NAVAL AIR SYSTEMS COMMAND - LAKEHURST, NJ
CAPSTONE PROJECT & DESIGN CLINIC PROGRAM

TOPICS LIST

AUGUST 2011

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The NAVAIR Lakehurst Team is comprised of over 1,500 civilian scientists and engineers planning and managing technological advances and operational support for Naval Aviation, in the areas of: ***Aircraft Launch and Recovery Equipment (ALRE)*** and ***Support Equipment (SE)***.

THE NAVAL AIR SYSTEM COMMAND ~ LAKEHURST

Dedicated to Our Nation's Science, Technology, Engineering and Math Initiative

Capstone Project Topics List Contents

NOTE: PROJECTS WITH GREEN HIGHLIGHT HAVE BEEN ASSIGNED TO THAT SCHOOL

Project Listing

Welcome to the 2011-2012 Capstone Project & Design Clinic Program

Each year the ***Naval Aviation Systems Command (NAVAIR)*** in Lakehurst NJ, partners up with eager students from institutions of higher education, allowing them to work directly with our scientists and engineers, on real-life "learn-by-doing" projects.

<u>Please review:</u>

1) Topics in this Catalog.
2) Planned Schedule (see below).
3) The Guidance that follows.

If your institution is interested in participating and taking on one or more of these projects, call Gaetan Mangano at (732) 323-2899 or email Gaetan.mangano@navy.mil.

2011-2012 Capstone Project Schedule	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Send Topics List to Schools					
Fall Semester Start/Project Selections by Students					
Kick-Off Meeting/Team Site Visit to Lakehurst					
Teams Work Projects/Periodic Progress Reports					
Winter Break (Progress Report Due)					

2011-2012 Capstone Project Schedule	Jan-12	Feb-12	Mar-12	Apr-12	May-12
Teams Work Projects/Periodic Progress Reports					
Final Presentation & Report @Lakehurst					
Navy Concurrence of Acceptable Project Deliverables					
School Sends Invoice for Payment of Services					

Guidance

Please read the information on the next five pages, prior to requesting a Capstone Project / Design Clinic:

General Background Information

- ✓ ***Capstone Projects/Design Clinics*** are usually assigned on a "first-come, first-serve" basis and will be referred to as "***Projects***" from here on out.

- ✓ United States citizenship is required for any faculty or student associated with the Project. Proof will be checked at the beginning of a project.

- ✓ *Projects* highlighted in ***Green*** are no longer available, as they either have been assigned or are no longer relevant.

- ✓ *Projects* typically revolve around the school year, starting in August/September and ending in May/April.

- ✓ *Projects* should complement and sharpen the student's learning from their respective institution of higher education, as well as develop and enhance their communication skills.

Employment Considerations

- ✓ NAVAIR Lakehurst hires new engineers through the Navy "Acquisition Intern Program", or NAIP.

- ✓ NAIP is an entry level developmental program that provides new engineers and scientists with a competitive starting salary, rapid advancement, both internal and external rotations, professional graduate degree tuition assistance and continuous on-the-job learning.

  http://www.navsea.navy.mil/careers/naip/default.aspx

- ✓ Students interested in employment with NAVAIR ***MUST*** attend their school's appropriate career fair, visit the NAVAIR booth, speak with a recruitment representative and provide a copy of their resume.

- ✓ It is ***highly suggested*** that students attend the fall career fair, as hiring managers usually start early in the school year, looking for the best and the brightest.

- ✓ It is also highly suggested that you have a sound understanding of the NAVAIR Lakehurst mission in Naval Aviation. Please visit the following website for more information:

  http://www.navair.navy.mil/nawcad/index.cfm?fuseaction=home.content_detail&key=EE354A16-CF83-413F-BEE5-F9E73098B21

Phase 1 –Project Initiation

- ✓ *Projects* will be worked on by ***Teams*** consisting of ***3-5 students***.
- ✓ As *Projects* are assigned, ***Teams*** and ***Faculty*** will visit the *NAVAIR* Lakehurst site, to meet their ***technical Point of Contact***, otherwise known as the ***Navy POC***. The ***NAVY POC*** information is listed under the title of each project.
- ✓ These ***initial visits*** are ***1-day events*** and should take place as soon as possible; usually at the end of September or the beginning of October; and should include a tour of relevant *NAVAIR* Lakehurst facilities and laboratories.
- ✓ If the ***Team*** is unable to visit Lakehurst at the outset of the Project, it is advised that the Team stay connected to their ***Navy POC***, to ensure the requirement is clearly understood. Do not let time elapse without regular contact with your Navy POC.
- ✓ It is also ***strongly suggested*** to hold additional visits to *NAVIR* Lakehurst during the course of the *Project*, depending on the availability of the ***Navy POC*** *and student schedules*.

Phase 2 –Responsibilities, Work & Communications

- ✓ ***Teams*** will be organized and supervised by faculty members from their institution of higher education.

- ✓ ***Teams*** should work on their project on a weekly basis, with a realistic expectation of 2-5 hours per team member.

- ✓ The ***Team*** will assign one student, called the ***Team Lead***, as their single point of contact with the ***Navy POC***.

- ✓ When ***Teams*** meet regularly, ***meeting minutes*** will be recorded and will clearly show the agenda, progress made and any challenges that may have surfaced.

- ✓ The ***Navy POC*** will be "timely" provided with the meeting minutes and any other relevant information.

- ✓ Contact and Communication with the ***Navy POC*** may take the form of phone calls, emails, video teleconference, web-enabled media, etc – be advised that the Navy operates a strict intranet firewall, called the Navy/Marine Corp Intranet, which may restrict the use of some of these communications.

Phase 3 –Final Report & Presentation Deliverables

- ✓ ***Teams*** will submit a ***Final Report*** to the ***Navy POC*** (3 copies bound, 1 unbound) and present their findings on site at *NAVIR* Lakehurst.

- ✓ The ***Final Presentation*** date will be coordinated with the ***Navy POC*** *and* ***Gaetan Mangano***, at least 3 weeks in advance of the actual date. Mondays, Fridays and National Holidays should not be scheduled, unless approved by the above mentioned.

- ✓ Presentations will be held between the end of April and beginning of May, depending on final exam schedules; and will be approximately 60 minutes in duration.

- ✓ Presentations should be in the powerpoint format and should be mailed to Gaetan Mangano, unless > 8MB no less than 2 days prior to event. If >8MB, the use of "google" docs may be used.

Financial & Contractual

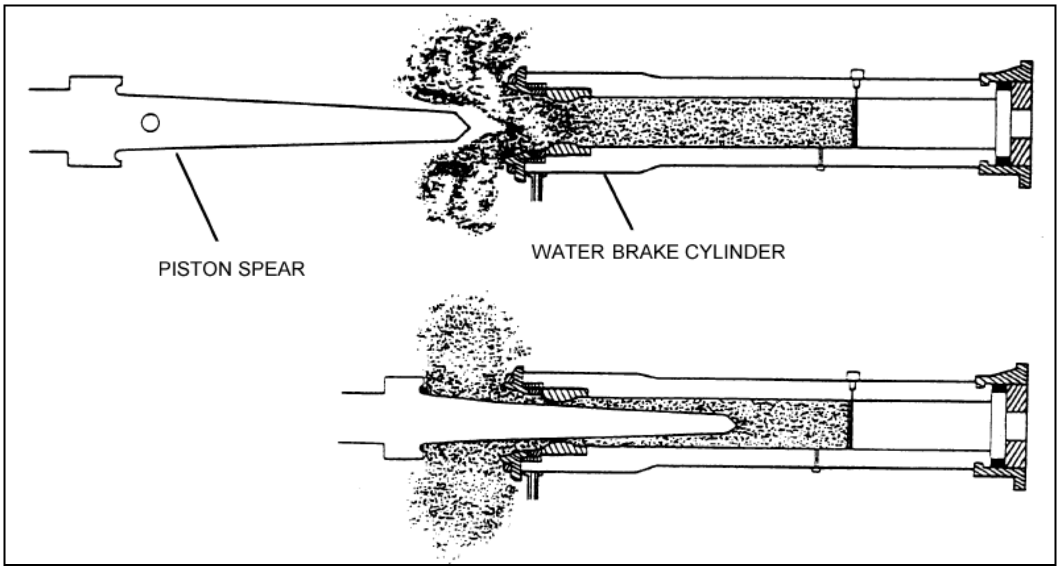
- ✓ It is anticipated that there will be enough funding for 10 projects and each will be given up to $5,499 to offset any costs. If more than 10 projects are selected and completed, then each project will receive something less than $5,499.

- ✓ A contract will be established between *NAVAIR* and the institution of higher learning for this payment. Payment will take place after an acceptable final report and presentation have been provided. For each project, an acceptable rating will be determined by Gaetan Mangano and the Navy Technical POC.

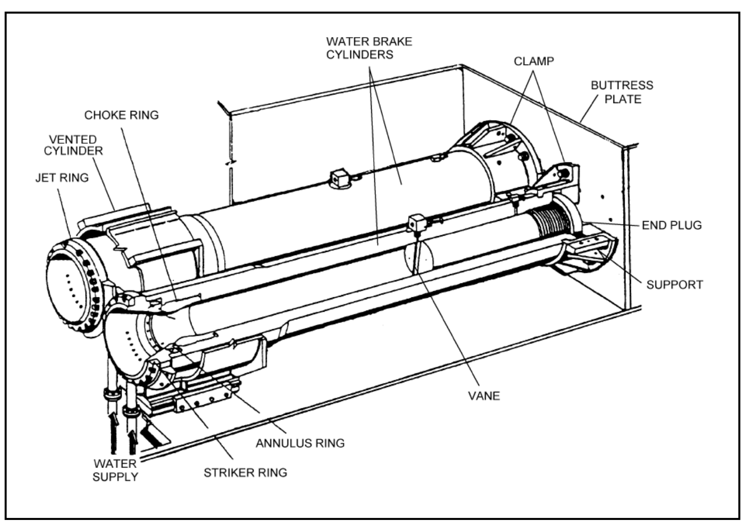
- ✓ Requests to extend a project from one school year to the next will be granted, if adequate justification is provided.

1. STEAM CATAPULT WATERBRAKE PRESSURE SENSING - Rowan

NAVAIR Contact Information:
Tom Riccobono, thomas.riccobono@navy.mil, 732-232-2073
Area(s) of Concentration: Mechanical and/or Electrical Engineering



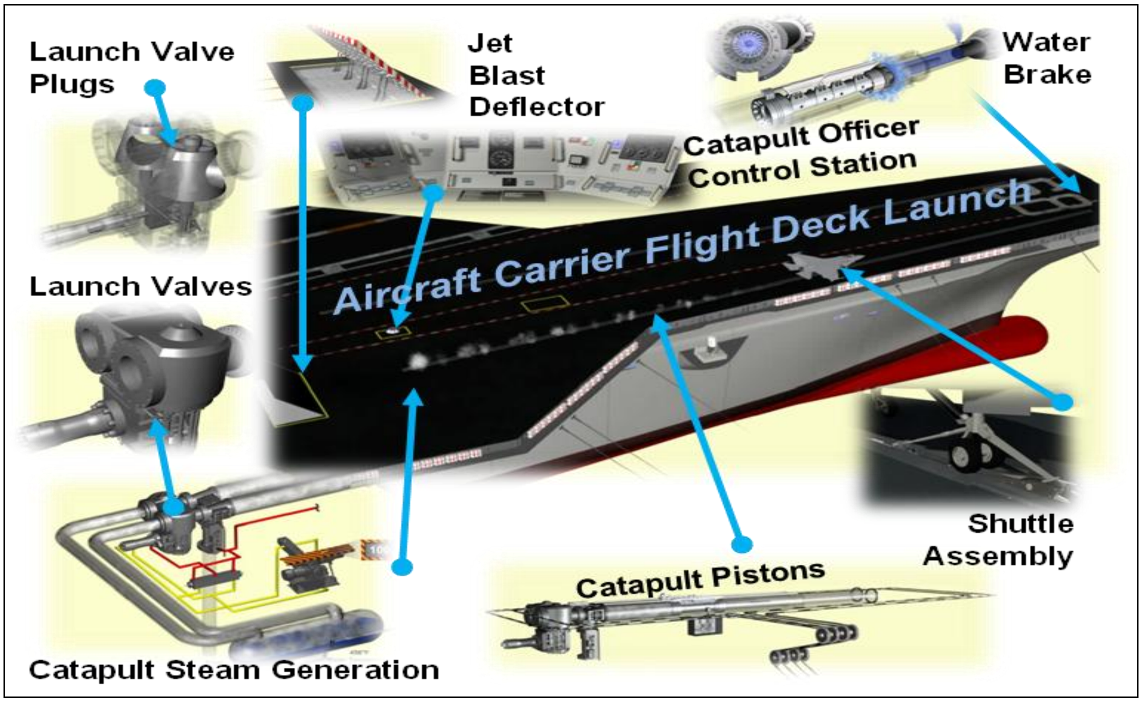
Background. The US Navy utilizes steam catapults to accelerate aircraft to a safe fly away speed on Aircraft Carriers. The catapult is linked to the aircraft by a shuttle and piston assembly. The water brake is responsible for absorbing the energy of the shuttle at the end of a launch when the piston spears enter the water brake cylinders. As the piston spears enter the water brake cylinders pressure builds up in the water brakes. By measuring and analyzing the pressure profile, it is possible to determine the condition of the water brake.



