

Direct Digital Manufacturing

The Impact of DDM on the Supply Chain

LMI

LMI

COMPLEX PROBLEMS. PRACTICAL SOLUTIONS.

Agenda

- Introduction--[Video](#)
- Overview - Impact of DDM
- Potential Impact in DoD supply chain
- DDM and counterfeits
- DoD readiness for DDM
- Gap analysis
- Recommended steps

Introduction

- General impact of DDM—
 - Advantages and disadvantages
 - Where DDM is in its lifecycle
 - Size of the market

Overview -- Impact of DDM

- Applications
- Rapid prototyping
- Production manufacturing
 - Customization
 - Production of tools for use in existing manufacturing processes
 - Etc.
- Materials
- Scale

DDM Applications

- Parts manufacture
 - Tooling
 - Design constraints
 - Customization
 - Iteration speed
- Medical devices
 - Implants
 - Prosthetics

DDM Impact on Design

Aircraft fuel:
about 4.2 cents
per pound
per **1000
miles** or
1.5 cents
per pound
per **hour**



If the lighter part saved 1 lb. on a commercial airliner with 3000 flight hours per year,
that's \$4500 savings in fuel *per year per hinge pin*

Example custom design



Rapid Prototyping

- Provides the following benefits in design / original manufacturing
 - Faster time to market
 - Fewer and faster design changes
 - Lower cost of product development
- For sustainment and technology insertion on existing product lines:
 - Reduction in time to final design for technology insertion (90 days down to 12 days)
 - Reduction in staffing (from 40 engineers to a dedicated team of less than 20 people)

Production Manufacturing

- Customization
- Producing tools used in current processes
- Materials
- Scale

DDM and Counterfeits

- Boeing and the Navy found the ice detection system on brand new P-8 Poseidons were defective
 - A batch of used and worn out parts were sold to a P-8 subcontractor as new parts
- “CAGE hopping” part of the problem
 - New parts suppliers set up shop with a new CAGE code and advertise legitimate parts, but sell cheap parts, and then move on.
- DDM can both help with this, or make it worse

DDM and Counterfeits (cont'd)

- DDM can both help with this, or make it worse ?
- DDM can lower the barrier to counterfeits, if we don't properly secure the data files that drive the 3D printer.
- However, with DDM DoD and OEMs can “build in” part authentication.
 - Allows DOD to be agile enough to adapt as counterfeiters keep evolving.
- AIA estimates a 5-15% decrease in weapon system reliability due to counterfeit parts
 - The Navy spends about \$1.4B / year on depot-level reparable
 - 5-15% of that is a sizeable chunk of money

Potential Impact of DDM on DoD supply chain

- Original Equipment Manufacturers as DDM users
 - Rapid prototyping
 - Faster Engineering Change turnaround
 - Lower costs
- DoD organic support
 - Small runs of parts
 - Rapid response to upgrade requests

Where And How Might DoD Invest In DDM?

“There are clearly times ... when creating new growth requires venturing not only into unknown market territory but also into unknown **business model territory** ... we have observed five strategic circumstances that often require business model change

“The opportunity to capitalize on a brand new technology by wrapping a new business model around it”

**“Reinventing Your Business Model”
Harvard Business Review December 2008**

A Business Analytics Framework

- Network design - at the strategic level, DDM printer location decisions are significantly influenced by the desired business model
- Inventory optimization - at the tactical level, stock range and depth decisions are influenced by DDM printer location decisions
- System performance – at the operational level, it is essential to understand the support network's robustness to day-to-day operational variability

Starting

- Two LMI modelers developed a simple model for a notional scenario
 - Optimize DDM Printer Location
- Model objective
 - Minimize costs of supporting base level MQ-9 operations
- Model scope
 - All alternative support facility locations and operational locations
- Model formulation
 - Network optimization utilizing mathematical programming (such as mixed integer linear programming) techniques

DoD readiness for DDM

- DDM is driven by 3D models
- DoD is just beginning to receive 3D models from contractors as documentation of weapon system design
 - A-10 Wing replacement – Boeing is delivering 3D models for the new wing
 - Standards and guidance for specifying, receiving & accepting, and managing 3D models is under development

Gap analysis --Current state:

- Navy has 3D models for some ships' onboard systems
- Army mostly has 2D drawings
- AF has some scattered 3D models, mostly 2D legacy data

Gap analysis –Future state

- Starting in 2013, expect more acquisitions to require 3D models as technical data deliverables.
- Also in 2013/2014, expect more DoD organizations to identify 2D data sets for conversion to 3D
- By 2023,??

Recommended steps

- For DoD, getting 3D Technical Data is even more important
- Prepare for negotiations on 3D Technical Data
- Get a cadre of managers in place who are smart about:
 - Value of 3D Technical Data
 - Data rights
 - Modern data management