

testing status along with identifying any significant testing issues for acquisition leaders.

- The *Technical Maturity* metric provides analyses of multiple major programs and shows the level of technical maturity possessed by each program at key stages of program conception, development and production. It is an excellent predictor of whether or not the program will meet established cost and schedule goals.

External Metrics

Program Fit. The first of the two external Level 1 factors is program fit within the capability vision. How well a program is supported in the larger service and the Office of the Secretary of Defense arenas is in large part determined by how well its

product supports the specific capability vision(s) it is designed to meet.

Program Advocacy. The final Level 1 factor is program advocacy. *Advocacy* is defined as actual, tangible support for a program on the part of a senior advocate in a position to affect the priority of the level of resources received by a program.

Future versions of the P(S) business process will tailor metrics with consideration to the program's current life-cycle phase. As the next generation AIM is developed, particular emphasis will be placed on tighter integration of source applications reducing the PM's workload. Assessment and development of an enterprise-level solution is being refined by DCMA and DAU.

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Converting Legacy Drawings to 3-D Models

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The engineering data for many Army combat and combat support vehicle systems remains mostly paper-based. Current vehicle systems will continue to be part of the Army Active or Reserve Component inventory or as part of the foreign military sales programs well into the 21st century. These systems need easily retrievable and stable product documentation for engineering support and maintainability. In April 1995, DOD set forth a management strategy for automated document conversion. This strategy centers on converting documents to an electronic or digital format and managing documents throughout their life cycle. The Army needs the capability to convert various documents to intelligent, editable 3-D solid models. This article discusses the U.S. Army Tank-automotive and Armaments Command's (TACOM's) initiatives to convert raster drawings to 3-D models and the resulting benefits and economic impacts.

Raster to 2-D Conversion

TACOM selected the M113 Family of Vehicles (FOV), high mobility multi-purpose wheeled vehicle (HMMWV) (Figure 1), M1 and trailer systems, among others, for bulk conversion in FYs 99, 00 and 01. The part selection criteria used included a business case, administrative lead time and procurement lead time reduction, Armywide conversion value and decrease in weapon system ownership cost. As a result of this conversion program, 9,500 engineering drawings for M113A3 FOV, 6,500 HMMWV drawings, 3,800 M1 drawings and TACOM and Defense Logistics Agency spare parts and trailers were digitized into 2-D computer-aided design (CAD) files by the end of calendar year 2002.

2-D to 3-D Conversion

The TACOM conversion effort did not stop with converting raster drawings to vector-based CAD drawings. One such solution is a commercial-off-the-shelf software called FlexiDesign™ from Imagecom Inc. The software is designed to automatically convert the 2-D CAD drawings to intelligent parametric 3-D CAD models.

TACOM has begun converting the 2-D CAD drawings to fully parametric feature-based 3-D models. The initial conversions resulted in a 3-D CAD solid model in the Pro/ENGINEER® format. A decision matrix is used to decide which drawings will be converted to 3-D. Some criteria used to select candidate parts follow:

- Future production quantities.
- Remaining life cycle.
- Potential for design changes.
- Technical data package availability and quality.
- Mechanical content.
- System density.

Figure 1. Soldiers of the 3rd Special Forces Group drive their HMMWV through a river on the way to the Daychopan region of Afghanistan. Army Special Operations Soldiers are playing a key role in *Operation Enduring Freedom* and the global war on terrorism. U.S. Army photo by SGT Horace Murray.



The 3-D models generated by Flexi-Design are intelligent 3-D models in Pro/ENGINEER 2001. Thus, the part is now represented as features such as holes, slots, cuts, fillets and chamfers. These features are individually editable within the CAD system. Furthermore, FlexiDesign creates the 3-D models in a neutral file format called Universal Feature Object (UFO). The UFO file can be converted to other 3-D CAD systems such as Catia®, Unigraphics or SolidWorks using the appropriate UFO-CAD plug-ins available. The flexibility to generate 3-D models in a variety of CAD systems is especially useful when procuring parts from suppliers. The 3-D model can then be sent to a supplier in the desired format and directly read by that supplier. In turn, this reduces the cost of manufacturing and procuring the part. Figure 2 illustrates a sample 2-D CAD drawing of a relay-circuit breaker box bracket from the M113 FOV that was converted to

a parametric 3-D model in a Pro/ENGINEER format using the above process. The part was successfully converted to a 3-D model in about 20 minutes using FlexiDesign with little or no human intervention.

Potential Benefits

Combat vehicle systems are consistently being designed, redesigned and upgraded to maximize battlefield performance. Design work continues to be done from cradle-to-grave and during an increasingly long in-service life. All drawings — prior to these conversion project efforts — were stored in hard copy or as scanned raster images. Cost savings can be achieved if these hard-copy documents are converted into 3-D CAD-based electronic documents that will be used for new designs.

The benefits also include reduced storage and maintenance costs for the technical data, shorter turnaround times in spare and repair parts procurement reduced inventory levels, fewer labor hours consumed in the procurement process and elimination of the negative environmental impacts currently faced in reproducing paper drawings.

Further, since combat vehicle and support systems are still used in the Active and Reserve Components, fleet readiness and combat capability can be improved



Figure 2. A sample 2-D CAD drawing of a relay-circuit breaker box bracket from the M113 FOV that was converted to a parametric 3-D model.

while achieving cost reductions in managing and supporting the Army's systems. Storing engineering data in a homogenous electronic data format can provide significant improvements to the Army's ability to manage data within its repositories; change, update or modify the data by engineering support activities; distribute engineering information for parts acquisition purposes and to manufacture parts by component vendors. In this role, the Army, like industry, can capitalize on advanced technology to reduce total ownership costs.

Accomplishments

The TACOM conversion team has exceeded the planned targets for drawing conversion goals by prudently managing and successfully converting 19,500 drawings into digitized 2-D format. In most cases, this was accomplished under budget. In addition, these digitized drawings are being made available to vehicle manufacturers for their respective uses in reducing the acquisition, engineering and logistics costs through the Automated Configuration Management System.

TACOM fully supports DOD's vision and acquisition reform strategy to convert to a paperless environment. Consequently, TACOM maximized its conversion funding by initiating bulk document conversion and data management projects. This will help ensure that data are available in the proper formats throughout product life cycles, and process and infrastructure changes are being made to universally share intelligent forms of digital data.

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Moving Technology Forward – Mobile Parts Hospital Manufactures Replacement Parts in Kuwait

Meg Williams



Soldiers in theater in Iraq identified a need for Squad Automatic Weapon gun mounts on their HMMWVs and the MPH Rapid Manufacturing System supported force protection by fabricating the mounts on short notice.

"We must constantly work to discover what we can bring forward from the future to the current force to increase our capability – now!"

GEN Peter J. Schoomaker
Army Chief of Staff

The Mobile Parts Hospital (MPH) operating in support of *Operation Iraqi Freedom* is a real-world example of bringing technology forward to increase Soldiers' capabilities now. The MPH's mobile manufacturing system