NORTHWEST INDIAN COLLEGE
Xwlemi Elh>Tal>Nexw Squl

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Northwest Indian College Space Center USLI Team

2010-2011 NASA University Student Launch Proposal

October 1, 2010

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Northwest Indian College Space Center USLI Team Proposal

School Information

The Northwest Indian College Space Center USLI Team would like to officially declare their intent to compete in the NASA University Student Launch Initiative for the 2010/2011 Academic year. Our team has fully read and understood all expectations of the program as described in the Request for Proposals and Guidelines sent out in August 2010. We agree to follow all guidelines set forth by the Lummi Nation, NASA and the governing bodies in regards to safety standards, rules, and regulations.

1. Northwest Indian College is a tribally controlled college whose main campus is located on the Lummi Nation near Bellingham, Washington, USA. Its street address is 2522 Kwina Road, Bellingham, Washington, 98226. The Space Center (NWIC-SC) is the creation of several students and a faculty advisor and has been in existence since November 2009.

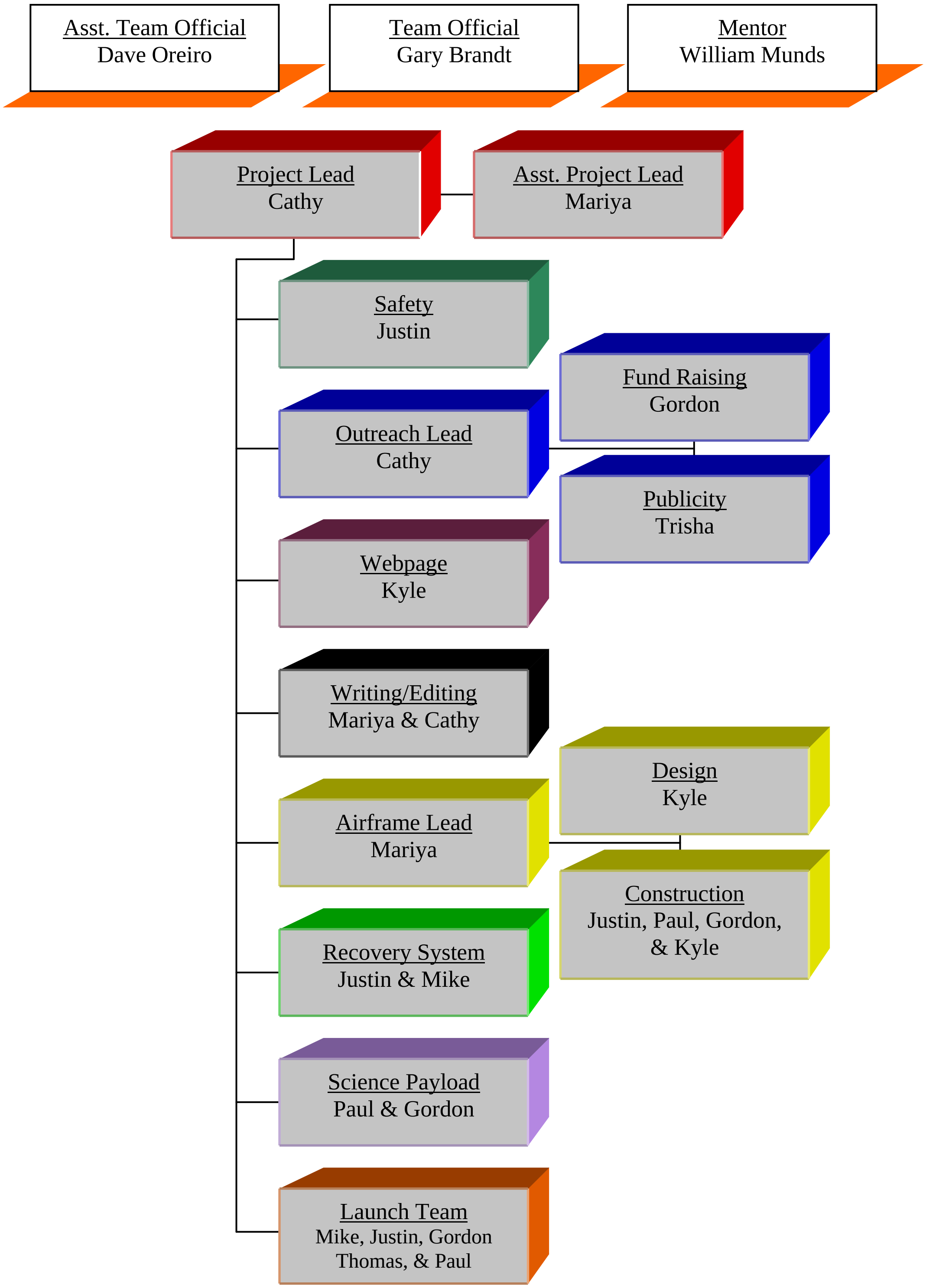
   The NWIC-SC believes that doing things is the quickest way to learning. Doing new things is the quickest way to expand one's horizons which can help make dreams a reality.

