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NEWSLETTER
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CONSULTANTS' NETWORK OF CONNECTICUT (CNC)

CNC is associated with the Institute of Electrical and Electronics Engineers, Alliance of IEEE Consulting Networks (AICN). CNC members are expert, independent contractors who can provide quick help and a can-do approach. Advantages of using CNC members are objectivity and generation of new ideas. Further, CNC members can supplement existing staff very cost effectively.

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NEWSLETTER

This is the third quarterly newsletter. The newsletter for December, 2001 is integrated into this, the March issue. These newsletters are published electronically on the first of the month in which meetings are held.

Each newsletter contains general information and articles written by group members. The membership is invited to submit articles to the editor, Clem Skalski.

Reader feedback is invited and appropriate letters will be published.

The **Connector** (newsletter) of the IEEE Connecticut Section provides more general information to IEEE members and associates. To view the current Connector, go to www.ieee.org/ct.

MEETINGS

These are held quarterly on the third Wednesday of March, June, September, and December.

The meeting of March 20 is at ARRL, 225 Main Street, Newington at 7:00 PM. The first half hour is devoted to networking. Then the business meeting starts at 7:30 PM. The atmosphere is casual and there is no admission fee.

INTRODUCTION TO ARTICLES

"**The Significance of Electronic Packaging on Product Design**," provides a historical introduction to the subject. The author is Thomas A. Freehill, PE, of Eastern Connecticut Microelectronics, Inc. He is a consultant specializing in circuitry for miniaturization, low noise analog/ mixed-signal electronics and electronics packaging. Tom is former chairman of the IEEE Consultants' Network of Connecticut and a member of the Alliance of IEEE Consultants' Networks (AICN) Coordinating Committee. He can be reached at tomf@ectmicro.com.

"**Programming Your Organization For Survival**," reflects on the services offered by Loering M. Johnson, PE (Ret.). Mr. Johnson is a consultant who aids organizations in updating or developing quality programs. His article is based upon many years of guiding quality programs in military and nuclear industries and his current practice. For the past 15 years, he has assisted private clients with the preparation of ISO-9000 quality programs and with preparation of procedures for compliance with European Union Product Directives. In the past he taught Automatic Control Design at the University of Hartford. Loering can be reached at BLUEJAYL26@JUNO.COM

Abstract: **The Significance of Electronic Packaging on Product Design**

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quality program can be of considerable assistance in this evaluation and in developing new approaches that provide visibility to the organization, improve morale and training, increase confidence among customers/clients and suppliers, and facilitate communication in the business community

The Significance of Electronic Packaging on Product Design

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Abstract. Over the past 10 to 15 years, the commercial electronics industry has learned what the RF and microwave people have known all along – the package is often part of the circuit. Additionally, no matter how simple the application, the final package can make or break the product. This article covers modern electronic packaging from a historical viewpoint.

Without a doubt, the invention of the transistor was the largest single driver for high-performance electronic packaging. Prior to this, vacuum tubes with their large size and power requirements reigned supreme (I do not impugn the vacuum tube, as there is still a healthy niche market and my initial introduction to electronics was via the old RCA Receiving Tube Manual, which was still in print at the time).

The transistor's small size and low power availed it to many stand-alone applications and opened the door to integrated circuits (ICs). Initially, discrete devices were combined with passive components in a single package (hybrids). The development of the IC was supposed to be the death of the hybrid, but what was originally done with discretes, was now performed with the ICs and hybrids continued to thrive. They are still alive and well and are now usually referred to as "multichip modules" (MCM's).

Epoxy compounds were originally used for low cost packaging of the early transistors and IC's. What was not well understood at the time, was that in the process of curing, large quantities of salts and other ionic compounds were generated as by-products. Combined with any moisture and an applied voltage, these compounds quickly destroyed the metallization and hence, the device. Enter the hermetic package, which became the de facto standard in all defense and space applications.

Packaging compounds developed over the past 20 years feature contaminant levels measured in parts-per-billion (ppb). Probably over the past 10 years, the military establishment has gotten over its aversion to non-hermetic packaging. This is seen in the switch to "commercial off-the-shelf" (COTS) programs on modern systems.

There is still a niche for the hermetic package, however, even in the commercial world. Certain precision and/or low noise analog components can be affected by even

minute traces of impurities. RF and microwave components can be de-tuned by the parasitics associated with any dielectric constant greater than that of air.

The transistor also affected other packaging levels. Due to their low power gains relative to tubes, multiple stages were required to attain equivalent levels of performance. New methods of interconnect would be required.

