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Overwatch

Proposal for a Tailored Inventory Control Solution

Introduction

The engineering college at Florida Atlantic University is a mess. More specifically, the lab setup for the Engineering East building is a mess. Like most colleges and some businesses, the building is the site of a cold war between professors and faculty members, with professors struggling for funding and territory and faculty struggling to provide for students. In this conflict, it is the students who lose. One center of this conflict is the inventory of the lab manager's office. Stabilizing and bringing this inventory under control could go a long way to defusing some of this conflict and bring greater value to the students. In the following pages is presented a carefully considered argument based on an insider's view of FAU's engineering college, proposing a precision-engineered solution to a problem so complex that only several years of immersion within the procedures and politics could provide a deep enough understanding. The engineering college is a mess and Overwatch is designed from the ground up to fix that.

Context

For the motivated engineering student, the office of lab manager Hank Van Sant is a goldmine. The office itself is divided into two sections: Mr. Van Sant's actual office, and the Senior Design Lab. The Senior Design Lab is a small but complete workspace open to all engineering students and stocked with a vast array of cheap, disposable surplus parts and assorted scraps, all provided for students to use at their discretion.

Next door is Mr. Van Sant's actual office. Far more than the typical desk, chair, and PC, Mr. Van Sant's office is filled with drawers and containers stocked with every tool, microchip, sensor, and electronic component imaginable. The office itself is kept locked, with a counter next to the door where students can come and request parts and tools. These items are generally more valuable or limited than those found in the Senior Design Lab, and as such are loaned out for class projects with the expectation that the parts will be returned after the project is graded. It is here, where Mr. Van Sant loans parts to students, that the conflict arises.

The interested parties in this situation can be divided into four groups, each with their own needs which, when compared, make the inevitable conflict obvious. The first group is probably the simplest, largest, in theory the most powerful, and in practice the weakest. Students, of course, make up this group. They need free and rapid access to the vast collections in Mr. Van Sant's office in order to complete the rapid prototyping tasks necessitated by FAU's curriculum.

The next party, Mr. Van Sant himself, traditionally wields the most direct power over the inventory in his office. Mr. Van Sant, or one of his student assistants, is who students interface with directly when they need to loan out parts. It is Mr. Van Sant who decides what parts and tools go to whom, traditionally to his own discretion with minimal accountability. Being the generous sort who wants to help the students, Mr. Van Sant is more than happy to provide students with anything they request (H. Van Sant, personal communication, November 5, 2014).

Next, we consider the Professors. This group is largely responsible for raising the conflict, though perhaps is justified in doing so. Professors, to be blunt, all have their own agendas and most of them are not geared towards providing value for students or even FAU as a whole. Professors receive specific funding and make purchase decisions to their own discretion, sometimes electing to purchase bulk supplies that they task Mr. Van Sant's office for storing, tracking, and distributing to students (H. Van Sant, personal communication, November 5, 2014). In this case, professors sometimes press the argument that they alone, not Mr. Van Sant, have the authority to decide which students can and cannot use the supplies purchased with their funding allowance. Regardless of how valid this argument is, the importance of professors to FAU makes their turf wars beyond reproach and something to be observed and accounted for.

The final group suffers a great disproportion of responsibility versus power. That is to say that Teaching Assistants are held responsible for far more than they really have the power to control. Lab teaching assistants are responsible for distributing supplies and parts to students of various lab classes, and ensuring that these parts are always available. Some teaching assistants have limited purchasing authority for replenishing supplies, but are held responsible for where all these parts go (P. Pastran, personal communication, September 8, 2014). Parts that Mr. Van Sant has the authority to distribute to his own discretion for the benefit of students but to the detriment of teaching assistants and ire or professors. With the last group connected, we see the heart of the conflict: Mr. Van Sant distributes inventory to students that teaching assistants are held accountable for and that professors claim authority over.