2. The Team Official is Gary Brandt, currently NAR Level 1 certified and a faculty member in good standing at Northwest Indian College. Dave Oreiro, NAR Level 2 and a vice president of Northwest Indian College is the secondary Team Official. William Munds is our National Association of Rocketry (NAR) point of contact for the duration of this project. Mr. Munds is a small business owner, Puget Sound Propulsion, and has an NAR High Powered Rocketry Level 2 Certification. Our team will coordinate test launches with NAR Section 538, the Washington Aerospace Club, for FAA waivers over 3000 feet above ground level. We will utilize our own launch complex for flights at or below 3000 feet above ground level.
3. The safety officer for our 2010-2011 USLI project is Justin. These safety officer is responsible for implementing the team's safety plan and will ensure that the team adheres to Tribal, Federal, State, and NAR guidelines.
4. The NWIC Space Center has nine students that have committed to this project. Their ages range from 18 to 76 years old and represent five tribes. Key resume′s are in Appendix A.
5. National Association of Rocketry Section 578, Washington Aerospace Club is assisting us and William Munds is our mentor.

Team Responsibilities

Team Lead	Coordinate team efforts
Safety	Ensure that safe procedures are adhered to, checklists are created and followed, and safety information is posted.
Outreach/Public Relations/Fund Raising	Work with organizations to educate, publicize our efforts, and raise money. Outreach emphasis will be on exposing students of all ages to the excitement of science, technology, engineering and mathematics through rocketry and related activities.
Webpage	Maintain team website to include activities, documentation, outreach, and sponsorships
Writing/Editing	Principle authors of documentation that needs to be submitted
Airframe Design	Design airframe that will meet the USLI team goals
Airframe Construction	Build and test airframe through simulations
Recovery System	Design and test redundant recovery system that ensures safe recovery
Science Payload	Design, assemble, and test the Science Mission Directorate (SMD) at NASA deployable science payload.
Launch Team	Organize and load all necessary equipment for both local and off-site launches. Maintain all ground support equipment in working order. Keep inventory of equipment and supplies.

Team Official	Gary Brandt	gbrandt@nwic.edu
Asst Team Official	Dave Oreiro	doreiro@nwic.edu
Project Lead	Cathy Ballew	cballew@stu.nwic.edu
Assistant Project Lead	Mariya Williams	mcw_713_33@hotmail.com
NWIC USLI Email Server	All team members	usli@nwic.edu
NWIC USLI Website		http://blogs.nwic.edu/usli



Organizational Chart

Facilities and Equipment

1. Our primary work area is Gary Brandt's classroom that has a portion of it set aside for building activities. The classroom houses the computer maintenance, robotics, and electronics programs. It is open from 8:00 am to 5:00 pm Monday through Friday. Mr. Brandt's office is also located in this classroom. The classroom is available at anytime any of the team members need to have access. The space has adequate ventilation, fire extinguishers, a first aid kit, safety goggles, as well as other safety gear that ensures the safety of its occupants. We have a covered outdoor space for construction and painting.

   We also have access to the Maintenance workshop which is connected to Mr. Brandt's classroom and entered through a separate exterior door. Its hours are also 8:00 am to 5:00 pm Monday through Friday

   B&J Fiberglass, who specializes in fiberglass repairs and fabrication, has offered us their facilities and an individual to assist us in using composite materials such as fiberglass and carbon fiber. Their shop is located five miles from the campus and is available upon our request.

   Gary has a fully equipped home woodshop which we also have access to. Student use will be Supervised as required.

   Northwest Indian College Space Center received a 3000 foot waiver from the Federal Aviation Agency and the Canadian Aviation Administration in August 2010. We have established a launch area that we can use any Saturday and Sunday (it needs to be renewed prior to August 29, 2011) for flights that do not exceed 3000 above ground level. For higher flights, we coordinate with the Washington Aerospace Club, NAR Section 538, and use their facilities at Mansfield, Washington.