Issues. Typical non-modified COTS (Commercial Off-The-Shelf) direct sensing pressure transducers have proven unreliable given the conditions that exist during a catapult shot. These extreme conditions include dynamic water pressure that rises from about 0 to 25,000 psi in 0.1 milliseconds and forces on the structure that can reach up to 1000 g's. The sensor must also be able to survive 3000 full scale cycles and temperatures of the medium and environment that can reach up to 130 degrees Fahrenheit during operations and 300 degrees Fahrenheit, when water is not being circulated, during the non-operational states. The sensor would not need to be functional at 300 degrees but must survive that temperature and be functional when the temperature returns to nominal.

Requirement. Investigate potential technologies that could be used to measure the water pressure in the water brakes during a catapult shot and that could survive the environment. Any approach should be considered, including direct and indirect measurement techniques. Design, model, and analyze the approach in order to prove the concept before potentially prototyping the design.

Supporting Information. The diagram below shows the hardware and equipment necessary for the Steam Catapult launch system on board the Navy's fleet of aircraft carriers. The steam catapult relies on the availability of large quantities of high-pressure steam. The steam charges a steam accumulator so that it may be released faster than it can be produced by the ship. The steam catapult consists of two slotted cylinders—typically 18 inches in diameter. The cylinders contain free pistons connected to a shuttle which protrudes through a slot in the flight deck. The nose-wheel of the aircraft to be launched is attached to the shuttle by a launch bar. On completion of the launch the piston is traveling at high speed and would cause damage if not stopped in a controlled fashion. This is done by a **water brake**, which is a horizontal dashpot into which sea water is pumped with a swirling action as fast as it can flow out of the open end. The combination of the slight compressibility of the aerated water, the restriction as the water is expelled from the dashpot and the force produced by the expelled water hitting the front of the piston assembly itself serves to absorb the energy of the piston without damage. At that point a return mechanism readies the piston and shuttle for the next launch.



2. INTELLECTUAL PROPERTY TECHNOLOGY TRANSFER (Smart Connector for Electronics Fault Isolation) – Rowan &/or Drexel

NAVAIR Contact Information:
Dr. Russ Shannon, Russell.shannon@navy.mil, (732) 323-4538
Area(s) of Concentration: Electrical Engineering and/or Industrial Engineering and/or Technology Transfer/Intellectual Property Strategic Management/Marketing

Problem Statement: Currently, within the Navy and Marine Corps, there are aircraft whose on-board electronics (also called "avionics") do not function as well as they should. Their diagnostic systems sometimes indicate that there is a problem with a particular system, when in fact, no problem exists. These are false-alarms. Sailors and Marines doing maintenance do not know that the indications are false alarms. Therefore, they remove and replace the suspected-bad electronics in an effort to fix the aircraft. Only later does NAVAIR realize that a large number of false alarms are occurring. Figure 1 illustrates how one particular system is costing the U.S. taxpayers nearly $1M per year.

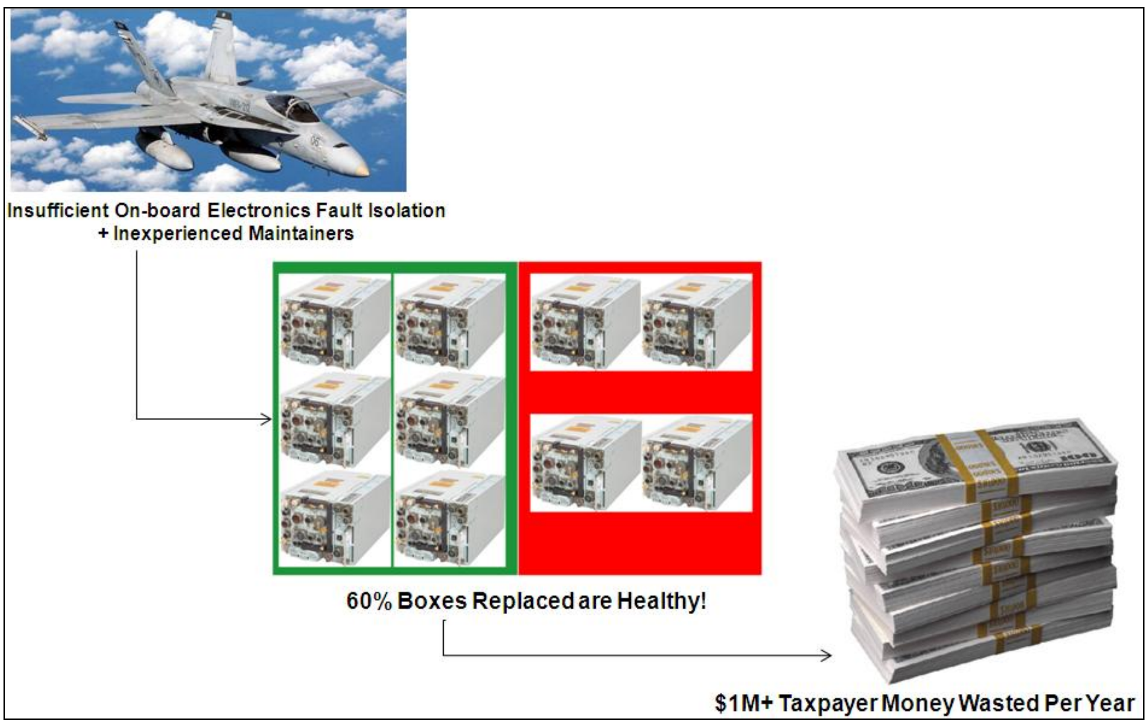


Figure 1. Current Navy/Marine Corps Operational Need

The same problem exists in private industry. Companies such as Lufthansa, Rockwell Collins and Delta Tech Ops (who repair Delta aircraft) have all publically reported false alarm rates over 50% in some of their avionics systems. Similarly, there is much anecdotal evidence to suggest that the same problem exists in automobile maintenance. Figure 2 below, illustrates how a similar situation in the commercial world can cost customers money.

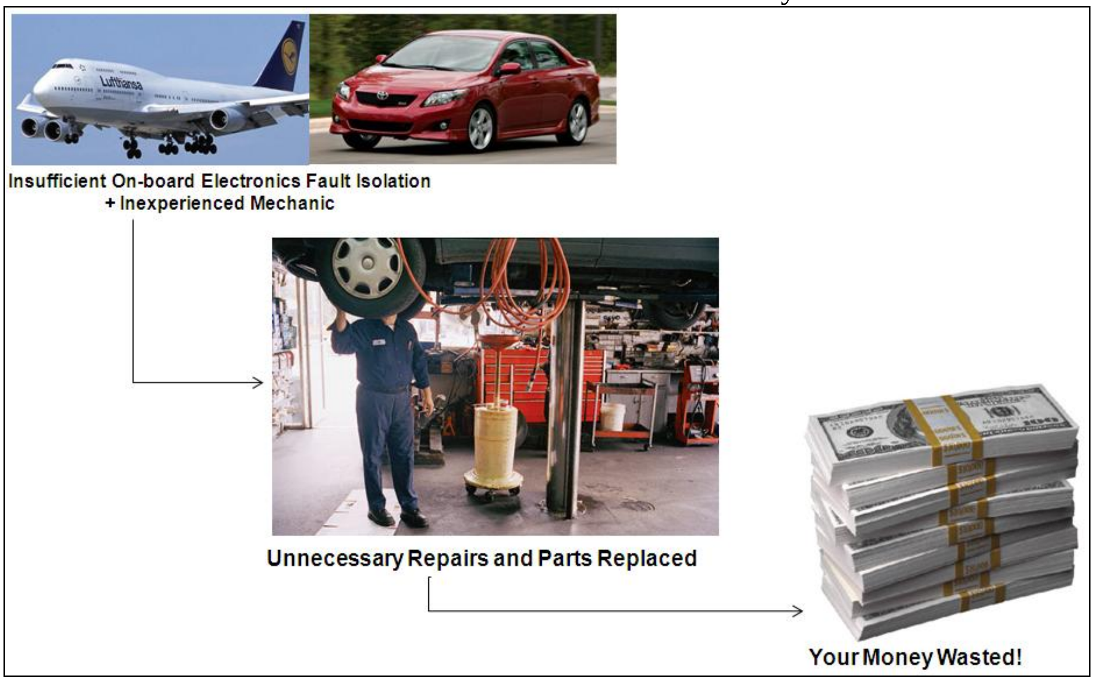


Figure 2. Current Commercial Aviation and Automotive Need

<u>Solution:</u> For Navy and Marine Corps aircraft, NAVAIR has patented the Smart Connector Tester, shown in Figure 3. It is U.S. patent number 7,626,398. The tester is able to do two functions. The first: monitor data lines between two pieces of electronics and/or power lines for signs of failure. The second: actively exercise the electronics to determine the source of the failure, if one exists. It can also test any cables running between the electronics.

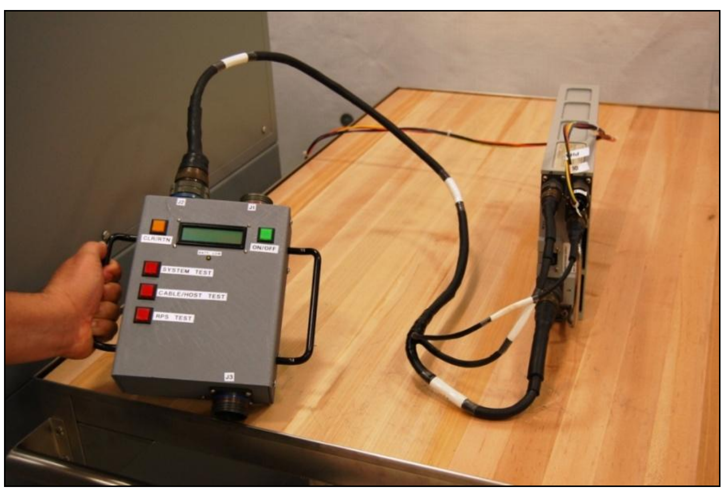


Figure 3. The Smart Connector Tester

There is currently no version of the Smart Connector targeting commercial applications.

Project Tasking and Deliverables: It is thought that this technology has the potential to save customers and businesses in maintenance and repair costs; thereby increasing the efficiency of business operations. The Smart Connector may be able to impact the following markets: Aviation Industry, Automotive Industry, Telecommunications Industry and Smart Grid Industry. A bottoms-up analysis was done of the Aviation Industry and the Automotive Industry. It determined that the potential markets for the Smart Connector Tester were $14M and $18M respectively.

Project Deliverables:

1. A new bottoms-up analysis of the civilian airline industry to determine the size of the market for this device.

2. A new bottoms-up analysis of the automotive industry to determine the size of the market for this device.

3. An analysis of the telecommunication industry to determine the size of the market for this device.

4. An analysis of the emerging smart grid industry to determine the size of the market for this device.

5. For each industry, a list of potential licensees, complete with contact details of key points-of-contact (POCs).

6. For each potential licensee, a recommendation as to whether it would be most beneficial to only license the technology or whether it would be most beneficial to work with the company on the development of a commercial version of the tester.

