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RADBOT – Project Management in an Interdisciplinary Capstone

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Abstract: The Defense Threat Reduction Agency (DTRA) sponsors an interdisciplinary Capstone annually at the United States Military Academy to develop an autonomous, radiation detecting, and mapping robot known as RADBOT. There are four separate functional areas represented to include Systems Engineers. This paper identifies the nuances of managing said project while operating in a weak, matrix structure organization. The authors found that project task organization required more analyzing than expected in order to streamline communication. Furthermore, this paper details how the System Engineer Project Managers analyzed and executed risk management. It concludes with an emphasis on how project continuity will be delivered for future years' members.

Keywords: Project Management

1. Background

Cadets Davis and Ogunsanya worked with a group of students in the Nuclear Engineering Department, Electrical Engineering Department, and Computer Science Department to develop a semi-autonomous radiation detecting robot (RADBOT) for the Defense Threat Reduction Agency (DTRA). Team RADBOT's mission is to develop a modular system for unmanned devices that supports the semi-autonomous navigation of unknown environments and the simultaneous localization and mapping of radiological and nuclear information in real time. This robot will tremendously reduce risk to soldiers operating in radioactive environments and revolutionize the way that intelligence is gathered.

1.1 Functional Groups

The functional areas within the project are made up of four different groups as outlined in Figure 1 below. Each of these groups refers to a different academic field that the cadets are majored in. PANE is the Nuclear Engineering department, EECS is the Electrical Engineering department, CS/IT is the Computer Science & Information Technology department, and DSE refers to the Systems Engineering department. Each of these cadet groups answer to different faculty within their departments and receive different graded events from their corresponding instructors. Although it is largely administrative, these divisions amongst functional areas create conflicting demands on the RADBOT group. This type of matrix project structure, where project members report to higher ranking functional area individuals, creates a unique environment for project managers with lesser influence.

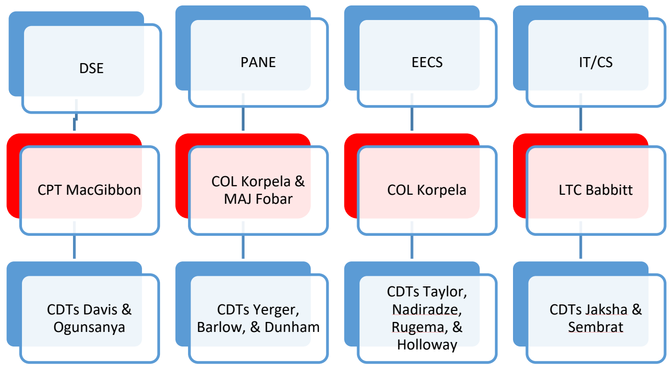

Figure 1. Functional Groups

1.2 Organizational Project Structure

The Project Managers (PMs) task organized the team into two groups, each headed by a PM. This enables each functional area to pursue separate tasks concurrently to further the overall end goal of the project. Each of these subgroups pursue complementing goals that, when completed, will result in the completed version of the project. Initially, we decided to create these groups as outlined in Figure 2.

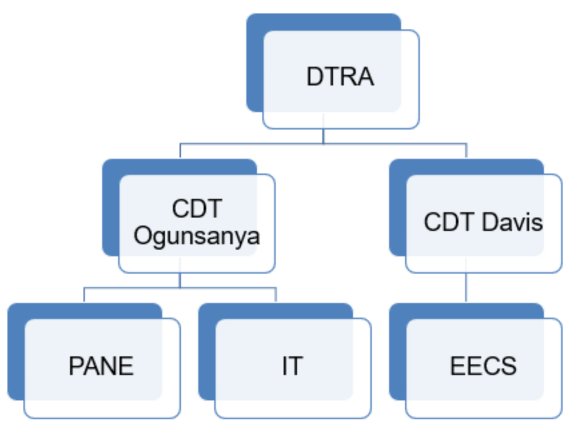

Figure 2. Original Project Structure Matrix

We found over time that the scope of CS/IT and EECS overlapped, and PANE worked mostly separately from the other groups, which was different than expected. Once this was understood, we re-organized the project structure as outlined in Figure 3. This made better use of PM time due to less overlap in PM responsibilities and reduced friction, enabling communication to become more efficient.

