1.0 THE NEED TO CONSIDER THE HUMAN IN SYSTEM DESIGN, OPERATION, AND SUPPORT

Despite advances in automation, there is a continuous need to examine the roles and impacts of humans in systems for both industrial and business processes. Furthermore, the attention to the human element should begin with the inception of design and continue through operation and support. Ideally, the team that develops a system or process should include someone with a human factors background or, possibly, an industrial engineering background. Actively considering the human element, beginning in design, has both operational and economic benefits.

Significant operational benefits can result from considering the impact of humans. Few people are aware that up to 70% of operational failures are due to human errors. One sees the consequences of human error in aviation in the form of accidents and near misses – "incidents." The consequences of human errors in automobiles and trucks are well known. Similarly, the impact of human errors in other modes of transportation, such as rail, is well publicized. In medicine, human errors can be life threatening. However, what is less well recognized is the operational impact of human errors in manufacturing. For example, in-plant assembly errors in automotive assembly also can be life threatening. For consumer products, improper design for humans can result in the loss of life or injury with attendant expensive product liability lawsuits.

Severe economic liabilities are associated with neglecting the human element. For example, 40% of in-plant rework is due to human errors, resulting in additional rework cost. Assembly problems due to human error, if they are not life threatening, can increase product costs and delay deliveries. In consumer products, both durable and disposable, inadequate design for the human element negatively affects customer satisfaction and consequently producer competitiveness. Recognizing that human errors affect competitiveness, as well as customer satisfaction and well-being, some companies have been persuaded to dedicate programs to the systematic reduction of human errors. Some of these are discussed in Sections 4.9 and 6.3.3.

Part of addressing the need to consider the human is resolving the management and "cultural" issues associated with merging the human-oriented engineers with hardware and software engineers. Factors that affect human performance tend to be taught only to psychologists and, to a lesser degree, industrial engineers. Other engineers, especially reliability engineers and system engineers, must develop sensitivity to human errors either by "osmosis" or unpleasant experiences. Consequently, a communications gap frequently exists between the human-oriented staff and the remainder of the staff. This gap can be eliminated in two ways:

- Improve communication between human factors experts and other design staff members by using multi-disciplinary teams and by cross-training human factors experts, reliability engineers, and other engineers.
- Improve awareness of project and corporate management.

Another part of addressing the need is to make it easier for development staffs to use human-oriented design techniques. Some design automation products are available and evolving to help ease the design burden.
The human can impact a system or process in many ways, as illustrated in Figure 1.0-1.

From Figure 1.0-1, it becomes clear that almost any human associated with a system or process can have a significant impact on the system. Not only are operations and development economics affected, but the support system and the cost of ownership are also influenced by the human element. Shortcomings in design frequently result in additional burdens on the support system in the form of increased training and staffing requirements, increased spares, and possibly significant changes to facilities. Inadequately designed human-machine interfaces tend to require increases in job aids such as manuals, on-line help, and pocket cards. Complex procedures usually translate into extensive training and frequent retraining (not a well-recognized fact). Poor design for maintenance by humans can result in faulty maintenance, maintenance-induced failures, and an increased need for spare parts.

The "bottom line" is that one must maintain a life-cycle view of the human impact on system performance, operation, and support that begins with the interpretation of customer requirements and continues through the disposal of the system or the dismantling of the process.