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Minnesota Defense - Supportability Assessment

Executive Summary

Minnesota Defense as a full service cable and wiring harness design and manufacturer is in a unique position to assist system level manufacturers in establishing interconnection concepts. These interconnect concepts have the potential to reduce the space claims and weight for system cabling, have a positive effect on system reliability, lower unit and Operational and Support Cost, and assist in system-level diagnostics. Integration of design, manufacturing and quality functions contribute to lower cost and reliability, improve response time, and ensure optimized design. Minnesota Defense has also transferred expertise from the medical industry to its defense business to take advantage of lessons learned in creating reliable products where a failure could be life threatening.

Introduction

In March 2004 a supportability assessment was performed on Minnesota Defense products and services. Minnesota Defense is a division of Minnesota Wire and Cable of St. Paul, Minnesota. The objectives of the assessment were:

- Review Minnesota Defense products and services for supportability benefits and impacts
- Determine how to complete the implementation of supportability considerations within Minnesota Defense products and services
- Identify actions for Minnesota Defense to take to improve supportability characteristics of products and processes

Assessment Process

The assessment was performed by examining the products and services in terms of the following logistics elements:

- Requirements
- Reliability
- Maintainability
- Special Equipment
- Facilities
- Skills and Training
- Parts and packaging
- Transportability

Concluding a plant review and interviews with key engineering, manufacturing and management personnel, a checklist was used to assess supportability in Minnesota Defense products and services:

- More reliable or durable
- More maintainable/requires less maintenance
- Requires fewer tools and equipment or no new tools and equipment
- Reduce need for facilities

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- Require fewer customer skills or more easily learned skills
- Requires fewer parts or fewer types of parts
- Uses standard packaging
- Requires fewer transportation assets

Key Findings

The key findings discussed in this paragraph are a summary of the data that was collected. Detailed examination of each key finding is present later in this paper.

1. Minnesota Defense Engineering processes ensure quick turn around of design supporting customer developmental efforts. Minnesota Defense is in a position to add a great deal of value to major defense programs enhancing the process of assembly, test, and checkout.
2. Reliability at Minnesota Defense is enhanced by medical and other industry experience. Minnesota Wire and Cable's experience in the medical industry is being transferred to their Minnesota Defense division. This experience in the critical reliability requirements can directly transfer to military applications.
3. Lowering of Operation & Support (O&S) Cost is built into the Minnesota Defense culture. Standardized construction at Minnesota Defense, while meeting customer requirements, allows their customers to take advantage bulk pricing of materials.
4. Minnesota Defense design approach results in lower weight and smaller footprint cable, connectors and harness assemblies.
5. Minnesota Defense goal in maintainability is to design for discard, building cable and wiring harnesses that have low failure rate and cost.
6. Minnesota Defense has integrated engineering, manufacturing, and quality processes to shorten lead time, increase throughput and improve cycle time of prototype, engineering support

Engineering Processes

Minnesota Defense Engineering processes ensure quick turn around of design supporting customer developmental efforts. Beginning with program planning including pricing, costing, sourcing and bidding, Minnesota Defense builds in engineering reviews to ensure best technical approach, uniformity of materials and processes, avoiding miscues or "start-overs" in design and manufacture. This ensures on-time delivery meeting customer requirements. Minnesota Defense accepts files from all major CAD software systems, eliminating delays in paper transfer and quicker interpretation of design requirements. Contracted design control processes used at Minnesota Defense incorporate lessons learned in the efficient design of cables, building interconnection systems. These lessons built form the unique Minnesota Defense experience, result in better more supportable designs. This capability is limited at "build to print" cable or wiring harness manufacturers.

Enhanced Reliability

Reliability at Minnesota Defense is enhanced by medical and other industry experience. Zero defects is "first" nature where lives are at stake in medical products as well as military applications. Need for smaller, more reliable and able to "live" in an adverse

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environment is important in medical and military environments. Minnesota Defense experience in patient monitoring is directly applicable to soldier monitoring requirements on programs such as Future Combat System and Future Force Warrior. Reliability is enhanced by Minnesota Defense vertical integration capability to design, manufacture, tool, and test in the same facility, avoiding “throwing it over the wall” syndrome. A key example is that contracted to build-to-print the Land Warrior System cables, the Minnesota Defense evaluation led to redesign which allowed Land Warrior to pass initial field testing and trial deployment to Afghanistan and Iraq.

Lower Operation and Support Costs

Lowering of Operation & Support (O&S) Cost is built into the Minnesota Defense culture. Uniformity of design and materials, feeding back to the customer cost saving alternatives for consideration. Alternatives in material selections that meet requirements are presented to customers to allow them to take advantage of Minnesota Defense bulk purchases reducing the need for minimum buys, cost and lead time. Pre-process validation eliminates process related changes during production runs, avoiding additional cost and delays. Agile integrated engineering and manufacturing processes allow rapid design changes to support customer development programs and also allow experiments in lower cost design alternatives.

Lower Weight and Smaller Footprint Cabling

Minnesota Defense design approach results in lower weight and smaller footprint cable, connectors and harness assemblies. Use of carbon fiber, composites and unique “tinsel” conductors, alloys, and composite shielding reduce weight while maintaining electrical and structural integrity. Minnesota Defense has experience in an emergent generation of connectors that are lighter, yet functionally equivalent. Early use of Minnesota Defense experience in product design allows evaluation of when to combine cables in given area, how to maintain efficiency of space and cable performance. Manufacturers should consider early involvement by Minnesota Defense in system level arrangement to optimize cabling runs and space allocations.

