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Barriers to Open Architecture

The U.S. Navy and Department of Defense has understood for many years the benefits associated with integrating open architecture (OA) designs in defense electronics products.[1] The Navy and the other services have created standards, guidelines, and courses in an attempt to increase the implementation of OA designs in military systems. In addition, there are many different definitions of OA that, when implemented, will have a direct impact on affordability and supportability benefits. The Navy recently updated its open architecture strategy document and defined it as the "confluence of business and technical practices yielding modular, interoperable systems that adhere to open standards with published interfaces."[2] This strategy encompasses three overarching goals to transform business practices, systems engineering, Navy acquisition, and program management culture to achieve the four major benefits to the successful implementation of a project under open architecture guidelines. These include:

- Modular design and design disclosure
- Reduction of long term costs
- Interoperability
- More rapid implementation of change
- Encourage competition and collaboration

Identification of research and development concerns with OA implementation is relatively the same as with design implementation, except the architect must be versed with near and far future engineering tools, as well as implementing solutions that are utilizing technology and capabilities that are the leading edge of technological development. An example is the use of Model Base Enterprise (MBE) efforts and methodologies that are being used with Model Based Engineering and Model Based Manufacturing to produce mechanical and electronic assemblies to date that are still being actively developed, refined, and honed.

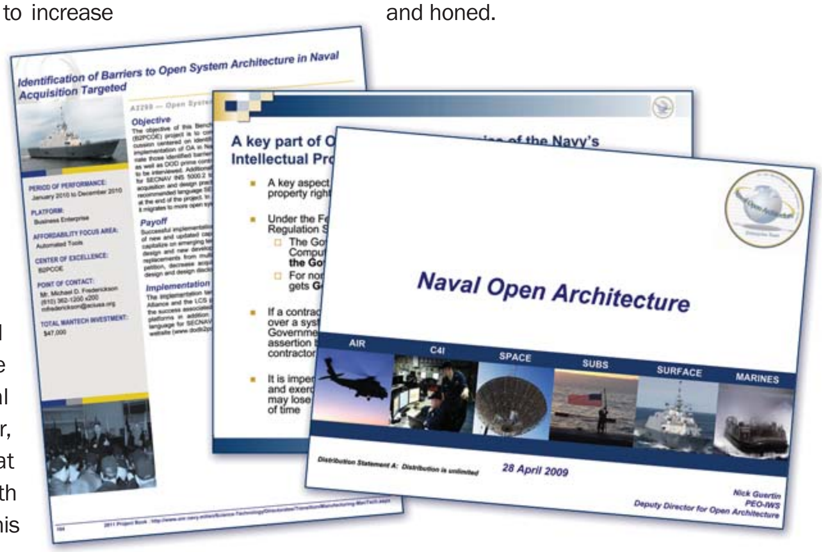

Figure 1-1: "Naval Open Architecture" presentation given at the 10th Annual Science & Engineering Technology Conference/DoD Tech Exposition. Also shown, Open Systems Architecture from the Navy ManTech Project Book.

The implementation of OA requirements in an R&D process as well as production is looked at as a change. Of course, as with the implementation of change in any culture, there are barriers that need to be eliminated and culture hurdles that need to be overcome to fully deploy the OA model in Navy programs. In fact, present culture and intellectual property and data right retention are identified and recognized in practice as two of the greatest, if not the biggest barriers to successful implementation of the modular open system approach.

Present culture issues are manifest in different ways. For example, since verifying that architecture is truly open is some times difficult, vendors have a lot of

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flexibility in terms of how they interpret what "open" means - they find "loopholes." The Navy and contractors have used multiple definitions for OA. Loopholes created with the multiple definitions lead contractors to continue old methods or call something OA when it is really not OA. Some of the present product implementations are partial implementations of OA at best, or labeled OA on some aspects of the programs with carefully selected contractor efforts based on some of the many definitions. These are enablers that allow contractors to use the statements that their products are Open Products, even when they are still considered proprietary by those contractors. The preservation of the status quo for the retention of data rights has also been seen to introduce program delays while attempts to contractually retain the IP and data rights continue.