Making a sticky situation worse is how Mr. Van Sant keeps track of where the inventory goes as it is loaned and returned (P. Pastran, personal communication, September 8, 2014). Effectively, he does not. While a basic inventory control has been mostly implemented, it is an ill-fitting solution that has largely been rejected by Mr. Van Sant and his assistants (H. Van Sant & K. Hibbert, personal communication, November 5, 2014). Instead, loans are documented on a legal pad with the students' names and e-mails scrawled alongside a cryptic note of what was loaned (H. Van Sant & K. Hibbert, personal communication, November 5, 2014). This legal pad is also used for more general note-taking,

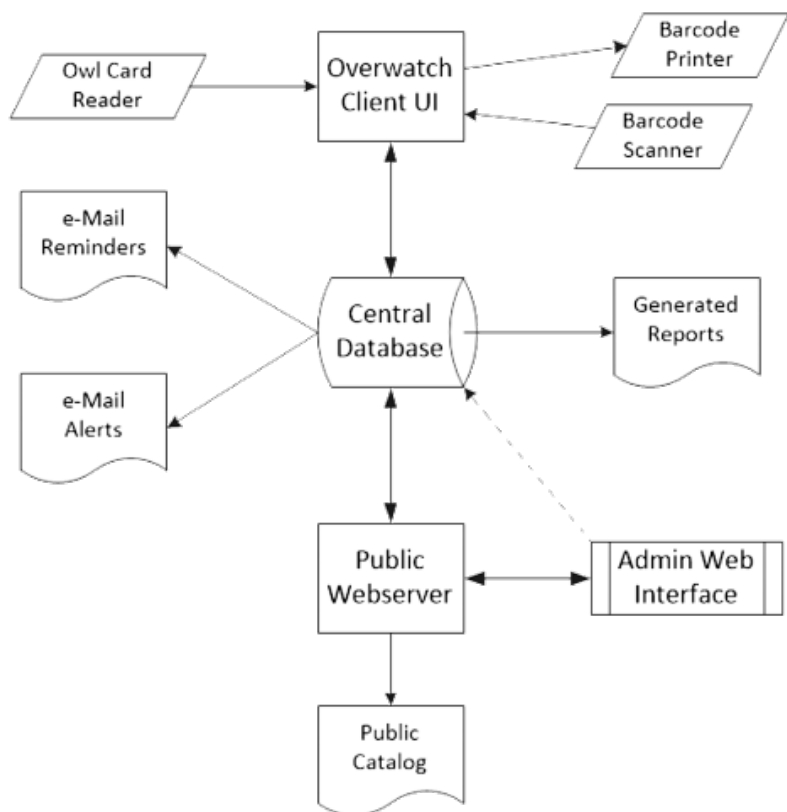
and sometimes goes missing, requiring Mr. Van Sant and his assistants to record these notes on loose papers. This system, such as it is, provides minimal reliability and effectively no accountability or actual inventory management.

This is the problem that Overwatch is designed to fix. Overwatch is a carefully designed, tailored, and tested inventory control system designed to perfectly fit this unique situation. It has been designed with the needs of each group in mind, and refined with input from the potential users of the system. It compensates for the political tension and is careful not to eliminate any authority from any user.

Technology

The heart of the Overwatch system is the central database. A secure Oracle SQL database keeps track of all inventory, users, and loans of inventory to users. The database would be composed of four separate data tables, each cross-referencing each other for simple maintenance and efficient querying.

The first table, Inventory, is the largest and most heavily queried. It contains entries for every different type of item in Mr. Van Sant's office. For each entry, there are five fields of data identifying that item. The first field is nothing more than the name of the item, just detailed enough to be human-readable, for example "Arduino Uno r3" or "MSP-430 Launchpad". The second field is the quantity of this type of item, which is simply decreased every time an item of that type is loaned out and increased every time an item of that type is returned. The third field contains the status of that type of item, regarding if there is a hold placed on it and who placed it, the purpose of which is detailed below. For the fourth every new entry to the Inventory table receives a completely unique numeric ID code. This ID is the key value of the table, and ensures that every entry is completely unique. The ID is also the value used for the bar code labels to be placed on every individual



Inventory	People	Loans
Name	Name	Person
Quantity	e-Mail	Item
Status	Owl Card Hash	Date
UUID	UUID	UUID
Description		

item. Lastly, as an optional feature to benefit students and less experienced faculty, each type of item can receive a text description for such details as device specifications, description of functionality, etc.

The second table, People, is strictly for Overwatch's internal record keeping. For reasons detailed below, Overwatch does not have access to FAU's existing databases of student information and must build and maintain its own in order to avoid storing any legally protected information. This information is all stored in the People table, sorted into four data fields. The first field is, not surprisingly, the full name of the student for human reference. The second field stores the student's FAU e-mail address for the purpose of sending automated reminders to return borrowed supplies or contacting the student if there are any problems. The third field contains the hash of the student's Owl Card magnetic strip number. Simply put, a hash is a form of encryption that can only go in one direction. Given the contents of an Owl Card's magnetic strip, it is easy to find the unique hash value and find that hash value on the People table, but with only the hash value itself it would be impossible to reveal the student's Owl Card number. In the unlikely event of a security breach, an intruder would find no private information in Overwatch's database. The fourth and final field is somewhat more analytical, containing a sort of reputation score for that student. For every item borrowed from the lab, that student's reputation score is increased. For every item returned in good condition, the reputation score is decreased. In this way, Overwatch provides a simple mechanism for identifying students who may be attempting to abuse the loan system to keep expensive supplies indefinitely or are especially careless and damage an abnormally large amount of supplies.

