

PENNSTATE



ARL

Applied Research Laboratory
The Pennsylvania State University

Design Environments and Manufacturing Integration

CPS PI Meeting
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DARPA's Adaptive Vehicle Make (AVM) Portfolio of Programs

...seeks to revolutionize the design and build process for complex defense systems by compressing the development timelines at least *five fold* while increasing the nation's pool of innovation by several factors of 10.

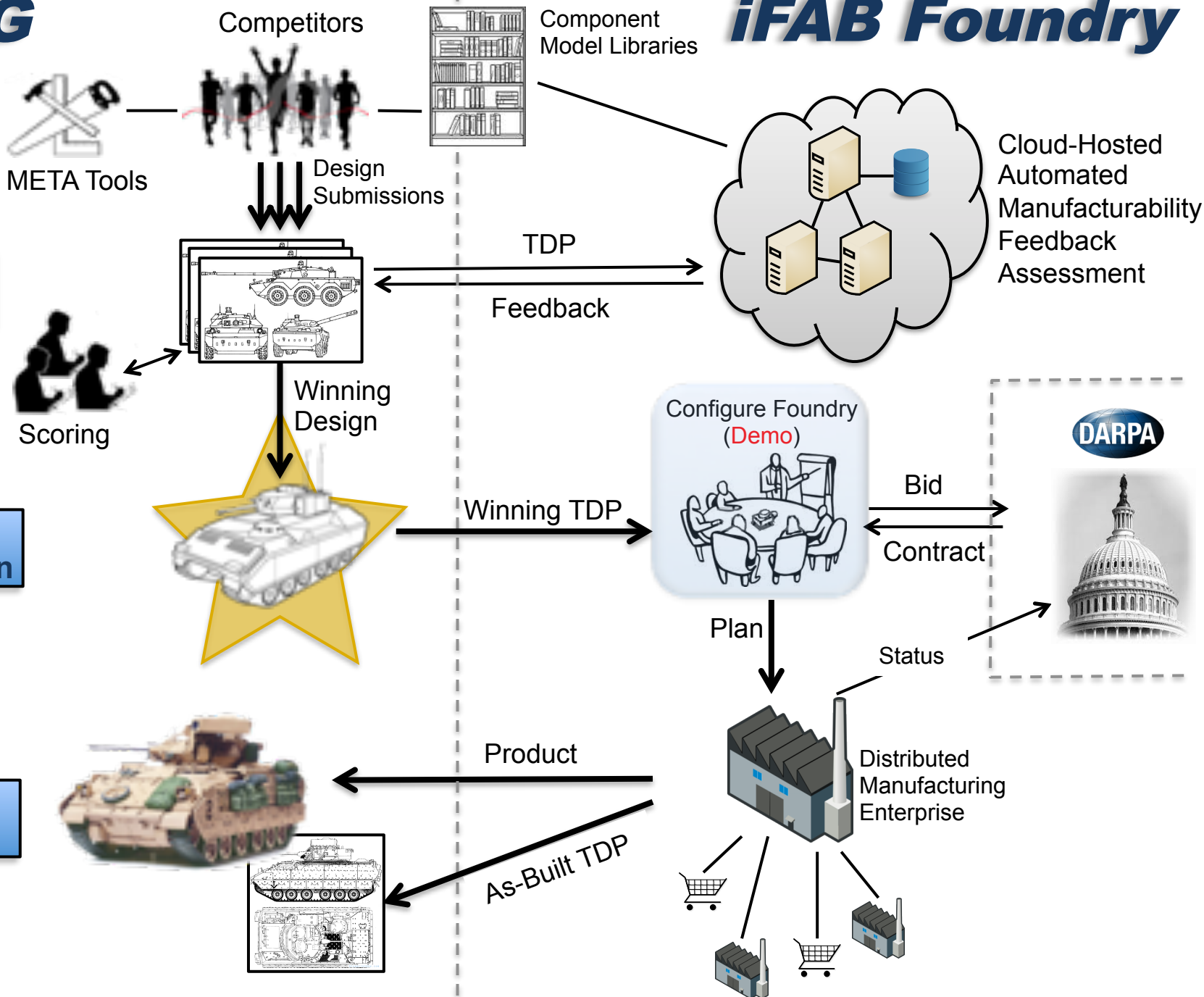
iFAB - Instant Foundry Adaptive through Bits

The creation of a flexible, programmable, distributed production capability able to accommodate a wide range of systems and variants with extremely rapid reconfiguration timescales.