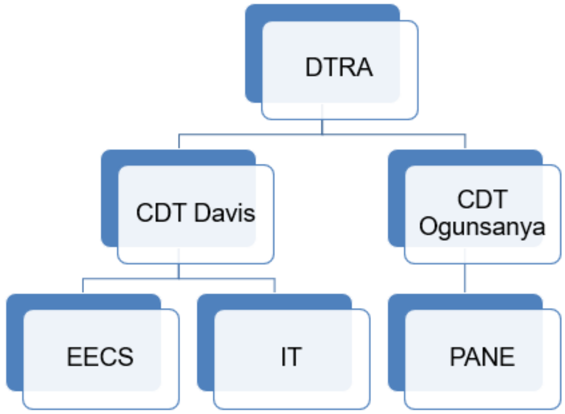

Figure 3. Updated Project Structure Matrix

2. Scheduling

An important task for the project managers in this project was developing schedules. The two PMs had to be in constant communication with each other to ensure that the tasks were on schedule. This is because of several different tasks between each group being dependent on previous tasks from other groups being completed. Also, certain tasks required sole access of the robot to a group which made proper scheduling a necessity. This made the robot a limiting resource and proper scheduling of this resource was necessary in completing project goals on time. This leads into the project organizational structure between the PMs.

To maintain this communication between project groups, the PMs lead a team huddle at the beginning of each working period to discuss what each group must do for the day, what they accomplished previously, and if any adjustments need to be made to the schedule. Then at the end of each working period, the PMs met alone to discuss any scheduling conflicts between each of their groups and rework the schedule if necessary. These meetings minimized the miscommunications and misconceptions that occurred between the groups working on the project and clarified any misunderstandings that may have been occurring.

3. Risk Assessment

To identify risk factors that could negatively impact our project and the stakeholder's goals, we conducted a brainstorming session for possible hazards with our individual teams. After this was conducted, we gathered to discuss lists of possible risks, potential responses, and causes of the risks for the overall project. To do so, we sought subject matter expert opinion from the cadets in each department along with the faculty assisting them and spoke about how and why issues in the project could arise. Next, we built a risk matrix diagram to plot the likelihood of each risk along with the consequence severity as diagrammed in Figure 4.

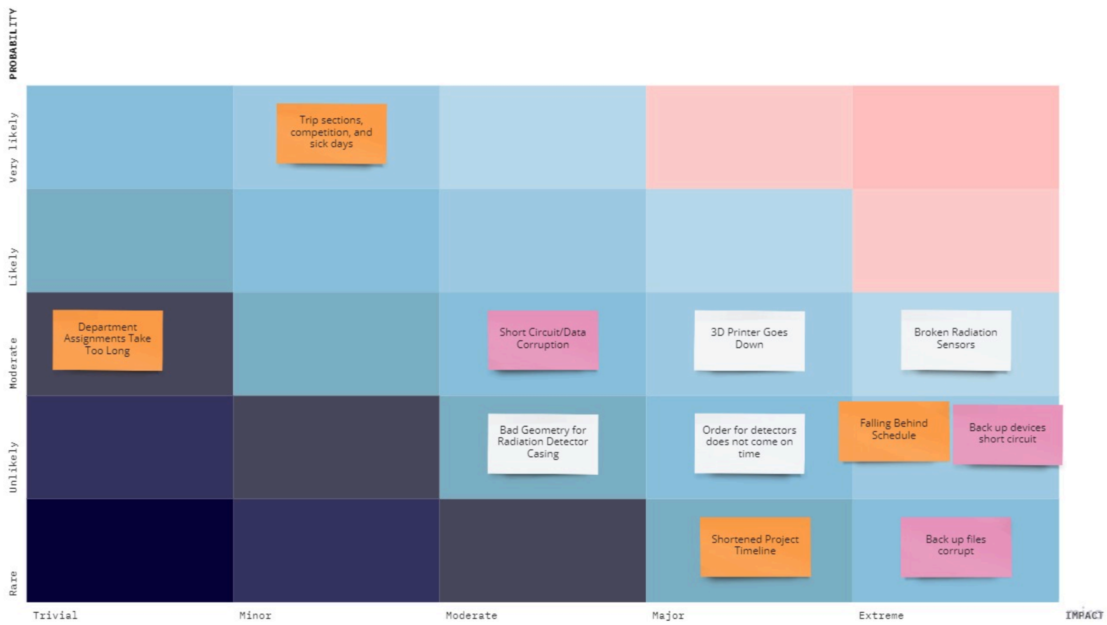

Figure 4. Risk Assessment Matrix

This was beneficial because it allowed us to address the risks with higher probability and severity, and plan a course of action for the risks occurring. When conducting this analysis, we identified that our most significant risks were the arrival of broken/unusable radiation detectors and the 3D printer going offline.

As Project Managers, we analyzed each individual risk and developed appropriate responses. For the first risk of the arrival of broken/unusable detectors, our only appropriate response given our time constraints were to use our existing detectors. The ramifications on the project are that the existing sensors are heavier than the new ones, which has a negative impact on the robot's overall performance.