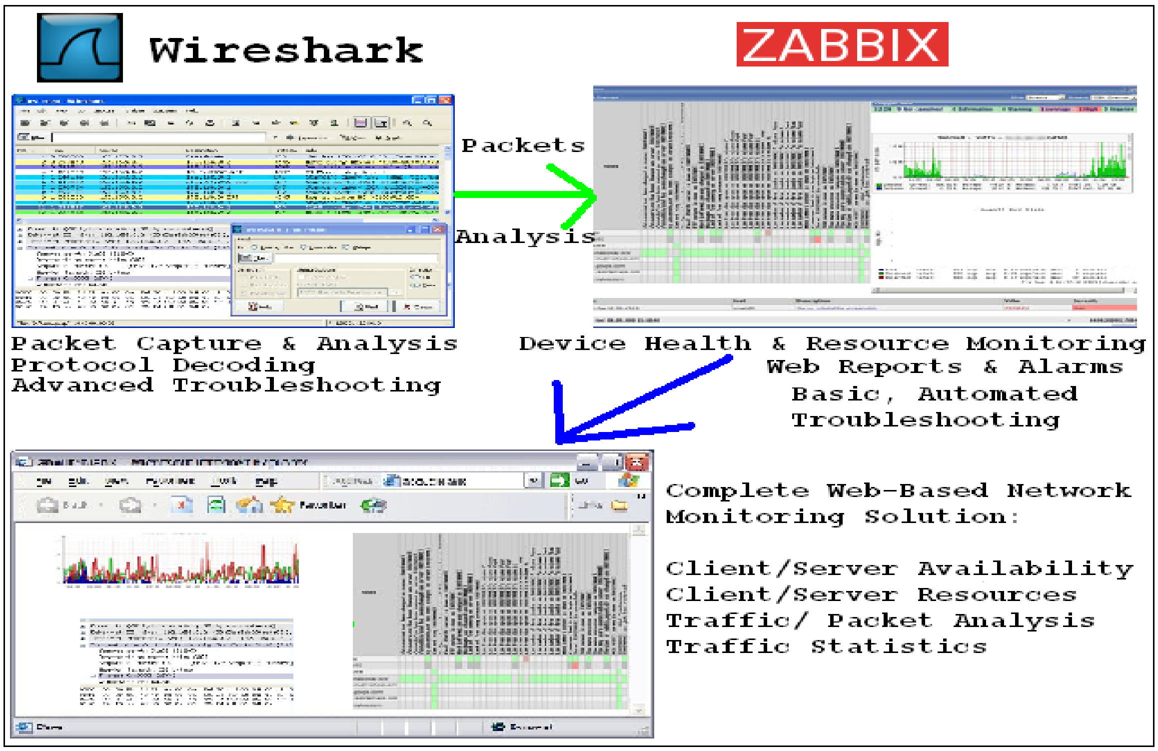
7. For the three potential licensees with the most potential, a detailed plan of action for selling the concept and moving forward.

8. A list of companies/industries/sub-industries for which an exclusive license would make sense.

3. COMMUNICZATION INTERFACE TOOL BETWEEN NETWORKS

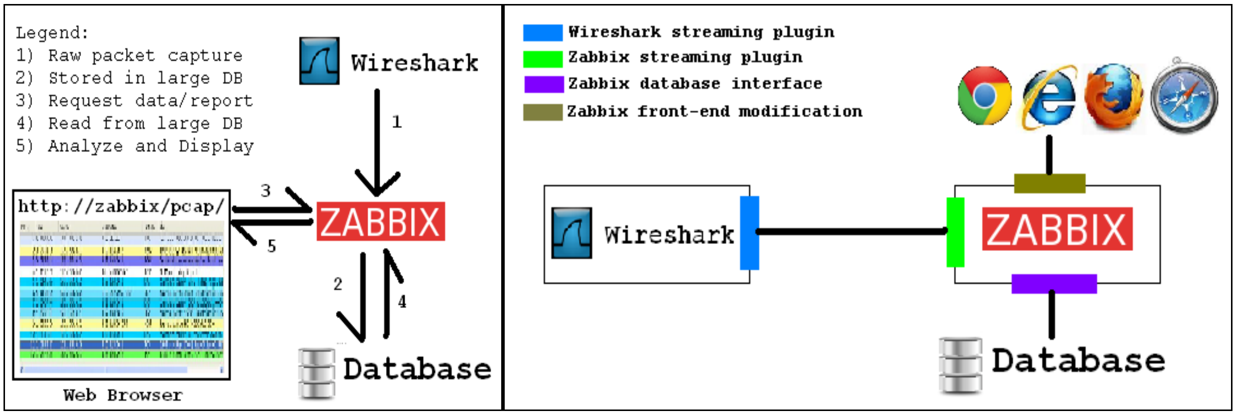
NAVAIR Contact Information:
Daniel Nowak, daniel.nowak1@navy.mil, (732) 323 - 7084
Area(s) of Concentration: Computer Science and/or Computer Engineering

Background Information. A team of computer engineers could create a complete network monitoring solution by developing a communication interface between two existing network diagnostic tools. The two tools in mind are the free and popular software packages Wireshark and Zabbix.



By developing an interface for the two to share data, a Lakehurst Engineer[1] could view a web report that includes network device health and resource status, as well as raw and decoded packet captures. A complete network monitoring solution with these coupled functions can save an engineer time in diagnostics, and a similar commercial solution can cost tens of thousands of dollars in hardware and software.

[1]**Note**: The Lakehurst Engineer would be working in support of the Navy's Aviation Data Management and Control System – See Supporting information below for more details).



Project Deliverables. The necessary components for the proposed interface are as follows:

1. A plug-in or script to allow Wireshark to stream raw, decoded, and/or analyzed packet captures to the Zabbix script or plug-in.
2. A plug-in or script to allow Zabbix to receive and process the raw, decoded, and/or analyzed Wireshark packet captures.
3. A modification to the Zabbix web front-end which allows the user to access packet capture statistics and analysis, as well as the raw and decoded packet data.
4. Evaluation should consist of a demonstration of the solution's ability to comply with requirements identified in the ADMACS network monitoring effort, as well as compliance with the GNU GPL software license of both Wireshark and Zabbix.

A team of four students should be able to complete this task in one year, without access to any of NAVAIR's facilities or equipment.

Supporting Information. The Aviation Data Management and Control System (ADMACS) operated onboard the Navy's Aircraft Carriers is a real-time data management system connecting the carrier's air department, ship divisions and Sailors who manage aircraft launch and recovery operations. ADMACS communicates aviation and command-related data across the system's local area network and the Integrated Shipboard Network System. The position and location of the aircraft on flight and hangar decks are then electronically displayed in the flight deck control room. ADMACS also displays the status of aircraft, launch and recovery equipment, fuel, weapons and other aviation and ship related information. The Navy operates an ADMACS Lab at Lakehurst.

4. REMOVAL OF AIRCRAFT TIRE RUBBER ACCUMULATION ON AM2 MAT

NAVAIR Contact Information:
Robert Galluci, Robert.galluci@navy.mil, (732) 323-7336
Area(s) of Concentration: Mechanical and/or Civil Engineering

Issue: AM2 Mat is coated with a nonskid material that provides an aggressive frictional profile for safe aircraft operations. After prolonged periods of aircraft operations, aircraft tire rubber accumulates on the AM2 Mat, resulting in a corresponding decrease in its frictional profile.

Action: Investigate the feasibility of designing a safe/economical method of removing tire rubber build-up from AM2 Mat surfaces, while the AM2 Mat is still installed on the airfield. This method can be either mechanical or chemical, but must be of an expeditionary nature and not adversely impact local EPA requirements. The means of rubber removal must also not react with the nonskid coating in a way that would not significantly degrade the mat surface friction profile.

Background Information: Although a truly "expeditionary" airfield (EAF) may only consist of no more than a cleared but otherwise unprepared area, more versatility is gained by the use of a surfacing system designated as AM2 mat. Assembled in a building block concept, sheets of AM2 mat are capable of forming runways, taxiways, parking areas, and other areas required for efficient aircraft operations and maintenance. AM2 mat consists of 2-ft by 12-ft, and 2-ft by 6-ft aluminum panels that are coated with an epoxy nonskid coating material. Each panel has four interlocking edges that permit easy assembly into rectangular expanses which may be theoretically endless in size and proportions. AM2 mat was designed to withstand the high wheel-loading imposed by tactical aircraft, including arresting hook impacts and heavy transport aircraft.

5. SUBGRADE VOID DETECTION SYSTEM - Rowan

NAVAIR Contact:
Omari Davis, Omari.davis@navy.mil, (732) 323-1164
Areas of Concentration: Mechanical and/or Civil Engineering

Issue: Airfield subgrade surfaces fully support AM2 Mat expanses for the safe operation of aircraft. As a result of natural erosion from water intrusion under the AM2 Mat surface, sections of these subgrades can be removed during these erosion events, thus rendering the AM2 Mat expanses un-supported in certain areas. There presently does not exist a scientific means of determining the location and extent of these subgrade voids without removal of portions of the AM2 Mat expanses, which closes that airfield section and degrades the airfield mission.

Action: Investigate the feasibility of evaluating the extent and location of subgrade voids beneath AM2 Mat surfaces, without disturbing the AM2 Mat or disturbing airfield operations.

Background Information: Although a truly "expeditionary" airfield (EAF) may only consist of no more than a cleared but otherwise unprepared area, more versatility is gained by the use of a surfacing system designated as AM2 mat. Assembled in a building block concept, sheets of AM2 mat are capable of forming runways, taxiways, parking areas, and other areas required for efficient aircraft operations and maintenance. AM2 mat consists of 2-ft by 12-ft, and 2-ft by 6-ft aluminum panels that are coated with an epoxy nonskid coating material. Each panel has four interlocking edges that permit easy assembly into rectangular expanses which may be theoretically endless in size and proportions. AM2 mat was designed to withstand the high wheel-loading imposed by tactical aircraft, including arresting hook impacts and heavy transport aircraft.

6. EXPEDITIONARY AIRFIELD MARKING OBLITERATION

NAVAIR Contact:
Jose Andujar, Jose.andujar@navy.mil, (732) 323-1537
Area(s) of Concentration: Mechanical and/or Civil Engineering

Issue: Airfield markings are employed at Expeditionary Airfields and painted onto AM2 Mat surfaces. As airfield operations change, or AM2 Mats are moved to alternate locations, these airfield markings are required to be painted over in order to alleviate the potential for distracting presentations to pilots and ground crew. However, many times, when airfield markings are painted over and invisible to the naked eye, they are still visible by night vision devices - used by all rotary pilots during night operations.

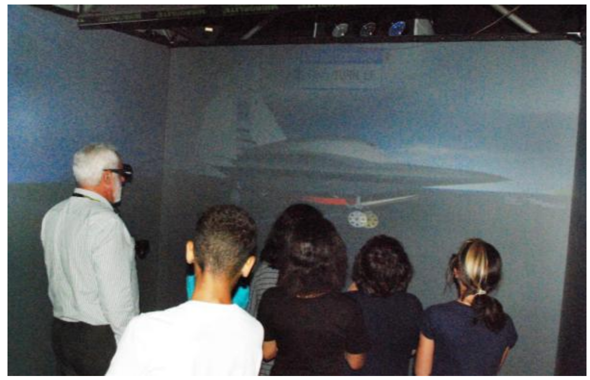
Action: Investigate a means to remove, or cover, airfield markings from an AM2 mat surface without creating a distracting reflective/contrasting image when viewed through night vision devices. This process should have the ability to remove markings with only negligible effect on the integrity of the matting non-skid coating, and should be achievable with an easily-maintainable, environmentally-friendly, single operator device.

