Global Aspects of EMC Management

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INTRODUCTION

Electromagnetic compatibility problems have increasingly become nasty technical side effects of modern electronics, causing sporadic malfunctions or even destruction of components as well as unintentional electromagnetic spectrum pollution in the vicinity of electronic/electrical equipment or larger systems. However, cost-effective mitigation techniques are available, and are being documented in international and national EMC standards and handbooks. With the EC EMC Directive and CENELEC TC 110, different European EMC standards are being harmonized to provide the end user with a free flow of reliable goods. This article discusses key normative and socio-political factors, and some historical EMC background is clarified. An attempt is made to describe market needs and perspectives.

Real-world scenarios and EMC case studies are also presented to demonstrate the importance of awareness, professional training, effective organization and good management. Centralized versus decentralized test house concepts and their investment costs are outlined. Finally, a recommendation for EMC cost minimization in small- and medium-size companies is given.

TECHNOLOGICAL DRIVES

Electron tubes, semiconductors, integrated circuits for analog and digital applications and densely packed microelectronic chips are technological milestones of the modern electronic age. EMC

Cost-effective, comprehensive and interdisciplinary EMC management programs are essential to controlling the interference problem.

problems such as telephone and radio cross-talk started in parallel with the early development of telecommunications using these elements. Faster computing (switching) requires physically smaller devices which result in increased sensitivity to electrostatic discharge(ESD). This can easily damage, degrade or destroy thin semiconductor junctions and lead to system failures.[1]

The decreased immunity of fast components is, on the other hand, accompanied by stronger EM emission levels due to short, high-current rise times down to the picosecond range. Uncontrolled electromagnetic environmental pollution far into the GHz frequency domain is created and sensitive microwave radio communications can be jammed. Since microelectronics have moved from predominately military and space applications into everyday life via stereo, TV, household appliances, computers and automobiles, interference sources abound.

Today, EMI protection of electronics is a must for civilized and industrialized societies. We expect medical electronic implants like cardiac pacemakers to function safely.[2] A customer buying an expensive car stuffed with engine management electronics assumes that the system will function smoothly in a critical acceleration process, even when passing high power transmitters. EMI, including lightning, can not be permitted to cause sporadic failures or permanent damage in reactors, power plants, intensive care units, or even grounded intercontinental ballistic missiles.

KEY NORMATIVE AND SOCIO-POLITICAL FACTORS

The need for early implementation of EMC system measures was recognized in the late 1950s and early 1960s in U.S. military circles. This resulted in equipment, system and platform standards (MIL-STD-461/62/63 up to 40 GHz and MIL-STD-E-6051D) which address emission and susceptibility.

In Europe, the NATO EMC specification (STANAG) and the German military specification (VG) followed in the 1970s and 1980s respectively. All aspects of EMC threats, including radio frequency interference (RFI), ESD, lightning, nuclear electromagnetic pulse (NEMP), and the radiation hazard (RADHAZ) aspects of non-ionizing radiation were considered. The result was the first modular, systematic, global and cost-effective approach to EMC.

In the civilian world, CISPR dealt with telecommunication interference on a worldwide basis in the 1930s. As a subcommittee of the International Electrotechnical

*See Advertisement on Page 235.

Committee (IEC), they issued control recommendations.

Mandatory emission limits were applied to radio- and TV-interfering devices (HF GERAETE GESETZ 1949 in Germany, FCC §15 J (1 GHz) for computing devices, and VDE 0871/Vfg 1046 1984, etc.). These legal acts protected national spectrum users from interference while generating license fees for government agencies with telecommunication monopolies and national sovereignty.

Over the years, as the European Community grew, harmonization of the differing national EMC standards and laws became crucial. In March 1989 the EC EMC Directive (89/336/EEC) was issued[3] as a political framework to reduce technical trade barriers.

