Ensuring Shipboard Electromagnetic Compatibility

It is rare that the opportunity presents itself to achieve shipboard electromagnetic configuration management to provide electromagnetic compatibility (EMC) from the beginning. This opportunity should not be lost and means that training and awareness of the EMC issues should be elevated to a high level *so that the promise and potential of the new ship is not compromised by poor system planning*.

Experience has shown that inevitable variations from ship to ship, even within a single ship class, pose difficult compatibility challenges. Modeling, analysis, or simulation of the environment are tremendously useful tools to predict performance of a baseline configuration. Nevertheless, they are limited by the continuous changes to the electromagnetic system which are approved and incorporated into the ship. In addition, the fidelity of the description of the EMC interaction is frequently lacking: a variation on the classic situation of bad (obsolete, inaccurate) input leading to bad (outdated, non-applicable) output.

What areas are affected? Emission characteristics such as: frequency, modulation type, power output, antenna type, antenna location, antenna neighborhood; sensor characteristics such as: bandwidth, sensitivity selectivity, filtering, frequency, antenna type; changes in ship infrastructure: shielding, bonding, and grounding integrity. [adapted from Shipboard Electromagnetics, P. Law, Artech House, Pub., Boston, MA, 1987.]

One popularized approach to the EMC topic is referred to as FAT-ID. The letters in the abbreviation stand for the main contributing attributes of the EMC problem: Frequency, Amplitude, Time, Impedance, and Dimensions. [D. Gerke & W. Kimmel, "The Designer's Guide to Electromagnetic Compatibility," EDN Magazine, Cahners Pub., Denver, CO, 20 January, 1994,.] These are the attributes on which greatest attention must be focused to achieve EMC.

EMC is threatened both by natural and man-made emissions. The natural emissions are relatively benign with the exception of lightning strikes. Man-made electromagnetic emissions, especially in a military environment, are an entirely different matter.

The simplest model to describe EMC is to the source-path-receptor model. The source is the emitting equipment, the path is the transmission media, and the receptor is the victim of the possible interference.   EMC system design is commonly broken down according to these three elements: the source will be shielded for reduced emissions, the path will be modified for attenuated transmission, and the receptor will be shielded to achieve reduced susceptibility.

Common EMC techniques are shown in Table 1.

Table 1. Electromagnetic Shielding Techniques

Active	**Passive**
Feedback controlled	Ducting
AC or DC fields	Eddy Current
	Conductor re-routing

General trends in ship electrical power (and importance of electrical power), ship size and electromagnetic interference possibilities are shown in Figure 1.

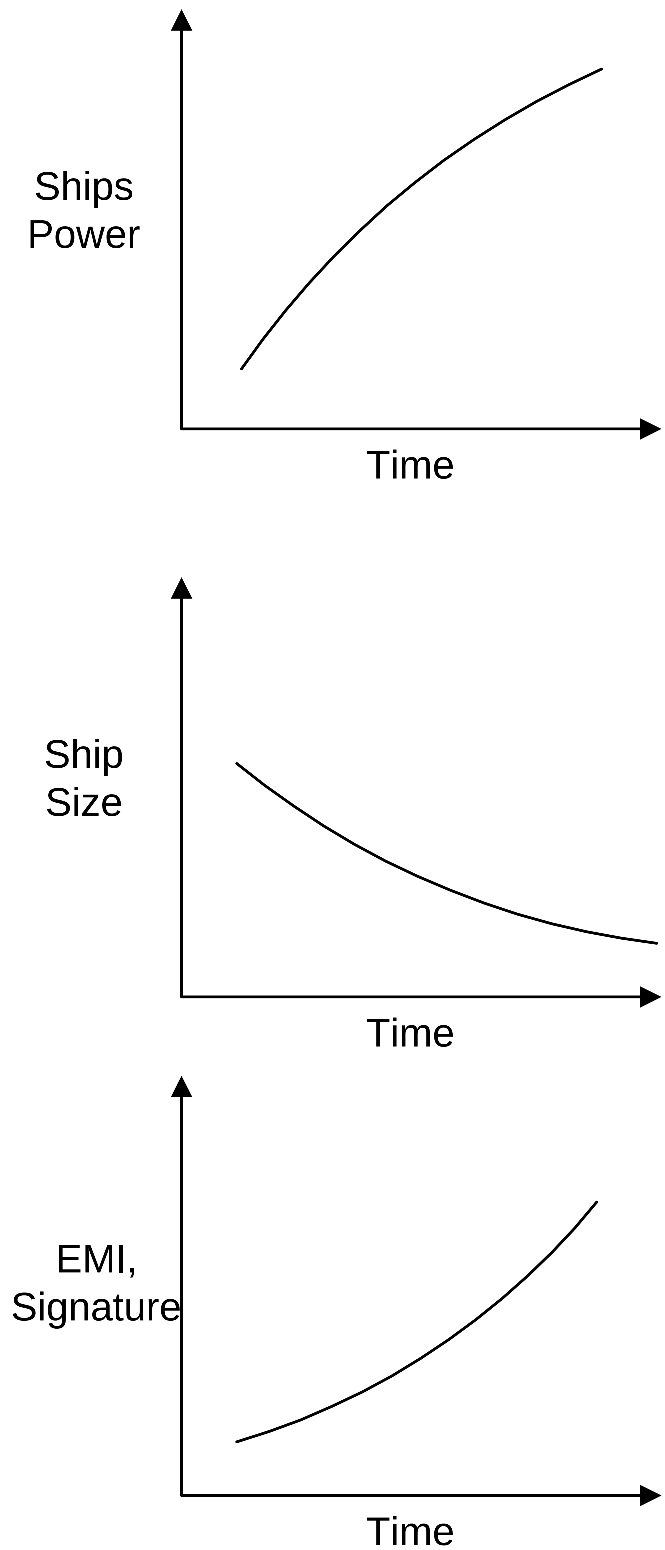

Figure 1. General Trends in Ship Power, Ship Size, and EMI Possibilities

Engineering Matter, Inc. personnel have had a great deal of experience relevant to the task of ensuring shipboard EMC. Table 2 shows a matrix of previous projects and technologies utilized.

Table 2. Engineering Matters Personnel Experience/Project Matrix

Experience / **Project**	**Distributed Power Processing**	**Electromagnetic Shielding**	**Specialized Electric Machines**
Aircraft Arrestor	✓		✓
Aircraft Launcher	✓		✓
Holloman AFB High Speed Track	✓		✓
Maglev System Design	✓	✓	✓
Locally Commutated Linear Synchronous Motor	✓		✓
High Speed Maglev Switch	✓		✓
Locomotive Propulsion		✓	
Electric Vehicle Shielding		✓	
Minesweeper DC Motor Controller		✓	
Minesweeper Circuit Breaker		✓	