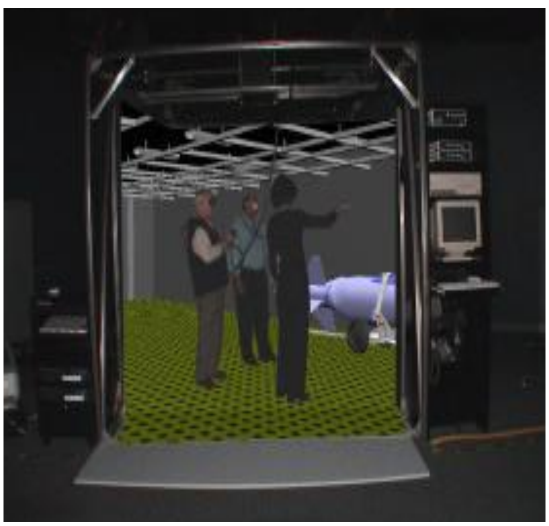
Background Information: Although a truly "expeditionary" airfield (EAF) may only consist of no more than a cleared but otherwise unprepared area, more versatility is gained by the use of a surfacing system designated as AM2 mat. Assembled in a building block concept, sheets of AM2 mat are capable of forming runways, taxiways, parking areas, and other areas required for efficient aircraft operations and maintenance. AM2 mat consists of 2-ft by 12-ft, and 2-ft by 6-ft aluminum panels that are coated with an epoxy nonskid coating material. Each panel has four interlocking edges that permit easy assembly into rectangular expanses which may be theoretically endless in size and proportions. AM2 mat was designed to withstand the high wheel-loading imposed by tactical aircraft, including arresting hook impacts and heavy transport aircraft.

7. MODELING AND SIMULATION (5 Projects)

NAVAIR Contact:
Gil Campbell, Gilbert.campbell@navy.mil, (732) 323-5225
Areas of Concentration: Computer Engineering and Computer Science

The M&S Laboratory at NAVAIR Lakehurst uses powerful computer and visualization hardware and software to ensure customer confidence in proposed products before actual development begins. The design and functionality of the system can be reviewed before the product is solidified, which reduces the overall design and development costs; shortens scheduled product developments; and increases the likelihood that the product will operate as expected in its final intended environment.





Two advanced visualization systems immerse users in a virtual environment that gives a three-dimensional understanding of how a proposed product will behave in its intended setting. The Visualization Center is a 6-foot-high by 19-foot-wide cylindrical screen that provides three-dimensional visualization and allows up to ten individuals to simultaneously view a scene and make decisions on how the proposed product should behave when installed.

The CAVE from Fakespace is an 8-foot cube that allows up to five individuals to walk into a virtual environment. Individuals can view the environment from three sides as well as the floor and to virtually "walkthrough" spaces while interacting with the environment. Both of these systems are powered by an Onyx 3200 from Silicon Graphics. The Onyx consists of eight CPUs, two graphic pipes, three raster managers, and 4 GB of RAM to drive the VisCenter and CAVE.

Multiple Projects. There are 5 Projects relating Modeling and Simulation.

MODELING AND SIMULATION Projects Continued

Capstone 7-1: Object Manipulation with 5DT Wireless Glove

A current project to support ATE acquisition utilizing the CAVE is to provide configurable virtual work centers so that Subject Matter Experts can be put through workflow scenarios to determine the optimization of candidate ATE configuration work center arrangements. A key aspect in these workflow scenarios is to provide a realistic means for the Subject Matter Experts to manipulate objects (Units under Test) within the CAVE.

A script to provide optical hand locational and finger tracking to provide object manipulation to execute in the WorldViz Vizard vitrual reality system will be required. A requirements plan, identifying the degree of interaction with the virtual objects, a software design, tasking and schedule based on the requirements will be developed. Development of the software and hardware package will be developed and integrated with the AMASE work center scenario.

Capstone 7-2: Work Flow Scenario for Automatic Test Equipment

Automatic test equipment (ATE) and efficient configuration of naval work centers to meet the demands of I-Level maintenance had until now been a manual undertaking with results relative to the experience of those responsible. A current project is putting together a virtual environment, utilizing CAVE technology so that alternative work center configurations can be evaluated with interactive workflow scenarios. The ability to exercise the work center configurations in this manner will insure a better fit for a give ship's maintenance requirements.

The work flow scenario will require 3D models of ATE test stations, Unit's Under Test (UUT), Weapons Replaceable Assemblies (WRA) and Test Program Suite's (TPS) hardware components that are needed to connect the UUTs to the stations. Examples of ATE stations are CASS and eCASS stations (Consolidated Automated Support System). Examples of UUTs are flight control computers, UHF and VHF communication systems. Examples of TPS hardware components are General Purpose Interface, Interface Adapter and other ancillary testing components.

Consolidated Automated Support System = CASS

MODELING AND SIMULATION Projects Continued

<u>Capstone 7-3: Interactive 3D Virtual World Applications</u>

3D Virtual World (VW) applications are being pursued by DOD laboratories because it provides a virtual world experience that approaches the look and feel of a live first person real world encounter. DOD laboratories are developing multimedia virtual world 3D applications to showcase their sites expertise in order to better market to their associates. The next step in the utility of the 3D virtual worlds is to design and develop more interactive VW applications that serve to realistically present capabilities and to provide usable interactive tools.

A current Advanced Special Operations Management System simulation provides an interactive environment that allows Subject Matter Experts to handle a model of an unmanned aircraft on the flight deck of an aircraft carrier. This effort would design and develop a 3D VW application that would use COTS hardware and software to allow porting this simulation to execute on the VW servers and allow users with access to the identified hardware and software to interact with the resulting application.

MODELING AND SIMULATION Projects Continued

<u>Capstone 7-4: Aircraft Crash Animation</u>

An existing simulation provides flight deck simulation of aircraft launch and recovery visualization to provide a virtual world experience to test the interaction of Subject Matter Experts with their work center consoles. To present real world stresses in a virtual simulation is a challenge and can provide a more rigorous testing of a given system when achieved. In addition to the sights and sounds of activities that are experienced on a flight deck during operations that serve to put stress on personnel and impact their performance the awareness of danger from mishaps is also constantly present. To bring this aircraft crash as an additional component into the virtual environment will provide a more relevant testing experience.

An animation of a aircraft crashing during a landing operation will be developed to execute in the WorldViz Vizard virtual reality system. The use of sound and visual components will be utilized to create a virtual aircraft crash. Integration of the animation with the existing operational CV 78 simulation Vizard application will be required.

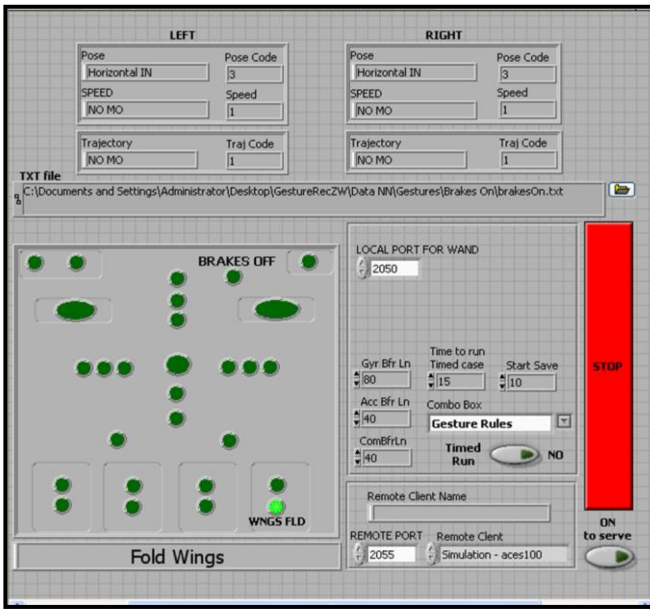
<u>Capstone 7-5: Landing Gear Tire Friction Model</u>

There is a need for landing gear tire friction model for our Simulation Cave Environment. The tire slippage (or a reaction without slippage) should be a function of strut physics, aircraft weight, aircraft, taxiing speed, thrust vector, friction forces, tire properties and deck conditions. The reaction of all tires to aircraft motion (forward, turn, and pivot) will effect how the next frame of the simulation will be drawn on the screen, thus producing a visible to human eye a realistic reaction to a handler command.

View of motion capture avatar controlling the UCAV on the carrier deck.

The deliverable would be a program in JAVA because it is easy to integrate with the simulation used in ORION. This program would take inputs from outside system (example: turn right 30 degrees) it would know (from the outside system feed back) a current state of the aircraft (nose gear is straight, speed is 2 mph, weight is 10,000 pounds etc.) and produce an output as tire reaction vectors (direction and magnitude) for each wheel in aircraft frame of reference passing these data in to the outside simulation so that a resultant vector could be computed (thrust is known). Once the resultant vector is know the next frame of simulation could be displayed. The resultant response at a current state to the command turn 30 degrees may in fact be somewhat different from 30 degrees hence the UCAV will be modeled based on physics.

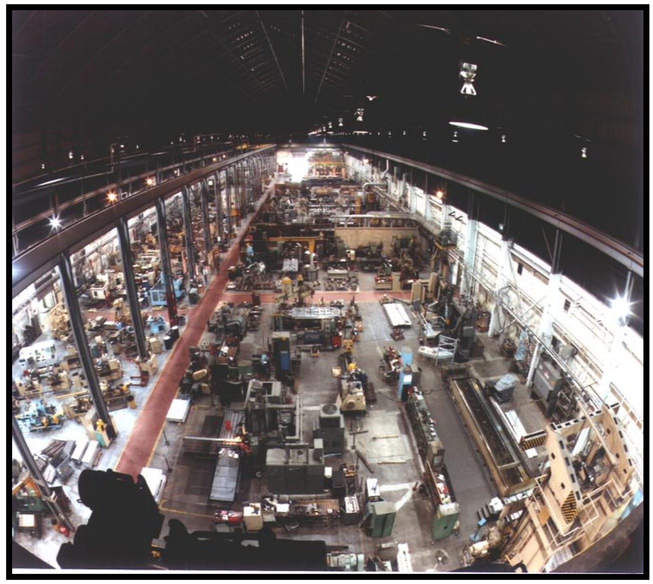
This project would be within the education scope of college engineering major. The upcoming ORION efforts will include development of a UCAV response based on physical modeling. The project could support this upcoming work. Also the above write up has sufficient details to actually start the work on a generic tricycle wheeled platform that has a mass and a thrust and physical parameters such as suspension stiffness, damping, frictions, etc.



A screen capture of the Labview GUI that interprets/maps wand gesture commands (movement commands), which is representative of TBD deck surface conditional GUI to affect model behavior.

8. DESIGN FOR MANUFACTURING - NJIT

NAVAIR Contact:
Bradley M. Smith,
Bradley.smith3@navy.mil, (732) 323-1205
Area(s) of Concentration: Industrial and/or Mechanical Engineering



This project is perfect for mechanical and industrial engineers who are interested in designing and manufacturing. The team could also use at least one member with strong mathematical skills.

RESEARCH OF MFG METHODS AND DOCUMENTATION:

The first semester will be spent researching and documenting geometric tolerance control of various manufacturing methods.

These methods include:

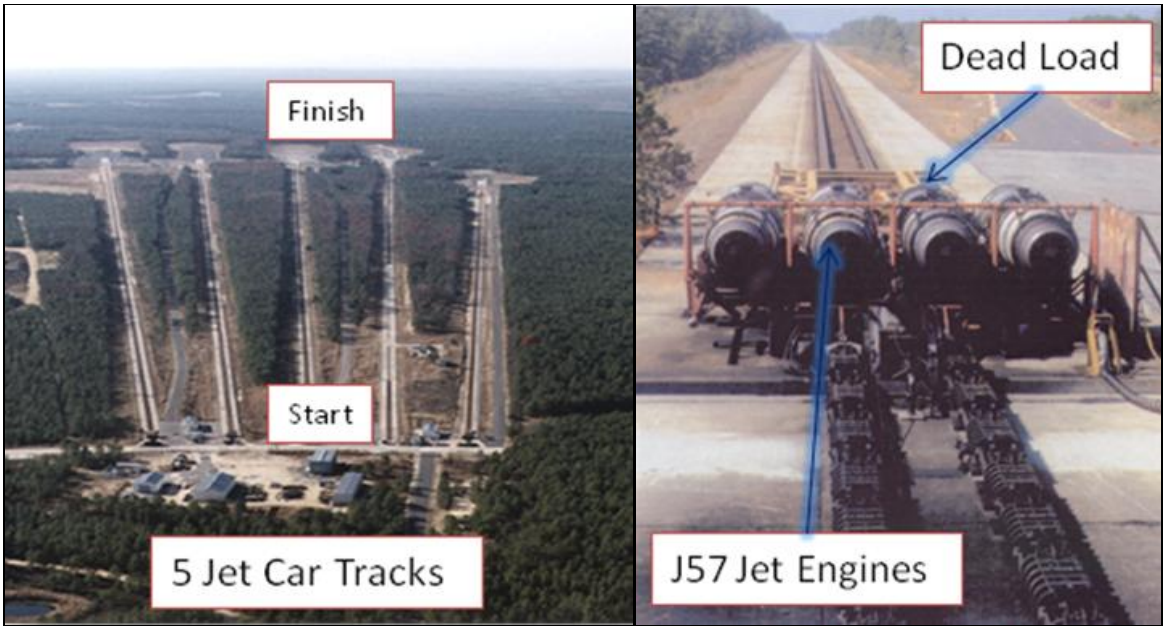
- Milling (Manual and CNC)
- Horizontal Milling
- Drilling
- Grinding
- Wire EDM
- Welding per MIL-STD-278
- Manual Torch Brazing
- Other methods here at Lakehurst

DESIGN AND MANUFACTURE:

The second semester will be spent on designing and manufacturing an item based on requirements provided. The design requirements will involve an understanding of geometry and the research collected in Semester 1. This project is an excellent opportunity to learn real-world engineering design and manufacturing, as well as help the US Navy directly.