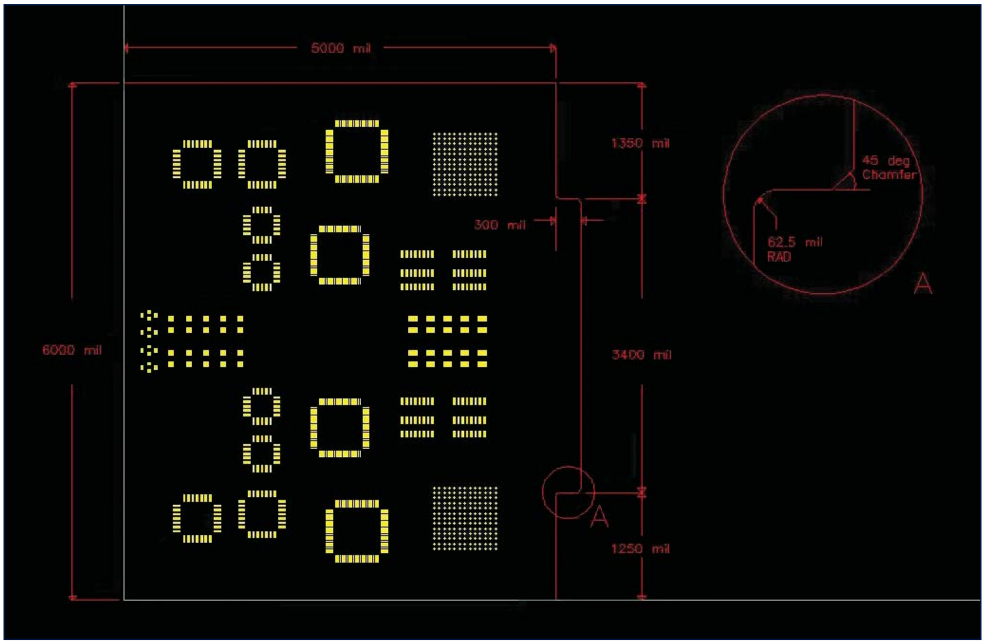

Figure 1-2: Gerber data file image.

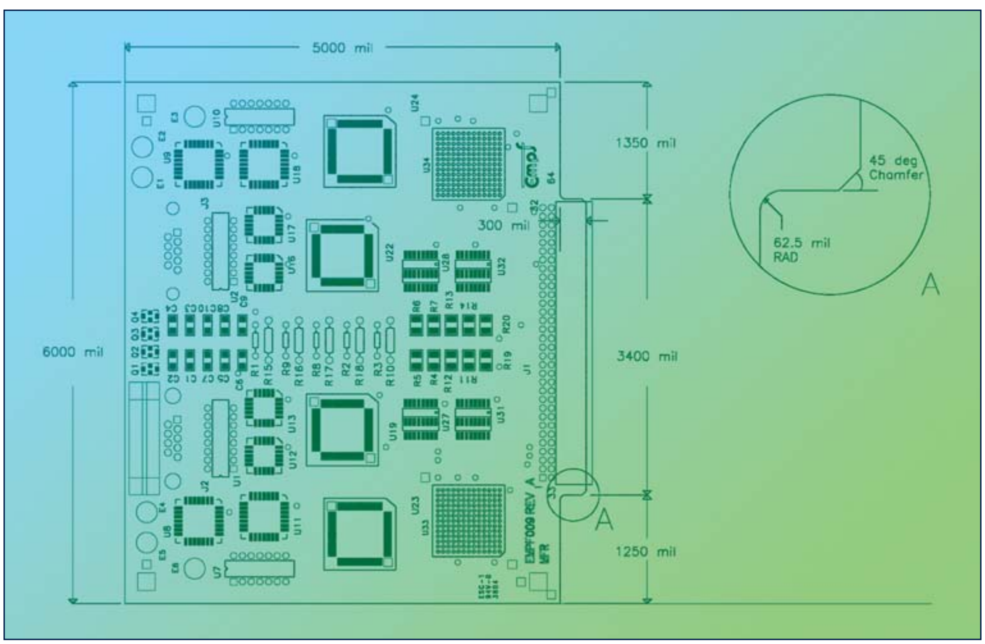

Figure 1-3: CCA drawing image.

OA does not really demonstrate short term benefits and program managers, even government PMs do not always see OA benefits, especially since they have not warranted separate funding to see to the successful implementation.

These and other barriers are of major concern to the Navy. Government ownership of data rights, the product, and manufacturing drawing packages (Figures 1-2 and 1-3) that are paid for with acquisition funding, is crucial to a successful acquisition program. Strict adherence to open architecture requirements guarantees that benefits are possible to the Defense Acquisition Base.

References

[1] "A2299 Open Systems Architecture." Benchmarking & Best Practices Center of Excellence. ACI Technologies, Inc. Web. <http://www.navyb2pcoe.org/success.aspx>.

[2] Guertin, Nick. "Naval Open Architecture." 10th Annual Science & Engineering Technology Conference/DOD Tech Exposition. Panel on Naval Open Architecture, Charleston, SC. NDIA, 28 Apr. 2009. Web. 10 Feb. 2011. <http://www.dtic.mil/ndia/2009science/Guertin.pdf>.