The next risk identified was the 3D printers going offline, this occurs relatively often with the amount of traffic the 3D printers see as the printers are not used solely for this project. We accepted this risk since we did not have the capacity to buy a new 3D printer and mitigated the negative implications by planning for extra time in the creation of the 3D printed parts along with time dedicated to reprinting these parts should they not meet the specifications or break.

These decisions were made due to the nature of working on a continuation project and not wanting to burden our group's successors with problems when the project is picked up. Following our risk matrix creation, we also created a fishbone diagram to analyze the risks to determine their underlying causes as shown in Figure 5. This allowed us to have another visualization of the risks associated with each of the six possible points of friction within the project. It was also beneficial in briefing project risk to the head of the functional groups and our stakeholder.

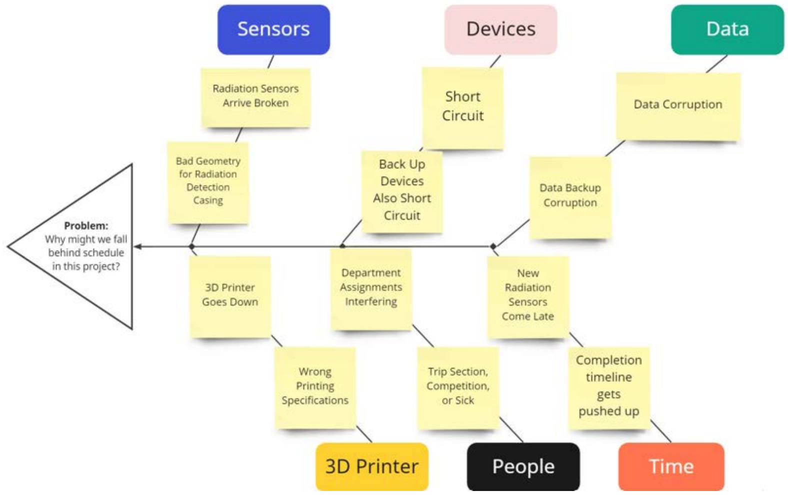

Figure 5. Fishbone Diagram

3.1 Risk Assessment Results

We believe that the Risk Matrix was beneficial for our group because one of the key risks we identified early on actually occurred. In our analysis, we determined that a possible risk for our project was the radiation detectors arriving broken or delayed. Identifying and planning for this risk in the earlier stages of our project allowed us to have a course of action to follow when our radiation detector order was cancelled. Although this slightly hindered our project's scheduling, it would have been at a greater magnitude had we not planned and mitigated the risk.

4. Continuity

This concept of continuity is highly valuable in the RADBOT project as our group received the project from a team and will pass it on to a new team starting next academic year. We define continuity as the documentation of the work completed on a project and how it is completed. This helps aid the transition of a project from one working group to another. A few attributes of continuity are organization and in-depth recording of work completed (Loomba & Mavroleon, 2013). This allows the new group receiving the project to have access to all the information about the existing work completed, allowing them to pick up where it was left off. This also decreases disruption in project timeline and reduces friction in a project due to the ability to revert to the most recently documented version of the project.

In assuming this project, we had several issues in finding out where the project was at in its lifecycle and what work needed to be completed. A lot of time was spent searching through these documents. To prevent excess search time when the next team assumes the project, the PMs have heavily emphasized continuity. Team RADBOT has detailed written notes on each working day of the project down to what exactly each group accomplished and is working towards. Along with this, we have data stores specific and organized by functional area to be passed on to ease the transition. All these continuity documents are housed on the RADBOT Microsoft Teams page and GitHub. This will allow the next team working on the project to easily pick up where we left off without having to spend time searching through old folders, resulting in a smoother transition on the project in the next academic year.

5. Conclusion

Organizational project management structure was an important detail in smoothly scheduling tasks and ensuring completion of these tasks. It allowed the PM's to effectively coordinate with one another and ensure each functional area within the project had the necessary resources to stay on task. A risk matrix we made early on also proved to be very beneficial; we were able to refer to our risk management plan that we created early in the project when our new sensors did not arrive. Throughout the lifecycle of this project, we found that continuity is necessary in creating a smooth transition from one project year group to the next. To emphasize this, we left documentation of our daily work, huddles, and a description of why the continuity portion of the project should be continued in an organized manner so it maintains momentum after this iteration of the project. This will allow for a seamless transition into next academic years. All these factors that contributed to the successes and setbacks of the project have been documented to provide a strong starting point for the group that assumes the RADBOT project.

6. References

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