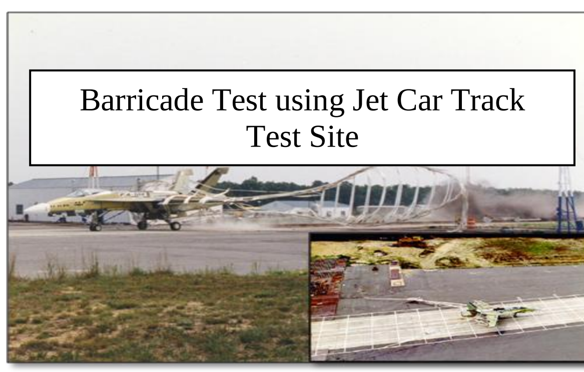
Special Note: This Project/Clinic requires multiple visits to the NAVAIR Lakehurst Manufacturing and Prototype Facility – Students should plan on no less than 5 visits during the school year.

9. JET CAR IMPROVEMENTS (7 Projects) 9-1 – 9-3 taken by Ocean County College & 9-4 taken by Fairleigh Dickinson University



<u>Background</u>. Jet Cars are used at Lakehurst to accelerate large masses (called dead loads) down a mile and a half rail track. The dead loads simulate the weight of an aircraft and have a tail-hook on them to engage arresting systems under test. The jet car is essentially a cart with up to four J57 jet engines (from B-52 bombers). The cars are guided by rails and drag friction brakes on the rails in order to stop. When the jet car stops, the dead load separates and continues on into the arresting gear.

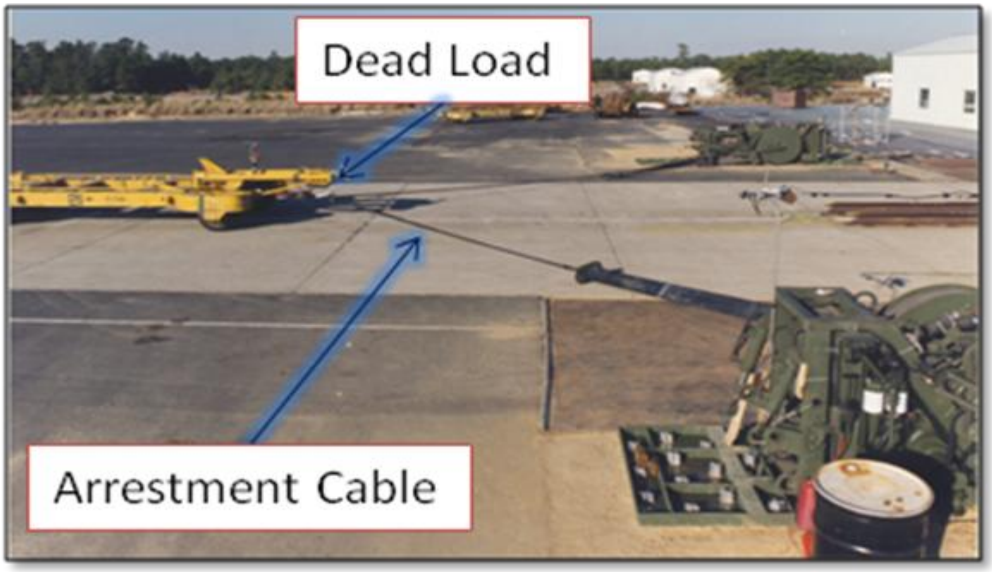
<u>Why Jet Cars & Test Tracks.</u> Jet Cars allow tests of arresting gear and barricades, with little risk to aircraft and personnel and at substantially lower cost than similar runway tests using manned aircraft. These tests may be conducted using weighted "deadloads" to simulate various aircraft landing conditions or they may use the airframe itself as in the nylon barricade tests conducted to qualify fleet aircraft. The jet car develops 42,000 pounds thrust - employs airframes or deadloads up to 100,000 lbs - can attain energies in excess of 140 million ft lb and speeds up to 250 kts. The remote location provides a safety and noise buffer. Runaway deadloads have harmlessly wandered off into the woods.


Barricade Test using Jet Car Track Test Site

Multiple Projects. There are 7 Projects relating to the Jet Cars.

JET CAR IMPROVEMENTS Continued

Below are the 7 projects, their associated descriptions and goals.



Capstone 9-1: Modernize the existing jet car engine control system – Ocean County College
Area(s) of Concentration: Electrical and/or Computer Engineering

The existing systems use discrete components and relays to maintain proper engine speed. These components are also responsible for adjusting the engines back down to idle at the end of the run. The components are prone to failure particularly due to the high vibrations experienced during the event.

The project involves redesigning the controller using present day electronics such as PLCs and packaging the components so that they will withstand the environment and provide reliable control functions.

A goal would be to redesign the system in such a way that the following two improvements could be added at a later time.

Capstone 9-2: Jet car speed controller to improve end speed accuracy
Area(s) of Concentration: Electrical and/or Computer Engineering

The process for obtaining the desired end speed for the jet car is very crude. It involves setting the engine RPMs based on external factors such as wind speed, weight, temperature, etc.

This project would involve accomplishing the tasks outlined in Capstone 1, but would add active, closed loop control of the jet car speed in order obtain more accurate end speeds.

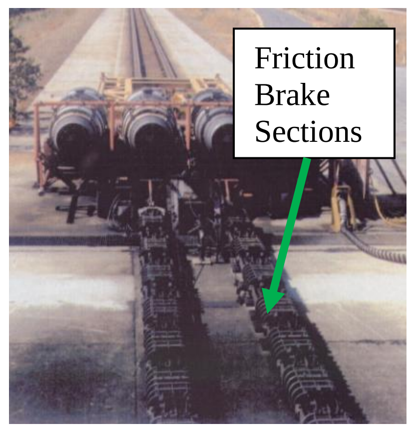
JET CAR IMPROVEMENTS Continued

Capstone 9-3: Wireless Idle and shutdown control of the jet car

Area(s) of Concentration: Electrical and/or Computer Engineering

Due to the harsh environment and the mechanical methods of setting the engine to idle and off, these functions frequently fail. It is then left to a person to approach the car and manually turn off the engines.

This project would again involve accomplishing the tasks outlined in Capstone 1 above but would add a wireless means to set the engine to idle and shutdown at the end of the run.



Capstone 9-4: Positive locking mechanism for the jet car brakes

Area(s) of Concentration: Mechanical Engineering

The jet cars trail up to 8 sections of friction brakes behind them during an event. The brakes get manually "set" at the beginning of the event and as the jet car proceeds down the rail, it enters a braking section. In the braking section, the rails become thicker and the trailing brakes begin to contact the rail. The friction between the two provides the stopping force for the jet car.

The brakes are set by manually rotating a bolt with a cam attached. The cams place the brake in the proper position to engage the rail. Several bolts need to be rotated in order to set just one brake section. If the brakes are not properly set or they become unset due to the vibrations experienced during the event, the braking force with be adversely affected and braking distances will increase. This puts the jet car at risk of not stopping before the end of the rail.

This project entails developing a positive locking mechanism for the brakes that ensures they are all properly set before the event begins and ensures that they stay set during the run. The device should make it obvious during a quick visual inspection (via eye or camera) that the brakes are set and ready.

Capstone 9-5: Adapt jet car dead loads to use current inventory aircraft wheels

Area(s) of Concentration: Mechanical Engineering

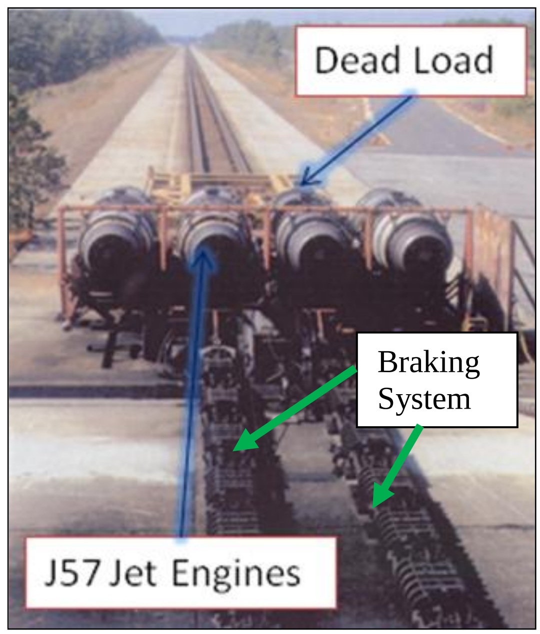
Presently, the jet car dead loads use older aircraft wheels (F-14). These wheels are no longer in the US Navy inventory and need to be special ordered when replacements are required. This is a considerable expense.

This project would involve selecting a suitable replacement wheel from the current DOD inventory and redesigning the dead load interface (hub & mounting location, etc.) in order to utilize the new wheel. The redesign will need to maintain the same geometry as today so that major changes to the dead load and/or rail system are not required.

This project could be extended to the actual jet car wheels and/or the catapult dead load wheels. Or these could be individual projects.

Capstone 9-6: Adapt catapult dead loads to use nose gear launch bar

The dead loads interface to steam catapults and EMALS using a bridle system. A bridle is essentially a thick wire rope that loops around the catapult shuttle. Older aircraft such as the A-4 Skyhawk used the same type of bridle for shipboard launches. Presently, aircraft use the nose gear launch bar that engages the shuttle via a slot in the top of the spreader. The project would involve adapting our dead loads to use the exact same launch bar that aircraft use and maintain very similar geometry. This would allow the catapult to maintain the exact configuration during dead load testing and would allow engineers to evaluate the performance of the shuttle used for shipboard operations.



Capstone 9-7: Next generation dead load propulsion system

The existing system has three major components, braking system, propulsion sled (jet car) and adjustable weight car (dead load).

The jet cars trail up to 8 sections of friction brakes behind them during an event. The brakes get manually "set" at the beginning of the event and as the jet car proceeds down the rail, it enters a braking section. Several bolts need to be rotated in order to set just one brake section. If the brakes are not properly set or they become unset due to the vibrations experienced during the event, the braking force with be adversely affected and braking distances will increase. This puts the jet car at risk of not stopping before the end of the rail.

The jet car houses the controls for up to four J57 gas turbine engines mounted on top. These components are maintenance intensive; the process for obtaining the desired end speed for the jet car is very crude. The existing systems use discrete components and relays to maintain proper engine speed. These components are also responsible for adjusting the engines back down to idle at the end of the run. The components are prone to failure particularly due to the high vibrations experienced during the event.

JET CAR IMPROVEMENTS Continued

The dead load is accelerated by the jet car to the desired speed along a mile and a quarter track at which time it engages any number of arresting systems being tested. Track configuration consumes a wide area and as such four propulsion sled rails are one and quarter miles long and one is only one mile long. There are no controls once the sled has been released.

This project would involve completely rethinking dead load propulsion. The primary goal is to eliminating the gas turbine propulsion systems, controls, mechanical friction braking system and dramatically shortening track length. This could be accomplished through the examples of linear synchronous motors or induction motor systems and their applications with amusement rides. This system shall be capable of moving a dead load weighing 180klbs to max speed of 200 kts. The system will allow operators to select settings for weight and speed, arm the system, and select a release switch to energize the propulsion system. Loads and end speed shall be recorded for each launch.