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Manufacturer's Corner: Samsung SM421 and CAD Data

All modern complex electronic circuit board designs are performed using Computer Aided Design (CAD) systems. CAD systems are critical to design the proper function and simulation of the circuit board. Once designed, the circuit board assembly is ready to be populated with components. Typically CAD data is transferred to a manufacturing house to make the bare circuit boards. They will be fed into a stencil printer for paste application and then into a chip placement machine like the Samsung SM421 (Figure 2-1) to place the components. CAD data is used by the Samsung machine to place the components on the board. The fast, efficient and accurate transfer of the designer's CAD data into the placement machine is a critical feature of a pick and place machine, and hours of set-up time is saved using the Samsung tools.

The CAD data is usually in an ASCII format and contains the component reference information, part numbers and the coordinates for placing the components on the board. These coordinates are usually measured from fiducial marks on the circuit board, and x, y, and Theta. Fiducials are designed into circuit boards to serve as "targets" from which to locate the position of the components on the board.

With hundreds of components to place, the speed and number of transfer heads determine the production rate. Equally important is the placement of the feeders in relation to the circuit board. The Samsung machine uses an optimizer program to calculate the installation sequence of the chips and to determine the optimal position to place the feeders to reduce the total travel time when populating the board. The shorter the distance between the feeder and the component location on the circuit board, the faster the parts can be placed. The optimizer software uses the CAD data to generate a map of where to place the feeders for the shortest total time.

CAD data efficiently places feeders relevant to the specific machine. In the case of high speed lines with two or more chip placement machines, it is important to decide which of the two machines will place which parts. In the complete surface mount line - composed of stencil printing, chip placement and reflow - the chip placement machine is often the slowest operation in the assembly process. To improve the throughput rate, two machines are often installed in series.

Figure 2-1: The Samsung SM421 pick and place.

There are advantages to having an additional placement machine in the same line. Thanks to the open architecture of the Surface Mount Equipment Manufacturers Association (SMEMA) configuration, any machine can be installed in a line and connect with any other SMEMA-capable machine. This enables two different chip placing machines from different companies to be placed in the same production line. For example, an older but faster "chip shooter" machine can be placed in the same production line as a new SM421 placer. The chip shooter excels at placing small parts very quickly, but is a poor choice for BGA placement. The SM421 can do the extremely small parts as well as the BGAs. This set-up is common, and shows the value in being able to split and download the CAD data to two different machines with varying capabilities.

For factory tours and demonstrations of circuit assembly production equipment, please contact the EMPF's Mike Prestoy at 610.362.1200, extension 241. The courses highlighted below can benefit personnel involved in purchasing, sales, and program management who want to achieve a better understanding of the assembly process.

Mike Prestoy
EAB Coordinator

Upcoming Courses: Electronics Manufacturing

Boot Camp (*A:* August 13-17; *B:* August 20-24) provides two weeks of intense training in every aspect of the electronics manufacturing process. Not just lecture, but hands-on experience in a working factory.

Mini Camp (October 2-4) offers a comprehensive overview of the electronic assembly manufacturing process, especially surface mount technology, in just three days. Learn troubleshooting methods and see an assembly line in action.

Contact the Registrar for details:
phone **610.362.1295** *e-mail* **registrar@empf.org**

Technical Data Package Recommendations for Open Architecture

The EMPF can provide recommendations for a Technical Data Package for an electronics assembly to fulfill the requirements of Naval Open Architecture.

Naval Open Architecture (OA) has been recently defined by Nick Guertin, Deputy Director of Open Architecture, Navy PEO IWS 7B, as: "the confluence of business and technical practices yielding modular, interoperable systems that adhere to open standards with published interfaces."[1] The core principles of OA are: modular design and design disclosure; reusable application software; interoperable joint warfighting applications and secure information exchange; life cycle affordability; and encouraging competition and collaboration. Successful implementation of OA requires changes in business models, technical designs, and cultural attitudes. This article will focus on the changes needed in technical designs.

The changes in technical designs include the use of published interfaces, widely adopted standards, and system modularization, while discouraging the use of proprietary components. To accomplish this effectively, the Technical Data Package (TDP) should serve as a compilation of all of the detailed engineering plans necessary for the construction of a product. The complete TDP is necessary for future competition and required to manage the product through its lifecycle. As the EMPF, electronics manufacturing is the focus of work with the Navy.

In order to construct an electronics assembly, the manufacturer needs a TDP that contains: a bill of materials (BOM); circuit card assembly (CCA) drawing; component location data; and a Gerber data file.

1. The BOM (Figure 3-1) needs to contain: the part number of a component, which could be a company generated part number or the manufacturer's part number; a written description of the part that should contain the manufacturer's part number, if it was not already given; the quantity used per assembly; and the reference designators where those parts are used on the assembly.

2. The CCA drawing (Figure 3-2) needs to contain the reference designators and polarity indicators of components on the assembly. If the boards are in a multi-up panel, then a drawing with the location of each board in the panel is needed.