A network of Information, Material, and Agreements

FANG

iFAB Foundry



Design Challenge

TDP Completion

Final Fit-out & Test

META Tools

Competitors

Component Model Libraries

Design Submissions

Scoring

Winning Design

Winning TDP

TDP

Feedback

Configure Foundry (Demo)

Bid

Contract

DARPA

Plan

Status

Product

Distributed Manufacturing Enterprise

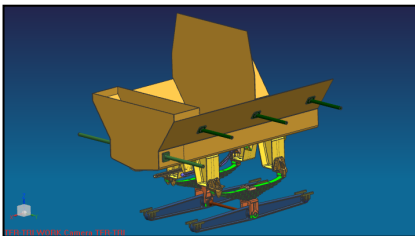
As-Built TDP

Key Challenges for iFAB

- Answer 1000+ queries/day as to whether a design is manufacturable
- Define Pareto front of feasible fabrication and assembly approaches for each design (cost versus lead-time).
- For a particular foundry configuration, generate
 - CNC instruction sets for all manufacturing equipment
 - Human work instructions
- Execute build across a heterogeneous, distributed enterprise

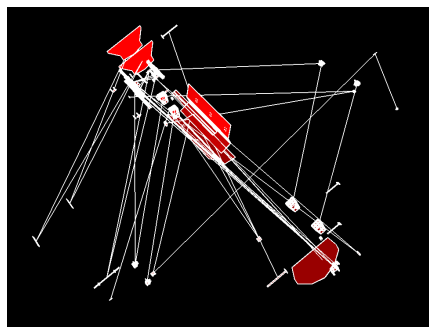
Manufacturability Assessment

Challenge Design



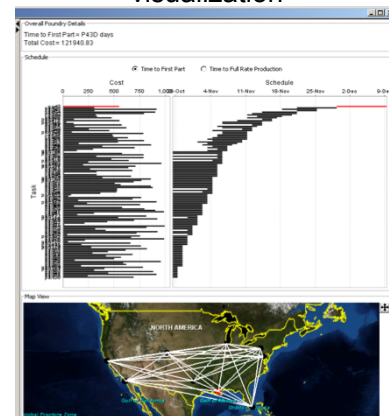
Load STEP Assembly

Decompose Model
Software & algorithms

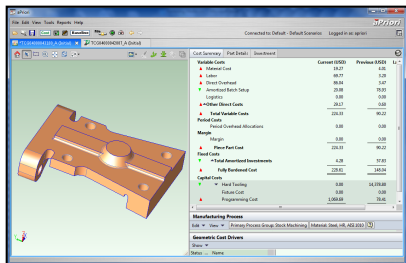


Auto-Generated Component Liaison Graph

Deterministic & stochastic Scheduling algorithms & visualization



aPriori
Virtual Production Environment
Machined, cast, plate, tubing



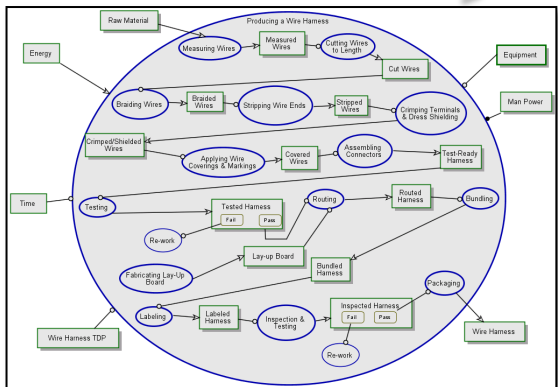
Assembly Planner
Software & algorithms

MFG Analysis for Each Piece Part

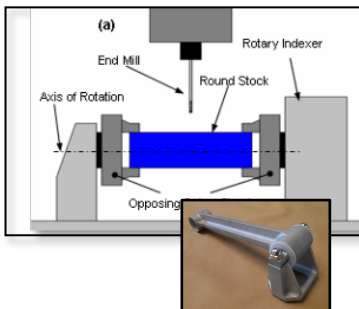
Schedule

Feedback
Yes – Cost & Schedule
No – Cause & Correction

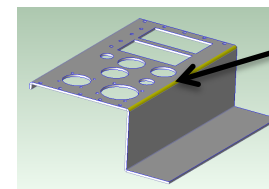
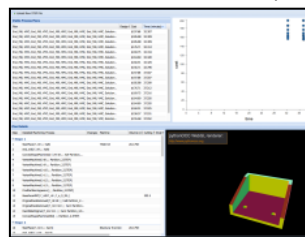
ARL Manufacturing Model Library Components



CNC-Rapid Prototyping
Iowa State Univ.



Automated Manufacturability Feedback Assessment (PARC)



Feedback: *Below recommended bend radius – may cause surface cracking*

Possible CPS Contribution Areas to Manufacturing

- Geometric Reasoning (on real-world sized problems)
 - Feature extraction/mapping – design to manufacturing
 - Analysis – tooling, fixturing, path planning
- Sequential decision making under uncertainty
 - Problem dimensionality precludes a priori preference capture
 - Compounded in distributed enterprise
- Enabling democratized design – promoting the AVM paradigm, while:
 - Protecting IP in an agent marketplace
 - Facilitating business agreements
 - Expanding enterprise reach/appeal

End Game: Flash Mob Manufacturing