10. VISUAL LANDING AIDS

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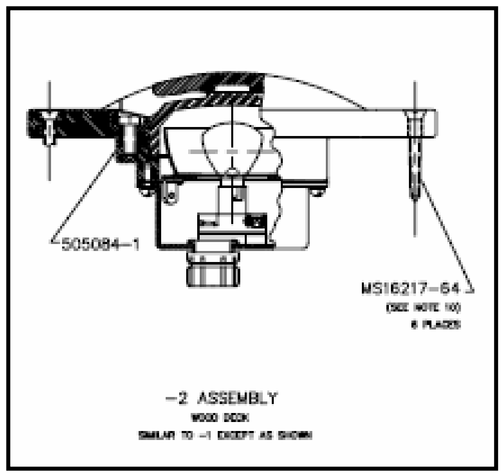
Areas of Concentration: Electrical Engineering

Deliverable. Design a prototype drop-in white LED Array Replacement Assembly for a Trade Number 1196 incandescent lamp used in a NAVAIR Lakehurst 609024-1 Spotpad Light. This light system is to be provided as Government Furnished Equipment, or GFE.

The constraints are:



(a) Fits within the existing light fixture without cutting wires, drilling of holes, or cutting of metal.
(b) Fits within the existing physical dimensions of the legacy light fixture.
(c) Provides the same spatial light output pattern as the existing incandescent light fixture.
(d) Provides comparable light output as the incandescent lamp over the voltage range of approximately 2.0 to 12.5 volts ac (without LED dropouts or dim-outs).
(e) Sufficiently robust to withstand shipboard electrical power.
(f) Provides a consistent color (to the unaided eye and as measured by color coordinate values) despite changes in LED bin numbers.
(g) Continues to provide light output even if a single LED fails.
(h) Energizes and operates over a temperature range of -40oF to 140oF.
(i) LEDs are not degraded by constant day in and day out exposure to ultraviolet light in sunlight.
(j) Provides sufficient spatial dimensions for an external Night Vision Goggle (NVG) compatible filter (dimensions possibilities to be provided).
(k) Document options and trade-offs.

11. AVIATION FACILITY CERTIFICATION

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Improve access to Aviation Facility Certification (AVCERT) documentation utilizing web-based products for easier fleet access and utilization. The current fleet access to AVCERT documentation is through printed paper documents and PDF files located on various Naval websites.

Issues: Inherent costs of producing paper products are growing. Often printed documents are outdated before or soon after printing. Printed document revisions are usually based on a 6 month or 12 month cycle, information latency is often the result of these schedules. The data required is often found in multiple locations and is not contiguous.

Requirement: Produce an AVCERT database or web-based document with hyperlinks that can be securely hosted and web accessed that are linked to other databases or data repositories that will allow the Fleet to access all AVCERT data from a single access point. NMCI compatibility is also required. Searching and reporting capabilities are also required.

The AVCERT Facilities Bulletin 1 series, Shipboard Resume, Naval Messages, HOSTAC APP/2 documents and any other AVCERT related documents are to be linked. These documents are currently electronic documents based in various word processing products. All documents should be reconstructed so that they can be easily maintained, updated and revised with little effort. All software utilized should be off-the-shelf products, readily available, with little or no customization. The ability to print all documents, searches and reports are also required.

12. VERTICAL ACCUMULATOR SENSOR

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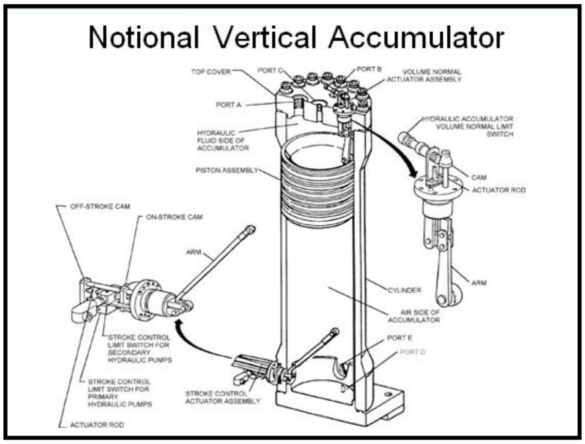
Areas of Concentration: Electrical or Mechanical Engineering



Background. Steam catapults are used to accelerate aircraft to a safe fly away speed on Aircraft Carriers. Current catapult systems utilize hydraulics to control movement of catapult mechanical components (valves, etc). Aircraft are launched via steam power/pressure which is hydraulically controlled and metered. The purpose of the vertical accumulator is to maintain a minimum volume and pressure of hydraulic fluid for the entire catapult system. Maintenance of the required volume of hydraulic fluid ensures nominal catapult performance related to the hydraulic components.

Challenge. Currently the volume of fluid inside the vertical accumulator is not measured during operations or test. The amount of fluid required to launch an aircraft is very important, a minimum indirect fluid level is measured by the current electrical system. A limit switch is used to determine if the piston inside the vertical accumulator is at a point which does not support a safe volume to launch (too high or too low). This switch is electrically tied to an indicator light and also drives a relay that is integral to the launch sequence in order to assure a safe departure for the aircraft launching.

13. FEASIBILITY STUDY: THERMOELECTRIC TECHNOLOGY (PELTIER EFFECT) FOR LIQUEFYING OXYGEN GAS

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The Cryogenics team will be procuring an Oxygen generator for expeditionary use. This generator will be required to output liquid Oxygen. The Oxygen will be generated from ambient air in the gaseous phase. A device will be required to liquefy the Oxygen gas generated.

A device using thermoelectric technology as the liquefier is a possible solution. The amount of Oxygen gas to be liquefied will be 720 SLPM.

The expected output of the feasibility study would include but not limited to a probability of success for such a device, if probability of success is greater than 80 %, a rough design of the device, an estimated power consumption of the device. - 486.10

14. EFFECTS OF PETROLEUM, OILS & LUBRICANTS ON EAF SYNTHETIC MAT SYSTEMS OVERVIEW

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Areas of Concentration:
Materials and/or Chemical and/or Mechanical Engineering

Lightweight and Extreme Lightweight Mat Airfield Surfacing Systems are manufactured from synthetic materials. These systems are installed to support aircraft operations including both launch and recovery, and aircraft maintenance.

Problem: When performing aircraft maintenance, various liquids classified as "petroleum, oils & lubricants" (POLs) are spilt onto the matting. Because some components of the matting systems contain petroleum-based materials, it is presently unknown if exposure to POLs causes a degradation to the strength or structural integrity of these mats. Furthermore, installed mats are continually exposed to ultraviolet (UV) radiation.

Design Challenge: Expose samples of the synthetic matting systems to the various combinations of POLs that may be encountered in the field, with and without additional UV exposure. Perform strength tests to these samples to allow comparison to known, baseline properties.

15. CATAPULT CYLINDER LIFTING SYNCHRONIZING

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Areas of Concentration:
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The steam catapult system uses slotted power cylinders which are assembled then lowered into a trough on the aircraft carrier deck. These cylinders when assembled are over 300 foot long and weigh over 100,000 lbs. They must be lowered with multiple gantry hoists with each hoist sharing the load. Currently there are thirty gantries used to lift or lower a row of cylinders. A crew of three (3) typically mans each gantry.

Present practice is to have all gantries tightened "snug" then hand-crank each gantry one quarter turn at a time to lift or lower the cylinders. Variation in the cable wrap, stretch and crank rotation can result in uneven loads. If one gantry lags behind, the adjacent gantries can be overloaded and fail. This failure can result in a cascading failure causing the entire row of cylinders to fall.

A method is needed to insure all gantries equally share the lift load and reduce the required number of personnel needed for the lifting work. This project is to design an automatic lifting system that is capable of raising the power cylinders in a uniform and controlled manner. The design should incorporate a load measuring device with a read-out for each winch to insure the load remains equally shared.

16. CSV MOTOR CONTROL PROJECT - Fairleigh Dickinson University

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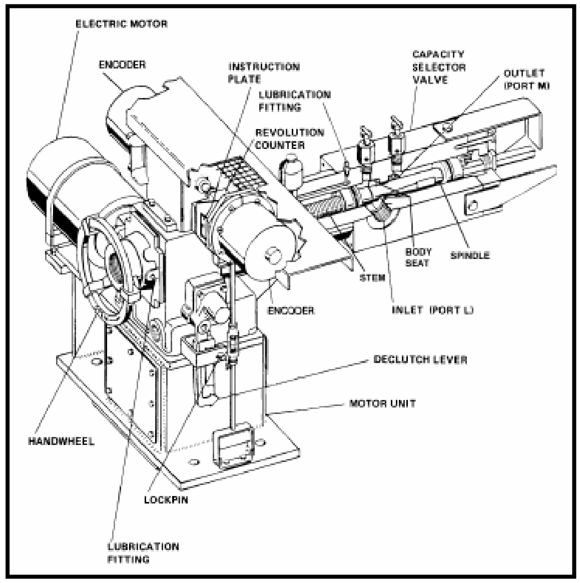
Area(s) of Concentration: Electrical Engineering



Capacity Selector Valve Assembly

As part of the Advanced Launch Control System Requirements the Capacity Selector Valve (CSV) will be controlled directly by ALCS. During the ALCS demonstration phase it was observed that the legacy motor controller did not have the control fidelity required and resulted in difficultly in narrowing in on the correct CSV setting (overshot the value etc.) The demonstration did not allow the flexibility to redesign the legacy motor controller to deal with this issue.

Technical Challenge: Research various motor controller technologies and identify best technology for the CSV application.

Background: The CSV System provides a means for controlling the opening rate of the Launch Valve (LV). During the launch, full hydraulic pressure is directed to the Hydraulic Actuator of the LV. As the piston moves, hydraulic fluid is forced out of two ports. One port goes directly back to the gravity tank and is only open for the first inch (roughly) of movement. After this first inch of travel all fluid is directed through the second port, which goes through the CSV before returning to the gravity tank (via the Launch Valve Control Valve). The position of the spindle inside the CSV determines the rate at which the fluid can flow controlling the opening rate of the LV.

Presently the position of the CSV is determined by counter rotating encoders. What the legacy CSV Electronics does is use two separate circuit cards to track the encoders and compare the readings.

When the Electronics drives the CSV from one position to another it takes in the Command Setting (desired position of the valve) and drives the valve either up or down from the current position. As the valve moves the CSV Electronics constantly compares the Command to the encoders. When all three match (there is some redundancy in the design) the CSV Electronics will turn off the motor driving the valve and apply the brakes to minimize overshoot.

The intention of the ALCS program was to eliminate the need for the separate electronics and allow the new control system to position the CSV. During the demonstration phase it was not possible to replace the hardware (motor) due to the need to operate the catapult in both legacy and in the advanced control system modes of operation. The ALCS team believes that a Stepper Motor configuration would be better suited to control the CSV under ALCS.