The fourth table, Loans, is the linchpin of the database and is where Overwatch provides its core value. Every time a student takes out an item on loan, a new entry is created with four fields. The first field is a reference to the student from the People table who borrowed the items. The second field is a reference to all of the items from the Inventory table that are being borrowed. The third field is a time stamp containing the date and time of the transaction, allowing Overwatch to track how long each student has had each part and send timely reminders to return the supplies when through using them. When an item is returned, the record of that loan is deleted from the database to keep the Loans table compact and responsive, but not before being appended to a comprehensive log file for archiving.

The face of Overwatch is the user interface or, more accurately, three user interfaces carefully tailored to suit each user group. The first and most powerful interface is the client GUI. Implemented as a desktop application, the client GUI is the essence of minimalism. A familiar “what you see is what you get” Windows interface visualizes the inventory in a way similar to the Microsoft Excel spreadsheets that make up the bulk of Mr. Van Sant's computer experience. This interface, while light on eye candy, provides all the information required for directly managing lab inventory and documenting loans and returns.

The client GUI enjoys a handful of faculties unique to this interface, allowing it to function as a sort of point-of-sale terminal with no money. While the client GUI runs on the counter PC, connected to the PC are three different USB devices: A magnetic card strip reader, a bar code scanner, and a bar code printer. When amending the inventory, the client GUI automatically prints out the required number of

self-adhesive bar code stickers for the new equipment. When a student needs to take out supplies on loan, the students simply swipes their university-issued Owl Card through the magnetic strip reader, while Mr. Van Sant scans the bar codes on each item being taken out. The process is repeated for items being returned.

The second interface is designed for student access. With the complete inventory stored in an SQL database on an Internet-connected server, a public webserver would provide a simple webpage accessible to students, allowing them to see a complete list of all supplies available to them, as well as the descriptions of those items, if available. This would help the students by keeping them informed of all the resources available to them, while reducing the workload of Mr. Van Sant's office from students coming in and asking for specific things that may or may not be available.

Lastly, the webserver provides a second webpage for professors and teaching assistants, secured behind a username and password provided for each professor and their respective teaching assistants. This page is very similar to the public student webpage, except with the additional functionality of placing holds on specific items. When a professor or a teaching assistant places a hold on an item in inventory, it is recorded along with who placed the hold. When a student attempts to take out a held item on loan, Mr. Van Sant is informed of the hold and who placed it and required to swipe his own Owl Card to verify his approval of the loan. If Mr. Van Sant chooses to approve a loan after being notified of a hold, the professor or teaching assistant who placed the hold is sent an e-mail notification of the transaction including what held item was loaned, to whom, and how many of that item remain.

This last interface is perhaps the most crucial aspect of Overwatch. While loans remain completely to the discretion of Mr. Van Sant's office, accountability is applied and professors and teaching assistants are able to directly monitor the flow of inventory in and out of the lab. In this way, Overwatch does not change who has the authority to make decisions, while adding accountability to which decisions are made.

Behind these three interfaces is a program running on the webserver and providing simple automation and generating detailed reports. A weekly report is generated regarding all inventory that has been loaned out and what has been returned, rendered into a neatly compact but informative document and e-mailed to Mr. Van Sant as well as any professors or teaching assistants who request the information. Once a month, a more comprehensive report is generated including a compact log of all changes in the inventory, statistics regarding the distributions of these changes and the reputations scores of students. This report would especially highlight any definite trends or anomalies in student reputation and borrowing activity, providing professors and faculty with as much information as possible to assist in their decision making process. Also on a monthly basis, Overwatch sends reminder e-mails to students who still have parts that need to be returned, reminding them of exactly what parts they borrowed, when, and that they are obligated to return them as soon as possible.

Competitive Environment

The competitive environment for Overwatch is fairly straight-forward and bodes well for adoption of the system. Three years ago, Mr. Van Sant maintained his own flavor of inventory control by keeping a simple Excel spreadsheet of students, what they borrowed, and when they borrowed it (H. Van Sant, personal communication, November 5, 2014). While not a perfect record, it served the purposes of Mr. Van Sant's office perfectly without hindering students. Unfortunately, this method was not suitable for professors or teaching assistants, since they had no access to the record.