Early "tube-type" systems were hand wired. This required cutting wires to length, stripping insulation, forming the leads and hand soldering. The tube sockets featured solder lugs for their end. Nodes were connected at components called "terminal strips". These terminal strips were also solder lugs and the entire process was labor intensive, prone to wiring errors and bulky.

Enter the printed wiring board (PWB). The idea behind the technology is to create a single master wiring layout, from which any number of copies can be created. The physical configuration was originally a strictly planar layout. This technology eliminated wiring mistakes and it was limited to 2 layers (top and bottom). A good example would be the transistor radios of the early to mid '60's.

As IC performance improved, more functions could be incorporated on a single die. This required an increase in the number of I/O's per die and a corresponding increase in the number of I/O's per package. Since "through-hole" packages (DIPs) robbed real estate from both layers, more layers were needed.

Enter the multi-layer board. The additional layers allowed recovery of the board space required of the through-holes, although more layers increased parasitics, costs and reduced system throughput (speed). The increased functionality also increased the need for more I/O at the board level.

As the feature sizes were reduced, more transistors could be packed in the same space. In addition to the increased functionality per square inch, the devices could operate at higher speeds due to reduced signal path lengths and parasitics. System speed, however, did not keep pace with chip speed. The problem was the package itself.

Compared to the silicon that it houses, the package is quite large. Package size is driven not by die size, but by the number of I/O required. A typical 40-pin dual-in-line package (DIP) has an active silicon area of less than .04 sq. inch, but the DIP itself requires over 1.5 sq. inches of board space. The large sizes affect system throughput by increasing signal transit times, not only within the package, but throughout the system. Fewer packages per board require more boards, connectors and back plane wiring. All of these things add delays.

The late 1970's/ early '80's saw the beginnings of the surface-mount revolution, along with its associated learning curves. Since package size is driven by the number of I/O's, pins were put on all sides of the package and in some cases, on the underside of the package. Pin spacing was also reduced. Because through-holes for pins robbed real estate on all layers, package leads were designed for attachment to the top layer only (hence

"surface mount"). The smaller sizes allowed higher densities (both packaging and routing). These in turn reduced parasitics and increased speed.

One problem that arose was with the use of "leadless" packages. These packages were typically ceramic and their "pins" consisted of metal pads deposited on the underside and edges of the body. Their inherent hermeticity made them ideal for the military systems. The problems were largely due to differences in the rates of thermal expansion between the ceramic and the board material (typically FR4). The stresses that developed were concentrated at the solder joints and resulted in cracks and ultimately, failure of the joints. This was not a problem for leaded components, since the leads had more compliance and could absorb the stresses without failing.

The use of ceramic boards was an obvious, though costly fix. Much research went into the development of "constrained" board designs (ie. copper-clad invar). These boards presented hurdles of their own. While limiting expansion in the x-y plane, expansion in the z-axis resulted in cracks and opens in vias and through-holes. Eventually, these problems were also overcome.

The development of flexible and rigid-flex PCBs changed boards from 2-dimensional to 3-dimensional structures. While designed, fabricated and assembled "flat", they can be rolled, folded or formed to produce 3-dimensional packages. While they are expensive compared to standard boards, the rigid-flex circuit is the most volumetrically efficient package available today.

The latest craze in packages, "chip-scale" is actually an offshoot of flip-chip, which has been around since the 1960's. Originally developed by IBM, flip-chip involves depositing solder bumps on the I/O pads of the die. The die is then placed face down on the PCB and re-flowed, the same as surface mount parts. Since there is no other package, the die requires little more real estate than its size dictates.

This has been a quick glimpse at the evolution of electronic packaging. As time permits, future articles may deal with the various levels of packaging and their effects on performance and costs.

Programming Your Organization For Survival

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These comments are based upon the author's 30 years in design and responsible charge of design to military and nuclear quality programs and upon 15 years (continuing) of private practice assisting clients with the preparation of ISO-9000 quality programs and with preparation of procedures for compliance with European Union Product Directives.

ABSTRACT

Successfully steering an organization through current business conditions involves examining and perhaps modifying internal practices. Following a quality program can be of considerable assistance in this evaluation and in developing new approaches that provide visibility to the organization, improve morale and training, increase confidence among customers/clients and suppliers, and facilitate communication in the business community.

WHAT ARE WE FACING ?

With a slowdown in the economy that began at least 18 months ago, organizations (such as industrial companies, professional groups, and associations) began to see a need for greater attention to their methods of operation. As receipts and sales began to decline, job opportunities became fewer and more prudent management became critical. The terrorist activities of last Fall and the ensuing focus on threats and security measures diverted much of the spending that could have been expected to result in an organization's income or profit.