17. CATAPULT SHUTTLE GRAB ASSEMBLY - Villanova

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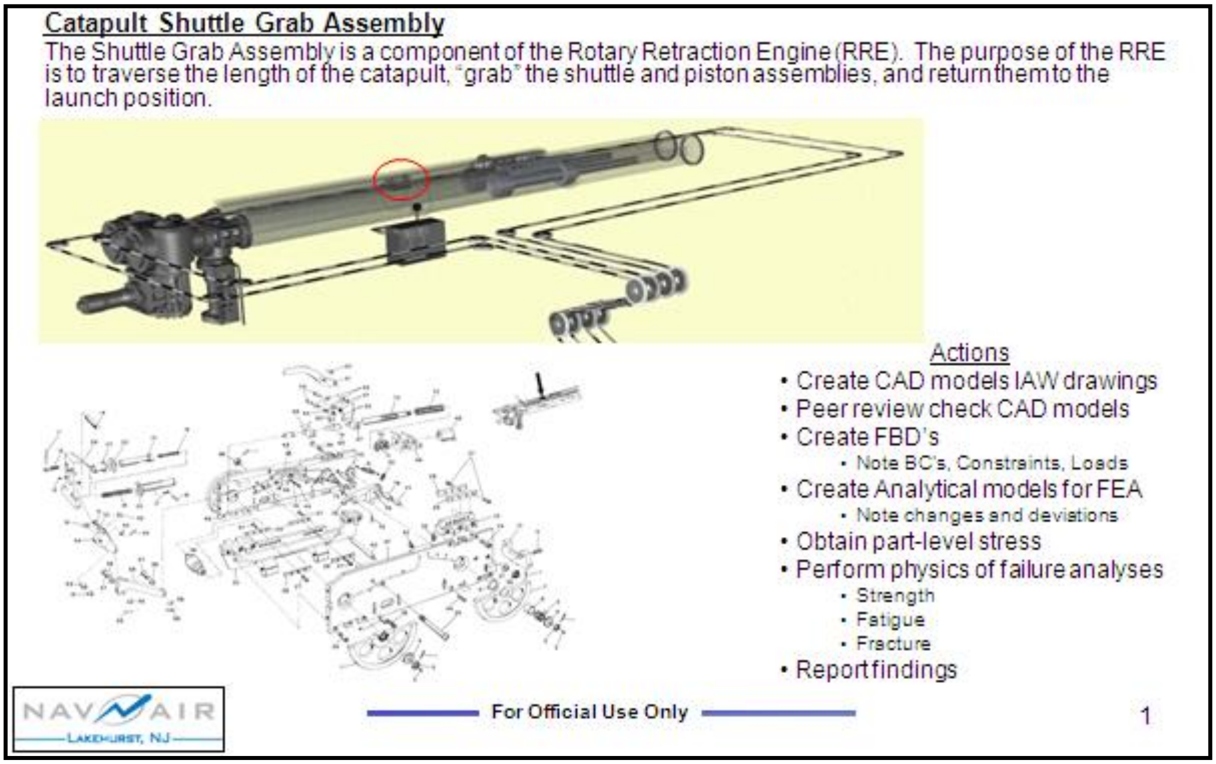
Areas of Concentration: Mechanical Engineering



18. MARK 7 ACCUMULATOR ASSEMBLY – Villanova

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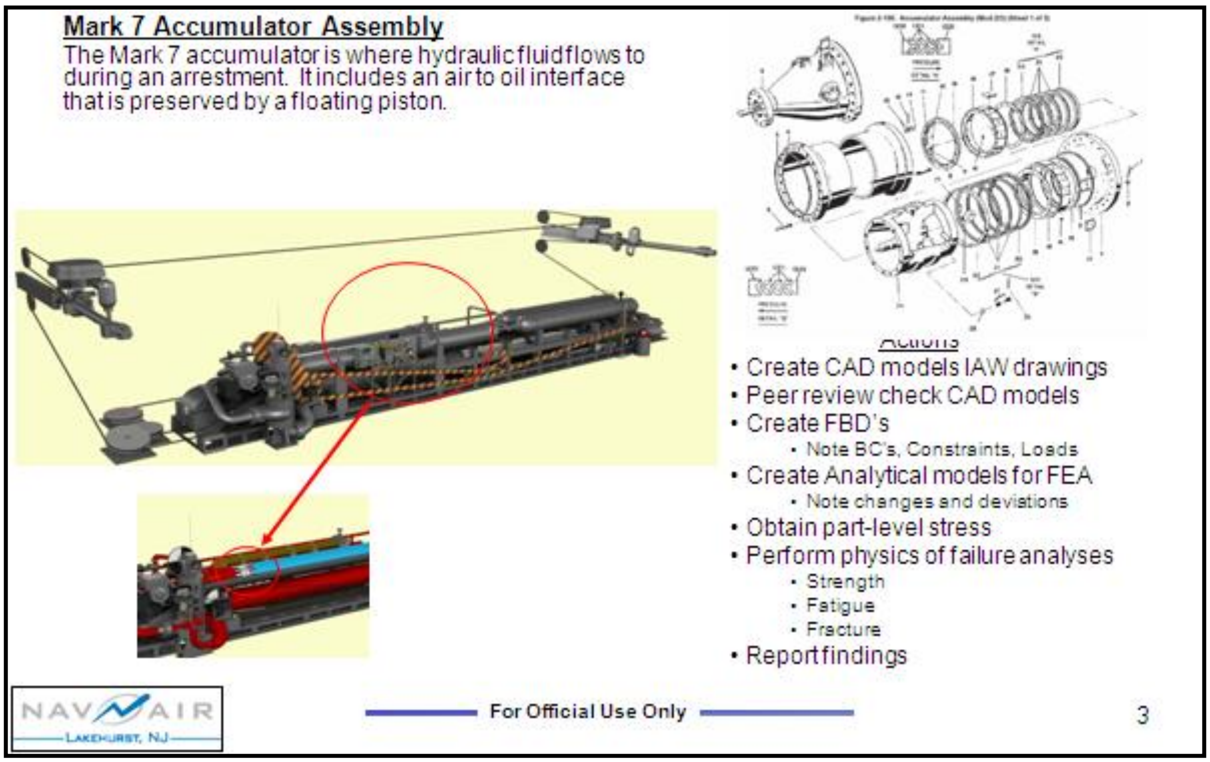
Areas of Concentration: Mechanical Engineering



19. MARK 7 RETRACTABLE SHEAVE ASSEMBLY – Rowan

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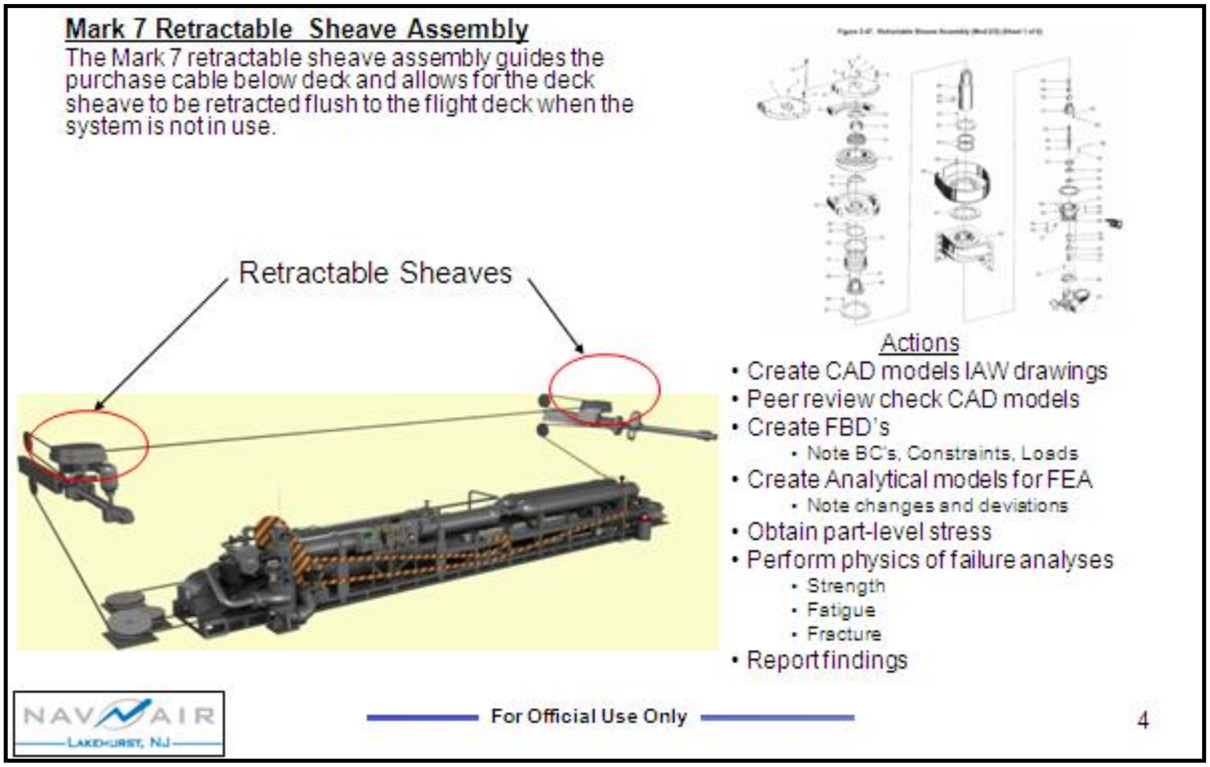
Areas of Concentration: Mechanical Engineering



20. CONCEPT VIABILITY FOR AN ELECTRIC AIRCRAFT CARRIER FIRE FIGHTING VEHICLE

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Areas of Concentration: Electrical and Mechanical Engineering

Outline

This project will investigate producability, viability and the potential cost/benefit of an electrically powered A/S32P-25 (P-25) or similar vehicle in the Navy shipboard environment. Initial student research has been completed and this effort will compound upon and validate these findings.

Requirements

In order to meet response requirements, the P-25 operates under the following mission profile during flight operations:

- Running, at idle, prepared to respond to an emergency
- Changes positions on deck
- Operates up to 20 hrs per day for 5-7 days per week
- Has the ability to nurse firefighting fluids to assist other ship systems for 2 hours

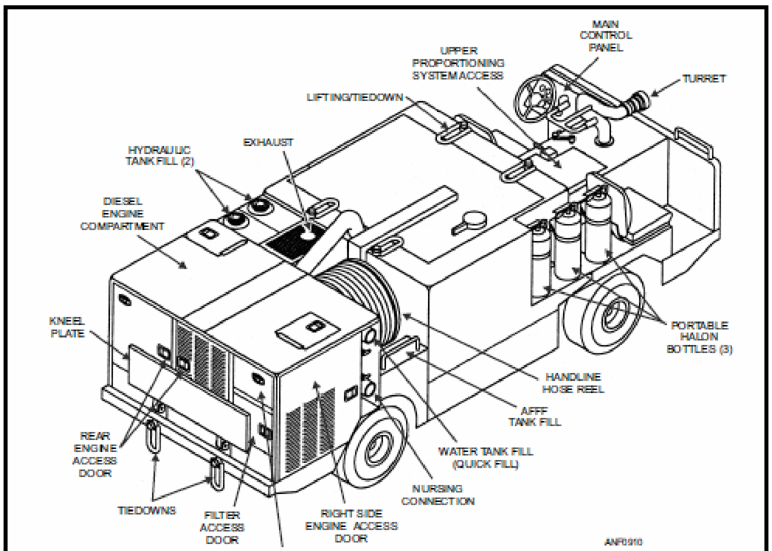

Figure 9-10.—A/S32P-25 shipboard fire-fighting and rescue vehicle—major assemblies and components (right side).

Background

The current P-25 weighs nearly 19,000 lbs loaded for duty and is powered by a 237 HP diesel/hydraulic system. It is deployed aboard all air-capable ships during flight operations and is considered "flight critical". An all electric system may provide the Navy with a capable vehicle that produces reliable performance while eliminating diesel emissions. This concept variant of P-25 may lead to other electrically powered support equipment.

21. AUTOMATED NETWORKED TRANSPORT SWARM (ANTS) – PART 1, HARDWARE

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Areas of Concentration:
Electrical and Mechanical Engineering

Part 1 – Hardware

Throughout the military services, a considerable amount of manpower is used to move materiel from one place to another. In the Navy, pallets and containers of weapons, food and spare parts are transported by forklift and un-powered dollies from staging areas to supply ships to surface combatant ships. Within each ship, there are considerable numbers of sailors dedicated to horizontal movement of materiel. This concept replaces the labor intensive task of moving materiel with a system that relies upon a system of automated networked support equipment. This equipment, as envisioned, utilizes collaborative swarm technologies to provide a reduced manning, low cost alternative to existing systems. A versatile "army" of load-bearing "ants" that are disposable, affordable, and reconfigurable would obviate the need for the high acquisition and maintenance cost that is typically associated with robotics.