In an attempt to improve upon the spreadsheet solution, Dr. Hari Kalva assigned one of his graduate students to design and implement an inventory control system to his own specifications (H. Kalva, personal communication, June 1, 2014). This system involved a database controlled and accessible only by Dr. Kalva or those he granted accounts to. Students could then go to a webpage, hosted by Dr. Kalva, complete a digital part request form, print out a receipt, and bring the receipt to Mr. Van Sant's office to have their order filled (K. Hibbert, personal communication, November 5, 2014). This solution suits the needs of Dr. Kalva perfectly, but it has some flaws. Mr. Van Sant was never given an account so neither he nor his assistants were able to fill orders. Most students were not able to access the system or were unable to print their receipts, and the vast majority of students were simply unaware of Dr. Kalva's system. These technical flaws, combined with the elimination of Mr. Van Sant's discretionary authority, led to a complete rejection of the system by Mr. Van Sant, the students, and the teaching assistants (H. Van Sant, personal communication, November 5, 2014). While Dr. Kalva certainly stands among those to the gain the most value from the widespread adoption of any inventory control system, the fact that Overwatch constitutes direct competition with his own privately-designed system could incite resistance against full adoption of the more neutral solution.

Because inventory control is such a common need, there are dozens if not hundreds of inventory control systems already on the market. Unfortunately, none have been found to suit the unique situation of FAU's engineering department. Most commercial solutions are closed source, meaning that the system will be unable to evolve or improve to better fit changes in the department. Overwatch, being open source, is capable of being improved and advanced indefinitely. Furthermore, most inventory control systems are geared towards commercial applications, keeping track of inventory being bought and sold. This is a poor fit for FAU's situation, where transaction are very similar to a point-of-sale scenario, but there is no money being exchanged. Lastly, there's the great benefit of a roll-your-own solution that the Overwatch system is design with flexibility in mind. By using a modular design and common, open standards like SQL databases, expansion of the Overwatch system or integration with other system is as simple as granting other applications at FAU access to Overwatch's various SQL tables.

Economics

While the software is being developed, installation will be performed, and training will be provided all free of charge, the hardware requirements of the Overwatch system mean that there will be some cost associated with the implementation and upkeep. The engineering department's own Technical Service Group (TSG) has stated that they prefer purchasing hardware from Newegg Inc. (M. Neelakanta, personal communication, November 10, 2014), and because TSG would be responsible for

purchasing and maintaining the hardware, all price quotes will be from this source if possible. The first of the three point-of-sale devices is a USB bar code printer. There is great flexibility regarding brand and model, so long as it is able to print a self-adhesive bar code label as small as 0.3 inches across. This specific dimension comes from the width of a DIP microprocessor, the smallest item in Mr. Van Sant's current inventory. Newegg has several brands and models for sale that fit this requirement, with prices ranging wildly from \$100 and up (Newegg, November 10, 2014). Virtually any one approved by TSG would suffice.

The second point-of-sale device is a USB bar code scanner. While there are some especially cheap models available from Newegg for under \$50 (Newegg, November 10, 2014), they lack many small features that would improve usability and functionality, such as wider scanning ranges, support for more encoding standards, and a hands-free stand to improve efficiency of scanning multiple items very quickly. Preliminary tests have already been performed on the Motorola Symbol LS2208-SR20001R, but unfortunately this model has recently been discontinued. The model has since been replaced with the Motorola LI2208-SR6U2100SGN, which features similar features in a more compact unit for \$120 (Newegg, November 10, 2014).

The final piece of point-of-sale hardware is a USB magnetic strip card reader. Newegg again offers a wide array of brands and models that would be suitable for reading the 3-track magnetic strips on FAU Owl Cards, with an average price of \$50 (Newegg, November 10, 2014), and again virtually any model approved by TSG would suffice. All together, this brings the initial cost of a point-of-sale setup for the Overwatch system to \$270, approximately \$300 including shipping costs, assuming that no educational discounts are available.

After the initial expense of point-of-sale equipment for the counter in Mr. Van Sant's office, and neglecting the expense of replacing that equipment should it be damaged or malfunction out of warranty, the only recurring expense of the Overwatch system is the expense of hosting and maintaining the inventory database and webserver. While this could potentially run into over \$100 per month, FAU's engineering department already boasts a powerful and versatile system of virtualized cloud servers configured for hosting databases and websites for institutional and educational use. Setting up a new webserver and SQL database would be fairly trivial and contribute no appreciable expense or burden to TSG, the office responsible for maintaining these cloud servers (M. Neelakanta, personal communication, November 10, 2014).