It has now become more important than ever to look closely at an organization's financial management, efficient use of resources, and dispersal of facilities to avoid catastrophic losses. At the same time, it is urgent that the organizations be kept productive and alert to opportunities. One of the things that management needs to do is to review the programs and procedures by which the organization operates. This is a helpful way to evaluate operations and to determine where improvements and changes could be made. It might be that these programs and procedures themselves need to be developed or updated to work best in current conditions.

WHAT CAN BE DONE ?

One of the approaches that can be taken to implement needed steps is to develop or update a quality program based on current quality standards. To those who have been familiar with the "old" quality systems, this may sound strange, but the new quality standards merit a second look. As these standards are oriented toward success in the market-place or workplace, they can provide useful benchmarks for comparison or evaluation.

The International Organization for Standardization, ISO, published its first set of coherent quality assurance standards, the 9000 series, in 1987. These standards were focused primarily on developing programs and procedures that would aid companies in producing products in a manner to minimize losses and reassure consumers of products that met requirements.

In 1994, ISO produced an updated series of standards which included provisions for organizations that provided only fabrication or service and emphasized corrective action and continuous improvement of the quality program. Requirements (of which there were 20) were clarified and were presented in a more logical manner. These widely-applicable and more easily followed standards led to much broader use.

In November, 2000, a second update was published; this time the format of the series was again substantially revised. The word “assurance” was eliminated from the titles and the program requirements were consolidated into one document with a companion document relating to performance improvement and another containing definitions completing the 9000 series. In this latest update, there is increased emphasis on people, both customers/clients and workers within the organization. These new standards are optional at this time; they will become mandatory three years from the date of issue.

The 1994 series of quality standards allowed for different type of organizations to develop quality programs adapted to their operations and products. The 2000 standards make adaptation easier. These programs are not only for large organizations; small ones can benefit, perhaps even more so, from having a program. The program should be customized for the organization for best effect. It is not the intent of the ISO standards that an organization change its management style to conform; the program documentation should be developed in a way to suit the organization (with the provision that the applicable program requirements are to be met).

HOW CAN A QUALITY PROGRAM HELP ?

a. Successful management and leadership of an organization requires the establishment of unity of purpose, direction, and internal environment that lead to meeting customer/client needs. A quality program provides a structured way of managing processes to effectively and efficiently use resources in implementing the organization’s purpose. Standards provide good bases for planning, analysis, and interpretation of the organization’s processes.

b. Use of a quality program improves the view of the organization by customers and clients. Elements of the program can be given to established or prospective customers/clients to show them how well their requirements will be met. Procedures in the program assist with the collection of information from customers/clients and converting that information into useful knowledge quickly, efficiently, and consistently in order to better meet client needs and improve client satisfaction.

c. Confidence and morale within the organization are improved as there is better understanding of goals and methods of operation. Training is facilitated with defined procedures. Also, procedures and standards can be an effective way of selling ideas and concepts to management or to fellow workers.

d. Communications with suppliers, subcontractors, and others may be improved with a quality program in place by having common understanding of definitions, practices, requirements, and goals.

e. Focus on ethical performance is increased. With defined ways to perform tasks, it is easier to assure that requirements are being met properly.

f. Errors with associated liability and losses of resources are reduced. This is especially important in smaller organizations where individuals may have to perform several different tasks. Having established goals and written procedures helps assure that mistakes are not made. Checklists can be included in the procedures and can provide an excellent way of assuring that all considerations have been addressed.

g. A systematic process for continuous improvement is established and facilitated. This is very important because of the continuing emergence of new technology, new markets, and new techniques. In order to keep pace with the changes, it is necessary to continually review one's product and to make corrections and updates where appropriate.

h. A baseline for management evaluation is established. In order to successfully compete or to survive, management must review operations and performance, make effective decisions to direct the course being taken, and evaluate results. These management activities are aided by having a systematic program for definition of goals, conduct of operations, and for making changes.

i. Lastly, having a quality program in place positions an organization to proceed with registration or certification to the ISO Quality Standards if such is desired. Proceeding with the registration step is not required if it is not in the organization's best interests at this time. But having and following a quality program can provide many benefits and can demonstrate to customers and suppliers that the organization supplies quality products and is focused on acknowledging and meeting customer requirements. And, should registration eventually become desirable, moving to that position will be easier if the organization has developed and followed a quality program.

WHAT TO DO ?

Development and use of a quality program can benefit not only technical or manufacturing organizations, but also those in education services, health services, legal services, and others. A commitment and involvement by senior management is vital. In developing a program, it is important to assure that the program is customized for the organization. It can

be modified as appropriate so that it fits the organization's operations and makes clear paths to meeting the standards' requirements. The continuous improvement process is used to make necessary corrections and keep the program current.

The author invites inquiries on the process of developing or updating of quality programs.