This topic would focus on the hardware – the low cost, disposable "Ant" vehicles. The project team would design the Ant. The design would include the structure, materials, power source and locomotion. It would also include a concept of operations: how many Ants are required, and how the Ants would interact with the payload. Requirements include:

- Payload for a swarm of Ants: 3,000 lbs
- Acquisition cost per Ant: $ 500

(Note: Photos are intended to stimulate students thinking and are not intended to demonstrate the current challenges or the solution)

22. AUTOMATED NETWORKED TRANSPORT SWARM (ANTS) – PART 2, CONTROL

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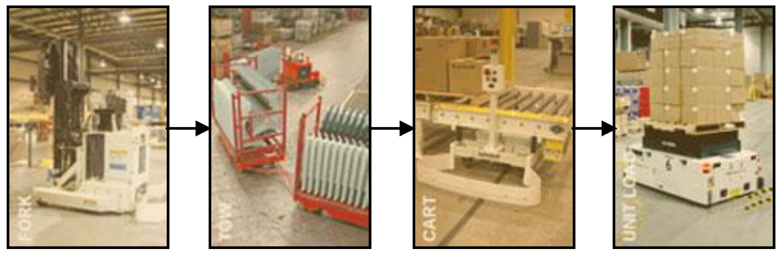

Part 2 – Control
Areas of Concentration:
Electrical and Mechanical Engineering

This topic focuses on the control of the Ants – how they interact with each other to accomplish a task, how they work together to avoid obstacles, and how they would interact with the human. To further develop the Ants concept, one of more of the following aspects of the problem should be investigated:

- Human - Machine Interface in a Collaborative Environment. The concept as proposed will require the agents to work in close proximity with humans as well as take direction from human operators. A control architecture is needed that allows the agents to take full advantage of the autonomous nature of the systems agents while not endangering the humans or putting other equipment at risk.
- Swarm Sensor Capabilities in an Operational Shipboard Environment. The amount of the agent's autonomous operations and activities, particularly local path planning, will be dependent on its ability to sense its surroundings. A sensor suite needs to be designed that will permit the agent to detect obstacles and provide Global (ship scale) navigation from starting position to the location of goal completion.
- Communications in a Collaborative Environment. Experimentation is to be performed to develop the necessary communications suite and demonstrate that the required communications, both external and internal to the collaborative swarm, are sufficient to coordinate inner-swarm and external-swarm activities.

Much research has already been done on cooperative control of swarms and off-the-shelf software exists. The student team is encouraged to research the state-of-the-art before embarking on this problem. The student team is also encouraged to buy small, hobby-scale robots and conduct experiments and demonstrations (e.g. of candidate hierarchies, control structures, path planning and obstacle avoidance) where possible.

(Note: Photos are intended to stimulate students thinking and are not intended to demonstrate the current challenges or the solution)

23. ELECTROMAGNETIC RESEARCH TOPIC

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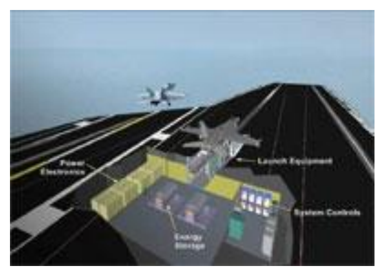
The Electro-Magnetic Aircraft Launch System (EMALS) is NAVAIR Lakehurst's #1 acquisition program. It replaces the 50-year old steam catapult with a technology that will provide better control of applied forces, improved maintainability, reduced manning, and increased operational availability. It consists of:

Energy Storage System
- Stores energy kinetically in rotating device
- Recharged from ship's power grid between launches
- 150-200 MJ delivered, 150-200 MW peak

Power Conditioning
- Controls power pulse from the energy storage device and delivers it to the launch motor
- 1.5-3.5 second pulse, 150-200 MW



Launch Motor
- Linear induction motor that provides thrust to the aircraft
- 300,000 lbs force

Control System
- Provides real time active control of the launch process

A major Key Performance Parameter for EMALS is weight and space. Too much topside weight on the aircraft carrier is a negative influence on the ship's center of gravity and seakeeping ability. Space is always at a premium on a ship. Any ideas for reducing topside weight and space would be appreciated, but the Energy Storage System and Power Conditioning could be ripe areas for weight/space reduction.

The deliverable for this topic would be a study and final report. The student team would provide novel ideas for improving EMALS and cite relevant current research from industry/academia to support those ideas. Trade-offs of various approaches for Energy Storage and Power Conditioning could also be evaluated. An energy density that approaches 10 kJ/kg and a power density approaching 8 kW/kg could yield a weight reduction of 30 tons per catapult. (Solid state approaches would be desirable for reliability/maintainability considerations.) For power conditioning, a power switch that combines high voltage/high power with high speed would yield a considerable weight and cost reduction.

24. SENSOR FOR PURCHASE CABLE INSPECTION

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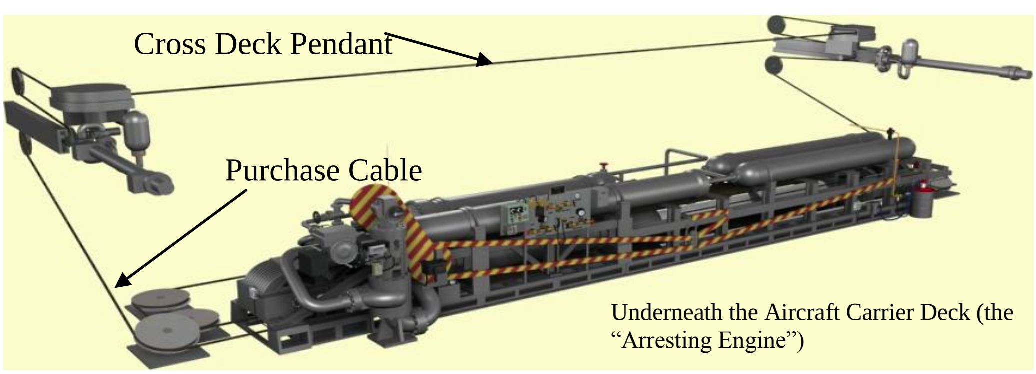
The Navy uses wire rope as the means of arresting aircraft aboard aircraft carriers. A length of wire rope (called the cross deck pendant) is spanned across the recovery area on the flight deck and attached to another length of wire rope (called the purchase cable) which is reeved on the arresting engine below decks. The arresting hook of the incoming aircraft engages the cross deck pendant which pulls the purchase cable initiating the arresting engine stroke. The arresting engine absorbs the kinetic energy of the aircraft, enabling the aircraft to land on the carrier's limited deck space. The current cable is steel wire rope surrounding a polyester core, 6 x 30, Lang lay, flattened strand. Diameter is 1-7/16 in. Operational life of the purchase cable is currently around 1700 arrestments, or "traps".

We take great pains to ensure the reliability of the cable, since a cable-breaking event would likely mean loss of life. The purchase cable is inspected every 300 traps initially, then every 100 traps after 1000 traps have been logged. The inspection is done visually, with sailors "eyeballing" the length of the cable while it is pulled on the flight deck by a tow tractor. Any broken wires found are cause for replacing the cable.

A sensor that could automatically determine whether there are any broken wires in the purchase cable without human intervention could save sailors considerable workload. The sensor would need to function without physically contacting the cable. The sensor could be mounted below the flight deck in a spot where the cable could be pulled through or past it, and it could "see" the length of the cable without moving.

Cost of the sensor would be a factor in its acceptance into the Fleet. A previous attempt to procure a cable inspection sensor found only one suitable solution which cost in excess of $200,000 per unit.



25. LARGE AREA NON-DESTRUCTIVE INSPECTION FOR AIRFRAMES

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Areas of Concentration: Materials and/or Industrial Engineering

Non-Destructive Inspection (NDI) is required for inspection of airframes, most notably composite structures which may have significant delamination within the material that is not apparent visually. Current methods of non-destruction inspection (NDI) are time consuming, requiring hours to inspect square feet. There is a need for large area NDI that could rapidly inspect large swathes of material at a time. Concepts could include flexible "blanket" of ultrasound sensors or remote electromagnetic sensors.

26. SYNTHETIC MATERIAL PURCHASE CABLE

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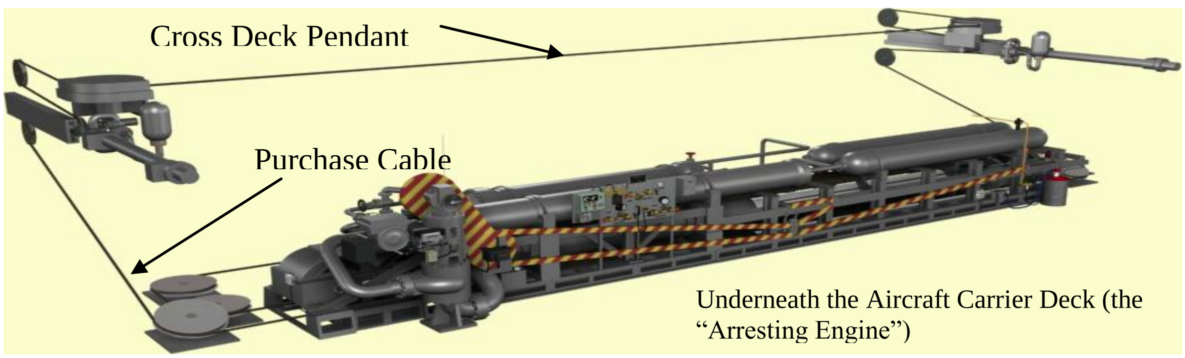
As aircraft get heavier and faster, arresting gear engines aboard aircraft carriers are starting to reach their performance limits for recovering the aircraft. Safety factor has become critically low, in some cases around 1.5. To recover the aircraft, the Navy is increasingly required to lighten the aircraft (i.e. jettison on-board fuel or ordnance) or steam the carrier at high speeds to increase the wind-over-deck. In addition, inertia of the arresting gear system threatens the airframe structure of smaller, lighter aircraft, such as T-45 or X-47.



A major contributor to the performance of arresting gear is the steel purchase cable, which accounts for 65% of the mass of the system. A lighter weight cable could reduce the system inertia, enabling the Navy to recover lighter weight aircraft, such as N-UCAS (X-47). It could also enable the system to recover energy earlier in the run-out, improving high-end performance for recovering heavier, faster aircraft. For this reason, the Navy embarked on a project with Cortland Cable Company (Cortland, NY) to develop a synthetic material purchase cable. Early work experimented with different synthetics (off-the-shelf materials such as Vectran, Kevlar, Technora or Spectra) and different cable constructions (e.g. braids and lays). The issue with synthetic material cable has always been service life. It has no problem achieving the required tensile strength, but it fails much earlier than steel during cycle testing. After four years of work, there were two encouraging data points: a Vectran wirelay achieved 3500 cycles and 6800 cycles in 2-sheave cycle testing. (Steel achieves 7600 cycles).

What we were finding was that the termination was failing before the cable was, so that we weren't getting a true measure of the service life of the cable. The cable strands must be placed in a socket and a special epoxy is poured into the socket. Because of the very high tensile loads on the cable, a "normal" poured socket will fail. A termination must be designed that equally distributes the load over each strand of the cable. ***This termination design is the objective of the project.***

Requirements for the cable:

- Maximum diameter: 1.5 inches
- Flexibility to bend around sheaves (sheave diameters: 28 and 33 inches)
- Max weight: 80 lbs per 100 feet
- Min tensile strength: 210,000 pounds, max tensile strength: 230,000 pounds

27. TERMINATION OF A SYNTHETIC CABLE

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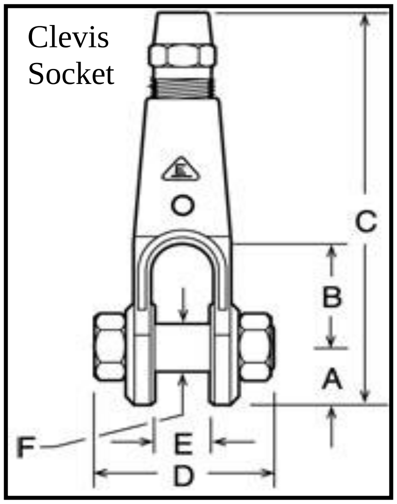

A related student project could be termination of a synthetic cable. The purchase cable is currently terminated (i.e. a terminal is attached to each end). This allows it to mate with the anchor damper at the arresting gear engine end, and the cross-deck pendant (the part of the cable that stretches across the flight deck and catches the aircraft tailhook) end. The termination needs to be near 100% efficient, i.e. there needs to be a minimal loss of tensile strength in transferring the load from the cable to the terminal, and there cannot be a risk of breakage at the termination point due to cable bending.

The only known termination concepts to date are: (1) Eye-splicing, where the cable end is bent around and weaved into itself, and (2) A proprietary method/product that presumably uses some kind of epoxy poured into a socket. The drawback to the eye-splice is that it consumes too much cable length. The problem with the proprietary method is that it ties the Navy to one sole source. It would be great, for cost and availability purposes, if a non-proprietary method could be developed that could be the basis of an open, competitive procurement.