EMPF009 LEAD-FREE BOARD KIT

COMPONENT DESCRIPTION	PACKAGE TYPE	DELIVERY MEDIA	REFERENCE DESIGNATOR	QTY PER BOARD	BUILD QTY
ENIG-EMPF009-Rev A-83005	PCB	N/A	PCB	1	20
Immersion Ag-EMPF009-Rev A-83005	PCB	N/A	PCB	1	20
20595 A PLCC20T-LF	PLCC20	Stick	U12,U13,U16,U17	4	160
20596 A-PLCC28T-LF	PLCC28	Stick	U8,U9,U11,U18	4	160
16082 SO16FT-3.8MM-LF	SOIC16	Stick	U27,U28,U31,U32	4	160
1608 LQFP80-14MM-.65MM-2.0-LF	QFP80	Tray	U23,U24	2	80
16079 LQFP100-14MM-.5MM-2.0-LF	QFP100	Tray	U19,U22	2	80
10274 1206SMC-PA-4K-LFNB	1206C	Tape & Reel	C1-C10,C20-C50	41	1,640
16077 1210SMR-PL-LFNB	1210R	Tape & Reel	R4-R7,R11-R14,R19,R20	10	400
SOT23-TR-LF	SOT23	Tape & Reel	Q1-Q4,Q10-Q40	35	1,400
PBGA169-1.5mm-23mm-LF	BGA169	Tray	U33,U34	2	80
PDIP14T-LF	DIP14	Stick	U7,U10	2	80
PDIP16T-LF	DIP16	Stick	U1,U2	2	80
1/4-W-AR-2.3X6.5MM-TR-LF	1/4 WRES	Tape & Reel	R15-R18,R10	5	200
1/8-W-AR-1.6X3.7MM-AMMO-LF	1/8 WRES	Tape & Reel	R1-R3,R8,R9	5	200

Figure 3-1: Parts list image.

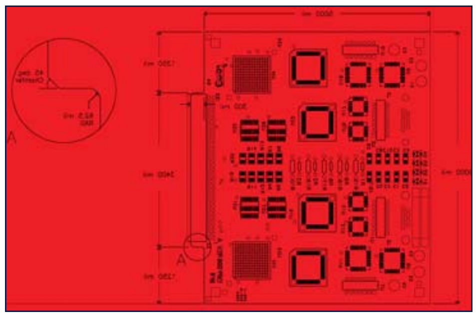

Figure 3-2: CCA drawing image.

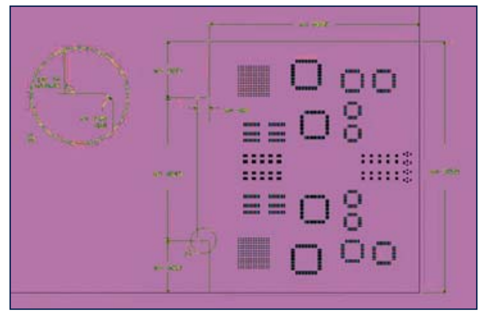

Figure 3-3: Gerber data file image.

3. The component location data is also known as SMT data or pick-and-place data and is generally supplied as a comma delimited or comma-separated value (CSV) text file. The data format though has not yet been standardized and is an area to improve upon. The component location data needs to contain on each line: a reference designator for each part; a part number (may be considered optional, but helpful when included); X-Y locations of the part on the circuit board; rotation or theta data for each part; and fiducial locations in X-Y data on the circuit board.

4. The Gerber data file (Figure 3-3) is needed to produce a stencil for screen printing solder on the pad locations on the circuit board. The Gerber data file is the standard image description format for the printed circuit board (PCB) industry.

A TDP with all of the above information is necessary to deliver the desired outcome and aid in the successful implementation of an OA electronics product. To reiterate, an OA electronics assembly begins at the design phase by using: well-defined, widely used, and preferably nonproprietary interfaces and/or protocols; well documented standards for defining those interfaces; provisions for expansion or upgrade through incorporation or addition of new technology; and performance-based specifications to spell out what the system should do. By following these design selections and providing the recommended TDP, weapon systems should become more affordable by taking advantage of competition and innovation in the commercial market and obsolescence should be mitigated by facilitating technology insertion.

The staff at the EMPF can provide engineering, assembly, and analytical services to assist in board, component and assembly inspections and qualifications, as well as materials identification and analysis to ensure that the product matches the technical data package. Contact the EMPF at 610.362.1200 for more information.

References

[1] Guertin, Nick. "Naval Open Architecture." *10th Annual Science & Engineering Technology Conference/DOD Tech Exposition*. Panel on Naval Open Architecture, Charleston, SC. NDIA, 28 Apr. 2009. Web. 10 Feb. 2011. <http://www.dtic.mil/ndia/2009science/Guertin.pdf>.

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