While the EC Directive was in the development stage it became clear that new standards should not be created unless absolutely needed. Instead, the goal was to harmonize existing IEC and CISPR standards and cross-check them with important national European standards to find major deviations. This is a continuing challenge. For example, IEC 801, basically a product-oriented (process control equipment) susceptibility standard, urgently needed revision to be more widely applicable.

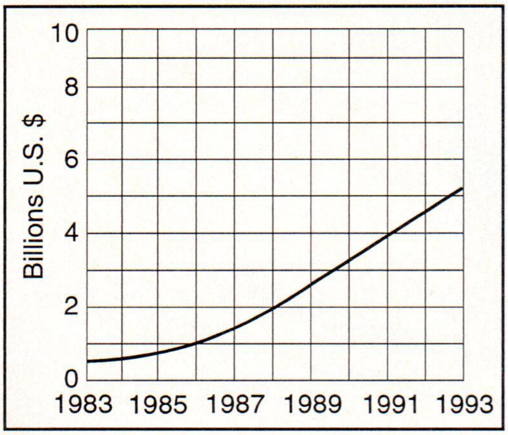

Figure 1. *Increase in Sales of EMI/RFI Shields/Shielded Enclosures.*

Following the intent of the EMC directive, one final goal is to assure adequate quality control to protect the end user in the different member countries. Therefore, there is a demand for uniform testing, laboratory accreditation, product marking and certification in both EC and EFTA countries.[4] The North American and Far Eastern trade partners of Europe, suddenly alerted to these rapid changes, now carefully watch the technical and political trends.

The deadline for introducing the new, legally binding EMC regulations is quite firm at this time, and it is essential for industry to prepare now. Product liability under the EN 45000 series quality control and CENELEC EMC specifications are decisive production factors for the marketer. But until 1996 there is an option to use traditional national EMC tests or the EC CE Marking. Nothing is perfect, so there are still challenging technical problems to be solved to achieve physically meaningful, cost-effective EMC testing.[5]

MARKET AND PERSPECTIVES

The expansion of the U.S. and European commercial EMC markets started approximately 15 years ago. This was paralleled by the growth of technical EMC expositions and academic symposia. At the same time, legally binding standards (FCC/VDE/EN) became driving forces in the development of new electronic technologies.

European filter, cabinet, connector, and cable manufacturers, along with test generator and RF equipment companies, have grown into a full market industry with an estimated total volume of more than \$4 billion (Figure 1). U.S. EMC products which were developed through large military programs once dominated the marketplace. In the early 1980s aggressive competition from the Far East began. Now new equipment and services flow from Asia into the U.S. and Europe.

Generally speaking, the growth of EMC markets is determined by:

- Product liability laws
- EMC Directive
- Competition
- Overall economy
- Legal control measures
- Transition period
- EMC awareness

Critical questions remain as to how to effectively organize and manage the response to the EMC challenge.[6,7,8,9,10]

EMC AWARENESS IN THE REAL WORLD

In many companies EMC is regarded as the "black magic" side effect of QC problems in poorly designed electronics. Ignorance of EMC concepts and principles is rampant throughout the ranks of upper management. EMC demands theoretical knowledge and extensive practical experience. Designers with this expertise seldom hold policy-making positions within a company. Therefore, excessive delays and expensive retrofits can result from the designer's absence in the decision-making process.

EMC ORGANIZATION/ CONFLICTS

Some larger organizations have learned their lessons the hard way. They have organized their EMC departments on a profit rather than a service base. The resulting cost constraints do not allow quality EMC components to be integrated into products.

Sales and marketing departments also contribute to the high cost of compatible equipment by promising the prospective buyer unrealistic performance, and consultants may specify the more stringent military specifications when commercial standards would have been adequate. Smaller companies generally have more control over their EMC programs but may still fail through EMC mismanagement.

EMC MANAGEMENT

EMC is not a stand-alone product which is immediately visible to everyone. EMC product liability/ quality control and associated business, engineering and legal decisions are clearly strategic top management issues. Motivating people on all hierarchy levels (top down/bottom up approach) and considering their different mentalities are important tasks which are difficult to accomplish.

