin Mission Data Systems, PA



Advanced Technology Laboratories

■ Universities

- University of Virginia
- University of Michigan

