Ethics Report | Emulation of Aerospace Actuation Systems

A Real-Time Controller Hardware-in-the-Loop Platform for Emulation of Aerospace Actuation Systems

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Summary

The Emulation of Aerospace Actuation Systems Project is an effort funded by Woodward, Inc. to validate an electrical drive alternative to replace the pneumatically/hydraulically operated Thrust Reverser Actuation Systems (TRAS) currently deployed on commercial and military aircraft. This project will interface a TI TMS320F28379D microcontroller with an OPAL-RT real-time processor to emulate several electrically driven aerospace actuation scenarios using a controller hardware-in-the-loop (CHIL) platform. Team members will program both the TI board and the OPAL-RT system in C to read/write synchronized digital and analog signals that reflect the behavior of real mechanical motors and drive systems located in a physical testbed at the Aerospace System Emulation and Test (ASET) Lab at the CSU Powerhouse. In addition, the team will produce a detailed system model of the code and associated testbed hardware using the principles of Model Based Systems Engineering in Cameo Systems Modeler. The overall product to Woodward, Inc. is a well-documented system model and thoroughly tested code package that can safely interface with the ASET testbed for the next phase of project validation.

Why is This Project Important?

The trend towards More Electric Aircraft (MEA) is expected to revolutionize the aerospace industry in the coming years, with promises of reduced weight, maintenance, and additional data analytics for real-time system prognostics compared to traditional drive systems. To verify these claims without incurring tremendous R&D costs to the customer, a CHIL platform allows for emulation of an expensive physical system using inexpensive software to test the behavior and benefits of an electromechanical TRAS.

Part One – Toshiba Accounting Scandal Analysis

The primary ethical dilemma in the Toshiba accounting scandal was certainly the illegitimate reporting of corporate profits by employees to satisfy their superiors. Accountants and executives and Toshiba conspired to book future profits ahead of time, push back losses, charges and other such techniques that directly violated ethical restrictions imposed on corporations to report truthful and accurate financial metrics. However, this is a more complex issue than it may initially appear. Toshiba's corporate culture in general enforced a "strict obedience to superiors, enabl[ing] fraudulent accounting practices," according to Investopedia [1]. Corporate leadership at Toshiba were adamant that the company would meet strict profit targets (called "Challenges") at all costs, even when there was clearly no time left in the fiscal term for that target to realistically be met [2]. More and more, Toshiba leadership was enforcing unethical and unreasonable requirements on their staff to the point that the only option, in their minds, was to lie about the company's success to preserve the company's image and, perhaps more importantly, their jobs.

Toshiba was found out after years of fraudulent financial reports by an independent investigation firm that was hired by potential investors when the company kept insisting that their own investigations should be sufficient for investors to want to engage with them in business [3]. This case goes to show the nuances of ethics as it pertains to race and culture. In Japan, it is considered shameful for any high-ranking Japanese businessperson to have to report negative information. This directly led to the string of CEOs who purposefully enacted policies that enforced what would inevitably result in reports of financial success, regardless of the ethical implications associated with those reports. In addition, there is a very strong emphasis on deep respect for authority in Japanese culture. This directly led to the individual contributors in the organization feeling pressured to find any solution to their superiors' harsh demands that would satisfy them, even if that meant a huge breach in ethics. A large part of the entire scandal was because of the pressure all Toshiba employees faced in their specific cultural environment [4].

After the Toshiba scandal, many recommendations were made by the investigating firm and many others to reform corporate culture by introducing robust whistleblower systems, eliminate the mandate of unrealistic profit margins, and create a stronger internal control/governance system within the corporation to track and identify these types of issues before they happened [3]. But beyond these solutions, this type of ethical violation can be prevented in the future by installing executives that come from diverse cultural backgrounds to allow for open-minded problem solving rather than a unified attempt to reach profit margins in an appropriately "Japanese" or other single-culture way.

In addition, this specific situation goes to show how important it is that corporations are always checked by independent third parties who have their own ethics system to judge by. The Toshiba scandal would never have been discovered if investors from other countries and backgrounds sensed something fishy and dug further. It is critical for every aspect of a company, from CEO to stakeholder to customer, to feel that they are acting within an appropriate ethical code. Perhaps if each industry prescribed to a certain set of ethical considerations in their daily dealings that transcended cultural predispositions, scandals like this would be much less frequent and much more difficult to cover up. Society needs to work on creating an environment where anyone in a corporation feels that they can speak up against unfairness and act with integrity.

This violation is very interesting because of its specific ties to a different type of corporate culture. While it's clearly irresponsible to push employees towards unrealistic financial goals and cause them to have to choose between professional stability and cultural integrity, it is nonetheless a glaring reason for diversity in the workplace.

Part Two – Ethical Issues Related to Our Project:

The CHIL platform as it is being designed is intended for use by CSU students and faculty who would like to emulate a system on a CHIL platform to validate their design before purchasing expensive parts and equipment. This directly supports the IEEE Code of Ethics in its goal to "improve the understanding of individuals and society of the capabilities and societal implications of conventional and emerging technologies," specifically as this platform is being used to verify an EM-TRAS system that may change the way aircraft operate globally [5].

By creating a system that allows researchers and engineers to validate their system completely virtually before ever requisitioning parts and materials, this project is eliminating waste generated by improper planning and/or insufficient understanding of the system requirements. This is an important factor when considering any engineering product because anything electronic generates a considerable amount of waste both in production, during use, and after consumption.

One potential source of ethical concern is the fact that for this project to successfully allow both in person and remote operation of the CHIL platform, the OPAL-RT machine must always remain powered. The powerhouse is a "100,000 square-foot green building that is a model for sustainable building practices," but a building of this size still draws a significant amount of power, and the OPAL is a large machine. There is a tradeoff between creating this accessibility for research while also still consuming large amounts of power, and as engineers, it's important to assess whether this tradeoff is justified [6].

All products, buildings, and energy-consuming items in the US and most countries are governed by specific energy efficiency standards and targets called minimum energy performance standards (MEPS). In some cases, products cannot be sold, and buildings cannot be created if they are less efficient than a minimum level. The ANSI/ASHRAE/IESNA1 Standard 90.1 specifies requirements for designing commercial buildings for maximum energy efficiency compliance [7]. This standard regulates how fan power, condenser heat recovery, and IT equipment power load should be handled and distributed. The highest point of concern for IT equipment power load is 10 kW in this standard, and the OPAL-RT falls far below that, so our project is not in conflict with this standard.

No major conflicts arose during this project. Conflict resolution skills employed in this project were mostly needed during periods of miscommunication. Due to the variety of tasks being undertaken between the CHIL element of this project and the other Woodward projects related to EM-TRAS, the scope of the project was often changing or unclear. Graduate students involved with the project were not always available to support the team and needed more frequent prodding to provide the requisite support. There was also a question of ethics from a teaching perspective. For instance, work had previously been performed by another student to identify the proper way to write code that would interface with the microcontroller. The team and advisor all faced an ethical dilemma of whether it would be acceptable to bypass the learning process associated with senior design work for the sake of time savings. In the end, the decision was made that it would be acceptable, although a delayed response from the graduate student who was meant to provide the code made it so that the team spent the extra time learning how to interface with the TI from scratch. The goals of the semester were still achieved, albeit at a slower pace than expected, but the learning that came from spending those additional hours understanding the code and reasoning behind it made for a better overall understanding of the system.

References

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