Negligible costs aside, Overwatch would cost FAU a one-time expense of \$300. This is a fairly sizable investment compared to the chief competition, which is free but limited in other ways, but even the greatest of expenses are justifiable if they can expect a rapid return on investment. According to the records of Mr. Van Sant's office, \$2,000 in Arduino microprocessors and related, expensive supplies were purchased in bulk less than a year ago. Today, barely a quarter of those supplies are still in stock, and the only records of where they've gone are a handful of names scribbled on a legal pad. When interviewed, even Mr. Van Sant was unsure of how accurate that record may be (personal communication, November 5, 2014). One of his assistants, when asked to estimate the accuracy of the

records he himself had been writing down, estimated perhaps 50% accuracy (K. Hibbert, personal communication, November 5, 2014). A cursory review of the record found numerous errors and entries that were too cryptic to identify the meaning of. It is most likely that less than half of the inventory will be recovered, meaning that \$1000 or more in supplies has hemorrhaged out of FAU in less than a year, never to be seen again or used by more students.

While the lack of reliable records means that these figures are crude estimates at best, the point remains that without a means of accurately tracking inventory, there is no way to ensure that inventory will ever be returned (P. Pastran, personal communication, September 8, 2014). When Dr. Kalva set aside \$2000 of his own funding for purchasing supplies, he gave Mr Van Sant's office a much-needed infusion of assets. Assets that, by providing students new opportunities to explore, invent, and learn, provided value for students. Whether or not the students are the customers of a university may be debatable among the faculty. Either way, it's in FAU's best interests to provide value to students, to provide the best possible learning environment. As such, supplies made readily available to students from Mr. Van Sant's office are assets to FAU as a business, and assets ultimately mean profit. When the same supplies are loaned out without accurate record-keeping, either those assets are lost and lose their value or must be replaced, which is an expense.

Overwatch is targeted specifically to addressing this problem. By providing a convenient and accessible means of recording all loans and returns, assets remain assets instead of expenses. Beyond this, Overwatch has the ability to improve the value provided by these assets by letting them be managed strategically. Traditionally, decisions of when, how much, and what supplies to purchase has been made based on the opinions, agendas, and personal perspectives of professors and teaching assistants. While it is beyond the scope of Overwatch to change that decision-making authority, for reasons discussed below, Overwatch would be an ideal method of supplying objective suggestions and large-scale trend analysis to the faculty with the authority to make such purchases. The weekly and monthly reports would reveal otherwise hidden trends regarding the usage of lab supplies. A certain component not commonly used by a teaching assistant or professor may be especially popular with students for use in their various projects. A specific component going out of stock early in a semester would possibly suggest that not enough had been purchased. This sort of targeted data analysis would be impossible with any other inventory control system, especially with the present hand-written legal pad solution.

Organizational Implementation

Overwatch is a student project, albeit a very carefully planned one. Because of this, it can be assumed that the graduate students who are developing it will eventually leave FAU and cease upkeep of the software (G. Laleau, personal communication, June 3, 2014). When this happens, the responsibility of pushing more bug fixes, addressing new errors, and implementing new features will likely fall upon either other graduate students or an employee of TSG. To facilitate this inevitable transition, the most rigorous of documentation standards are being employed to ensure that future developers will be able to quickly familiarize themselves with the existing code. To ensure that changes

are tracked and redundant copies of the code are always available, the complete codebase will be published as open source in a public repository on GitHub.com under the GNU GPL v3.0 license. GNU GPL v3.0 allows for commercial use, distribution, and modification of Overwatch, without providing any warranty or liability for FAU or the developers (Free Software Foundation, 2007).

In terms of implementing Overwatch for FAU, there is legal gray area that is best described as sticky. While student names and their school e-mail addresses are not considered private information (B. Alhalabi, personal communication, June 3, 2014), the unique identifier on the Owl Card magnetic strip may or may not be, depending on the context. The number is unique and identifying, but is not traceable to specific students or other private information without access to the highly secured Owl Card database maintained by the central Office of Information Technology (OIT). Unfortunately, OIT is also not inclined to grant a student-designed system access to this database either.

