

United States Naval Research Laboratory

Inexpensive Radar for Through-Object Viewing

Design Issues Paper

Team 4

Ali Aqel
Michael Volz
Garrett Warnell
Scott Warren
Michael Weingarten

Facilitator

Dr. Terence Brown

Introduction

Designing a product requires those who design the product to take into consideration many issues that contribute to the success and public acceptance of the product. A team may consider the environmental impact when designing the product and address issues such as usage of sustainable materials, components constructed from hazardous materials, and clean disposability of the product at the end of its lifecycle. Safety can also be a consideration as the well-being of the product operator and those who come in contact with the product have a tremendous impact on the success of the product. Likewise, Lifecycle Management is an important consideration for any design as satisfaction in a product relies heavily on a product's ability to operate on day one, month three, or year five. In this document, these issues will be addressed in the context of the Inexpensive Radar for Through-Object Viewing.

Environmental Impact

A product's impact on the environment is a consideration that every designer must address. A product that harms the environment in any way could have negative impact on its acceptance, and in a world like that of today, this harm would create huge societal uproar. In a world concerned with being as green as possible, it is imperative to design products that waste little and damage little.

In designing a radar system, Team 4 made an effort to reduce emissions as much as possible and waste as little energy as possible. The amount of electromagnetic radiation emitted by the radar is minimal, thus it is nowhere near polluting levels. Since power emitted by the radar is low, the radar system also uses small amounts of energy. The radar also emits no air pollution and generates no waste products that take up precious landfill space.

There are areas where the environmental impact of the radar system can be improved. For instance, the radar contains components that contain lead. An

effort to find lead-free components could have been pursued, but the time and cost constraints of the project prevented such components from being used. Likewise, the materials used to construct the component encasings could have been with renewable, sustainable materials. Finally, the system could have been designed in a way that allows for easy recycling or reusing of individual components.

Safety

Safety is one of the most important considerations when designing a product. It should be noted that when considering safety, the safety of those operating the product as well those who are in the immediate vicinity of the product should be taken into account. Any design that fails to take safety into consideration will not only result in product failure, but harm to other human beings and the consequences that harm brings. These consequences not only include penalties of law, but the certain possibility of a lawsuit. As a result, failing to take safety into consideration could result in the failure of not only the design, but the parties involved in the design.

Thus, a sound design takes the precautions necessary to ensure the safest operation of a design of its type. This not only protects the product operator and those in the vicinity of the product from physical harm, it also protects the designer from the legal damage that can be incurred from a design lacking safety precautions. A sound design also makes an effort to warn the operator and other affected parties of the possible safety hazards of improper operation of the product. This added safeguard helps to protect the operator from safety hazards that the designer has no control over and thus helps to protect the designer from further legal damage.

Safety is an important consideration when developing a radar system and this was in mind when developing Team 4's radar system. Electromagnetic waves have the ability to cause damage to a human body (or any living organism), but the waves generated by Team 4's radar system fall well below the

levels that can cause any damage. A radar system also makes extensive use of electronic components that are interconnected in order to transmit and receive signals from the radar antennas and this, coupled with the modularity of the main components of the system, means that extensive amounts of wiring are used to connect the system modules and their internal components. This has the ability of greatly increasing the safety hazards of the radar system. Team 4, however, took this into consideration and isolated all electronic components and any possibility of exposed wiring into protective cases. These cases serve a double role as the basis of the modular system components. To protect from safety hazards that can arise from the wiring between the modules, insulated cables with industry standard connectors are used as to not expose any conductive wiring outside of the system modules.

Areas also exist where Team 4 could have improved in terms of product safety. A warning label system should be implemented in order to inform the operator and anyone near the system of consequences resulting from improper operation of the system. Warning labels should be placed on the power supply module to warn users that it should not be operated while uncovered as such operation could result in electric shock. A similar warning label should be placed on the radar electronics component warning of the unexposed wiring danger. Another safety consideration could have been made in regards to protection from the elements. For example, waterproofing the component modules would go far in protecting from electrical shock in case the radar is operated in the rain or other forms of precipitation. This would not only improve the safety of the radar system, but add to the operability of the product.

Lifecycle Management

Lifecycle management is certainly an important consideration for any design. It is one thing to simply design a product to specification, but it is another thing entirely to design a product with other stages of development in mind. Team 4's radar system was designed with some aspects of lifecycle

management in mind, but there are many areas where the product could be improved in this regard.

Product lifecycle management's primary concern is to stay in contact with the product during its journey from conception to eventual disposal. That is, the corporation creating a product should have a good idea of what is happening at every stage of development for that product. This information can then be used to analyze the product and improve it. For example, with product lifecycle knowledge, it would be possible to design a product "beyond" customer requirements by incorporating manufacturing, service, and disposal considerations into the design from the beginning. The radar system developed by Team 4 was designed with lifecycle management in mind. A design decision was made to separate the system into three logical components – power, radar hardware, and signal processor. Each component sits within its own box and the system is connected through cables. Such a modular design is very beneficial at many stages of product development. The system could have been designed with very little modularity – for example, every single hardware component on a single board within a single box. Such a design would complicate manufacturing, in that if even a small thing went wrong the entire system would be defective. With discrete, modular components, a small problem is confined to a specific module without affecting the others. This reduces manufacturing costs. In a similar way, the modular design also improves product management during its service phase. If a purchased system needs to be serviced at some point in time after the sale, a modular design allows for a specific problem to be more easily located. Repair costs would also be less, since it is likely that only a small portion of the system would need to be replaced. Modularity also benefits the product lifecycle during a redesign or improvement phase. For example, if it is determined that extra components need to be added to the radar hardware, it is only necessary to redesign the radar hardware module as opposed to the entire system.

There are also ways in which Team 4's radar system could be improved with respect to product lifecycle management. For instance, there is currently no

way to collect product data while the system is in the field. As mentioned above, this data can be invaluable to a redesign process in that it could help to suggest improvements and new features in a future design based on customer use. Therefore, perhaps an unobtrusive data logging component could be integrated into the software to record things such as target signal strength, radar environment, and frequency of use of the various provided features. This type of information could be used to guide iterative development of the system towards customer desires. It would also be beneficial to have service technicians collect data about the various reasons that the product requires service. Perhaps through such data, a commonly defective module could be identified and redesigned before its impact became too great. Information about the radar system could also be shared across a corporation through the creation of a “virtual” system, or a digital model of the radar. Such a model would allow those without access to the physical product to easily view the exact design topology. This information could also be augmented with the “log” information mentioned above to provide a complete image of the system and all data pertaining to it. Such a model would prove to be extremely valuable to those working in all areas of the product’s lifecycle.

Conclusion

In the design of any product many important considerations have to be made. In the design of Team 4’s radar system, product safety, product lifecycle management, and the environment were all taken into account. Great strides were made in making the design of the radar system conform to the demands of each of these design considerations. The results of meeting the demands of these considerations is a product that will last long, operate safely, and leave little impact on the environment.