The most convincing argument is big cost savings (Figure 2). A true case study from a major manufacturer proves this for ESD failures. In 1982, losses were in excess of $150 million per year. ESD was found to cause 50% of all electrical failures. Implementing a QA program for ESD control led to dramatic improvements. In 1989, ESD was found to cause less than 1% of all electrical failures. The result was millions of dollars in savings per year with a rate of return on investment of several thousand percent.

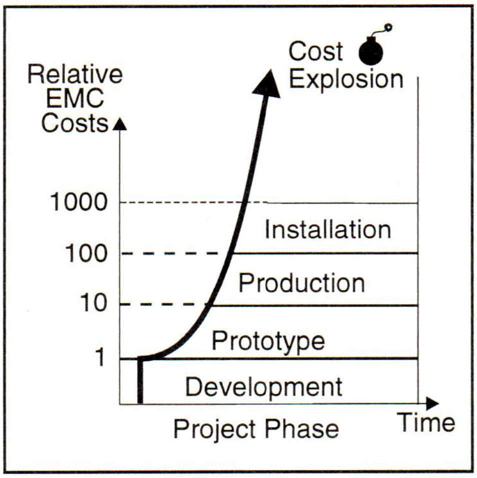

***Figure 2**. Cost Escalation with Delayed Integration of EMC.*

But there is another dimension to EMC problems: personnel. Is the young EMC engineer willing to deal with "dry" EMC standards and a job which requires perpetually defending oneself?

The ideal EMC engineer is a rare mixture of a techno/system/ hardware/RF-freak with some flair for software and EMC automation. The EMC manager, on the other hand, should be a diplomat, capable of selling EMI-control programs, including the necessary production steps, to the upper ranks in the hierarchy.

The manager also has to be independent from other groups in the application of the EC EMC directive. Competence and awareness of existing EMC measurement discrepancies are essential. This may appear impossible, but there are actually many satisfying solutions available, given top management support. Generally small and mid-size companies tend to develop solutions faster because of shorter lines of communication. Here are some success factors for good EMC management.

1. Provide awareness and technical training featuring EMC basics, analog/digital and system design, as well as EMC standards and management.
2. Establish EMC programs and project organizations, and include trained experts in the large divisions, which are decentralized but well-coordinated and scientifically supported.
3. Offer constructive positive and negative feedback to all levels of management.
4. Set up a program focused on legal aspects and cost savings.
5. Set up a program focused on technical and EM effect engineering issues.
6. Furnish a decentralized EMC department with well-equipped mobile facilities for quick and dirty checks in R&D.
7. Establish a data bank for EMC standards and update all information continuously.

EMC Test House: Rough Cost Estimate
In House vs. External Service

Investment: (EC 92 Test TC 110) ALC *10 m 1 Million (10 Y) $100,000
Equipment 1 Million (5Y) $200,000

Fixed Cost: Rent 500 m^2, 4 Salaries, Capital Investment Rate. . . $600,000
$900,000

Break Even: $900,000: Full Unit Test - $8,000→ 113 Units/Year

* Absorbed Lined Chamber

***Figure 3.** Cost Savings Realized Using Out-of-House EMC Service.*

CONCLUSION

It is difficult to predict the investment cost for internal EMC departments. They greatly depend on the space required, and the cost can easily range to many millions of dollars. Based on the author's international experience, a typical figure of $3 million for a medium size department seems justified. However, many of these labs run at only 70% efficiency. Night shifts will greatly improve the throughput but are not always possible because of unions and customers. Combinations of test house and research work (e.g., in universities) are not usually a good idea because of the very different outlooks, availability of equipment and test requirements.

A small external EMC service could be the optimal solution (Figure 3). The various requirements in companies demand a certain internal know-how in EMC but even small firms need a consultant's advice and suggestions from time to time.

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