The solution to this quandary is for Overwatch to collect Owl Card and student information itself, without actually storing the magnetic strip numbers themselves. Establishing a sort of Chinese wall, Overwatch asks first-time borrowers for their names and FAU e-mail addresses after they swipe their Owl Cards. The students then provide all the information voluntarily, which is stored in a table along with their Owl Card magnetic strip number, which is passed through a one-way encryption algorithm before being stored. In this way, the Overwatch database contains only information that students themselves have released, and no potentially sensitive information is stored. This eliminates most security concerns, as a digital intruder would not be able to collect anything more private than information that is already on public record.

With the table of student borrowers built, there are many potential applications for taking advantage of the accurate records kept on what students have which items on loan. Certain FAU faculty have already requested certain additional functions, such as charging fees to students who keep loans for excessive amounts of time, or even placing graduation holds on students with outstanding loans (P. Pastran, personal communication, September 8, 2014). This additional functionality had been thought of during the early planning stages and dismissed for multiple reasons, the most important of which being that such policy implementation is beyond the scope of Overwatch.

The guiding design philosophy behind Overwatch has been and always will be the establishment of accountability, not the making of decisions. As stated before, when a student attempts to borrow an item that a professor or teaching assistant has placed a hold upon, Overwatch does not automatically decline the transaction. Overwatch notifies a human, in this case Mr. Van Sant, to make a decision and holds that human accountable to other humans, in this case the professor or teaching assistant who placed the hold. However, Overwatch has also been designed to be modular and open to other authorized programs that may wish to enforce policies. Given the correct access to other FAU databases, it would be fairly trivial for a different program to cross reference graduating students with Overwatch's own database of outstanding loans and apply such fees or holds.

Prototype builds of the Overwatch client GUI have already been developed, as well as

documentation of the proposed database structure and complete software architecture. All of these materials have been examined by Mr. Van Sant and his office as well as several teaching assistants and students. Feedback has been evaluated and the designs carefully refined accordingly (H. Van Sant, K. Hibbert, P. Pastran, personal communications, June 3 to November 5, 2014). With the design and early prototyping phases completed, Overwatch is prepared to begin advancing in earnest. The first milestones of development are a working prototype build of the client GUI, with support for the bar code scanner, printer, and card reader. A working prototype of this this core functionality could be ready as soon as mid-December 2014 for on-location testing on a trial basis. Barring any unexpected obstacles, the entire Overwatch system could be up and running by February.

The most tedious part of implementing Overwatch will certainly be taking the initial inventory. Through the combined efforts of Mr. Van Sant's office and any teaching assistants who volunteer, a complete inventory could be taken within two days. However, this process would have to wait until the Overwatch system was effectively complete, meaning that by mid to late February Mr. Van Sant's office would be prepared to fully adopt the Overwatch system. Once Mr. Van Sant's office has become familiar with Overwatch, they will be able to start encouraging students to take advantage of the system as well, directing them towards the publicly accessible inventory page.

The final step of implementation is likely to be the most difficult (P. Pastran, personal communication, September 8, 2014), which is why it is left for last. While several professors have expressed interest in Overwatch as an inventory control solution, the esteemed Dr. Kalva has been less supportive. Overwatch is a direct competitor to Dr. Kalva's own inventory system, and is not built around the premise that Dr. Kalva should have complete control over what goes in or out of Mr. Van Sant's office. During earlier, more informal proposals, Dr. Kalva disregarded the need for an improved inventory system. If he or any other faculty take a disliking to Overwatch, or the way Overwatch does not grant totalitarian control to any one faculty member, full adoption of the system among professors and upper faculty would be crippled at best (P. Pastran, personal communication, September 8, 2014). At worst, it could become an uphill battle to prevent Overwatch from being officially banned entirely and a second attempt to force the entire department to use Dr. Kalva's rejected system (H. Van Sant, personal communication, November 5, 2014).

Conclusion

In conclusion, the engineering college is a mess and Overwatch is designed from the ground up to fix that. It is the general consensus of the students, the faculty, the teaching assistants, and the professors that the present state of affairs is unacceptable. The Overwatch system itself is carefully designed using proven methods and technologies taught by FAU's own professors, with working prototypes already receiving high praise from testing groups. All conceivable competition is at best ill-fitting while the current method is indefensible. Upkeep expenses are negligible and initial equipment cost would be compensated for in under a year through asset retention and added value across the entire department. The precisely tailored system is ready for a smooth implementation with full adoption possible in under six months, assuming full cooperation of professors and faculty. In conclusion, Overwatch is the ideal solution to problem that cripples FAU's engineering college.

References

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