Design for Discard Maintainability

Minnesota Defense goal in maintainability is to design for discard, building cable and wiring harnesses that have low failure rate and cost. Maintainability is enhanced by

- Reliability, in that fewer repairs are required
- Lower cost, in that discard on failure becomes the most economic approach

Design for discard eliminates the need for equipment to support repairs, soldier skills to perform repairs, and repair parts.

Future Enhancement in Reducing the Footprint

Minnesota Defense is developing processes that further benefit reduced footprint, these include:

- Fiber optics
- Composite shielding

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- Ink jet traces
- Combining fiber optics and wire into one bundle
- Exotic wire for strength eliminating the need for additional strength member
- Optimizing cable layout, runs and bundling at the system level in space constrained environment

In additional Minnesota Defense has developed the “Smart Connector” to assist the diagnosis of intermittent faults for the F16 program.

Integrated Engineering, Manufacturing, and Quality Processes

Integration of engineering, manufacturing, and quality processes permits shorten lead time, increased throughput and improve cycle time of prototype, engineering support. Minnesota Defense has built in extra capacity to allow shorten lead times flexibility, quick turnaround, and what-if prototyping. Minnesota Defense manufacturing contributes to product reliability and product low cost by of

- Extrusions
- Assembly or “connectorization”
- Injection molding
- Test and measurement
- Potting compounds and adhesives

All of which allow rapid customer system validation and lower cost.

Manufacturing Contribution to Reliability and Low Cost

Minnesota Defense manufacturing contributes to product reliability and product low cost by of

- Extrusions
 - More robust fatigue resistance construction and flex-life.
 - Experience in materials and construction that yield higher reliability.
- Assembly or “connectorization”
 - Conductors: Material selection of alloys and hybrid materials, unique construction techniques.
 - Isolators: Cut-through resistance, chemical resistance, broad operating temperature range.
 - Use of plastics and polymers.
 - Optimization of “lay-lengths”.
 - Experience in a protection of signals using a wide variety of shielding techniques to meet E³ (EMI, EMP, ESD) requirements contributes to survivability in a harsh electronic environment.
 - Staff experienced in using a number of connector styles allows flexibility to updates designs and respond to changing requirements without repeating the learning curve lowers costs.
- Injection molding
 - In-house tooling allows design and manufacturing of insertion molds, for any connector style, as well as stops, junction housing, and whole connectors.

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- Polymer choices for injection molding can be matched to extrusion polymers, compatible materials can be bonded together to ensure sealing. Also knowledge is in place at Minnesota Defense to allow bonding of dissimilar polymers.
- Test and measurement
 - Comprehensive testing capability allows rapid design validation
 - Capabilities include pull testing, water and dust sealing, /vibration testing, shielding effectiveness.
 - Process validation is required in the Minnesota Defense quality plan that exceeds customer requirement.

All of which allow rapid customer system validation and lower cost.

Supportability Enhancement

In determining how Minnesota Defense can utilize its unique position in the defense industry, it is recommended that they continue to assist system manufacturers and military customers by utilizing cable design to improve system level diagnostics. The Smart Connector represented one step in this direction. Another possible development would be to develop a cable design that allows cable testing without having to disconnect. Where critical, a short branch near the cable termination could be built-in, with water proof cover that when opened the cable internal wires would be available for pin probe testing. Typically testability analysis establishes testability ambiguity groups. If the ambiguity group is greater than one, most likely a cable will be involved. One approach is to "buzz" out the cable and if it is ok replace the box. Of course whenever a disconnect is made, damage is risked (maintenance induced failure).

This effort was undertaken by Richard Wizig as a consultant to Minnesota Defense. Mr. Wizig has served in various logistics management positions on major defense programs for the last 24 years. Most recently he served as a consultant to major defense suppliers, developing proposals, studies and planning implementation of logistics analysis programs. He has developed supportability strategies, requirements, planned program approach to system assessment, and metrics for performance based logistics (PBL) and supply-chain management. Previously, as the Logistics Engineering Manager on the Crusader program, he managed a team of logistics engineers performing logistics support analysis on complex electronic, mechanical, survivability, armor, and automotive systems. This effort included design influence, development of supportability requirements and guidelines, performance of trade studies, economic and CAD-based analysis of supportability features and issues, level of repair analysis, task analysis, and provisioning. Previously he was Logistics Engineering Manager for the Armored Gun System, where his accomplishments included development of support strategies, transportability requirements, packaging data, and detailed task procedures, as well as design and fabrication of support equipment. He has extensive experience in planning and executing logistics demonstrations, and validations for Bradley, Armor Gun System, Light Armored Vehicle, and Crusader. He has also served as Support Manager for Marine Corps programs including Advanced Amphibious Assault Vehicle and Light Armored Vehicle-Air Defense where his responsibilities, in addition to logistics also included execution of HARDMAN and MANPRINT programs. Additionally he served as Lead Writer/Training Analyst for the Bradley Fighting Vehicle program, developing and validating technical manuals and training materials for the Bradley Fighting Vehicle as well as the Multiple Launch Rocket System carrier. Prior to his experience in combat vehicle programs, Mr. Wizig, served as an Education Specialist at the US Army Engineer School where he developed extension and correspondence courses in cartography and terrain analysis. Mr. Wizig degrees include Master of Education in Instructional Technology and Bachelor of Science from the University of Texas at Austin. He is also a graduate of the Defense Acquisition Management course by the Defense Systems Management College.