2. All eight of our NAR/TRA Level 1/2 certified students/administrators are fully capable of designing and constructing a competitive rocket and payload. Currently we have an RDAS-Tiny altimeter and will obtain the required Perfect Flight MAWD altimeters when our proposal is accepted. We have used an altimeter in twelve of our thirteen HPR flights; the RDAS in ten and a Jolly Logic AltimeterOne in two.

3. The Northwest Indian College Space Center workplace has twelve Microsoft Windows-based computers:
   - 7 with Windows 7 and 5 with Windows XP
   - 5 with 2.87 GHz cpus and 7 with 2.00 GHz cpus
   - 7 with 80gb HD and 5 with 500gb HD
   - 12 with 2GB RAM
   - 5 have Rocksim
   - 12 have OpenRocket and RASAero
   - 4 have wRASP
   - 12 have Microsoft Office 2003 and 2007
   - 12 have Rhino 3D (3D CAD)
   - 12 have Adobe Master Suite CS4 which includes Photoshop, Dreamweaver, as well as most of the remaining Adobe suite
   - 12 have high-speed Internet access

We have WebEX video teleconferencing installed in one of our distance learning classrooms. Our website is hosted on Northwest Indian College's web server. Its url is: http://blogs.nwic.edu/usli. Jason Myers, 360-392-4318, jmyers@nwic.edu, is the contact person for Distance Learning/Web-based instruction and all things relating to the Internet.

4. All design reports and presentations created by the team shall follow the Subpart B technical standards of the Architectural and Transportation Barriers Compliance Board Electronic and Information Technology Accessibility Standards https://www.acquisition.gov/far/current/html/Subpart%2039_2.html

   Subpart B-Technical Standards http://www.section508.gov/index.cfm?fuseAction=stdsdoc

   - 1194.21 Software applications and operating systems. (a-l)
   - 1194.22 Web-based intranet and internet information and applications. 16 rules (a-p)
   - 1194.26 Desktop and portable computers. (a-d)

   These are the guidelines that we use to implement appropriate use of computer software, web design, and computers throughout the year.

Safety

Justin is the safety officer for the team. He is responsible for ensuring that all safety procedures, regulations, and risk assessments are followed. Justin is a member of the National Association of Rocketry and holds his Level 1 certification.

The Northwest Indian College Space Center has a 3000 foot waiver from US and Canadian aviation agencies that permits us to fly from 8:00am to 12:00pm on Saturday's and Sundays.

Safety Rules and Regulations

1. All members of the team shall adhere to the NAR High Powered Safety Code. The NAR HPSC is attached as Appendix E.
2. All members of the team shall adhere to the National Fire Protection Association (NFPA) 1127: "Code for High Powered Rocket Motors".
3. All members of the team shall be aware of Federal Aviation Regulations 14 CFR, Subchapter F Subpart C "Amateur Rockets".
4. 4. All team members shall read and sign the "Range Safety Regulations" (RSR) statement. The RSR is attached as Appendix F.

This is a list of current team members and their respective National Association of Rocketry (NAR) or Tripoli Rocketry Association (TRA) certification levels. One member and the advisor are currently level 2 certified, which will allow us to use the appropriate motor, and Bill Munds, team mentor, shall be the designated owner of the rocket for liability purposes.

Bill Munds	Mentor	NAR L2
Dave Oreiro	Administrator	TRA L1, NAR L2
Gary Brandt	Faculty	NAR L1
Mariya	2nd year	TRA L1
Michael	1st year	TRA L1
Kyle	2nd year	TRA L1
Justin	3rd year	NAR L1
Patrisha	2nd year	NAR L1
Gordon		NAR
Paul	1st year	NAR
Thomas	1st year	
Cathy	2nd year	

All team members will have been briefed as of Thursday, September 30, 2010 on the NAR High Power Rocket Safety Code and the risks involved with high power rocket launches.

Construction

1. The Airframe Lead has the final say while constructing any designs, subsystems, or sections of the rocket.
2. The safety officer is responsible for having all MSDS for hazardous materials. Also, the safety officer shall inform the team of any material or substance

hazards before use. A sample MSDS sheet and hyperlinks to the MSDS sheets are located in Appendix D.

3. All team members are required to wear appropriate Personal Protective Equipment (PPE). PPE includes, but is not limited to, safety glasses, gloves, ear plugs, and breathing masks. The safety officer will notify team members when materials that require PPE are being used. If additional PPE is required, it is the safety officer's responsibility to obtain the additional equipment.
4. Safety glasses shall be worn when any member is using a tool that may possibility create fragments of a material (Dremmel tool, hammer, band saw, etc.)
5. Power tool use requires at least two members be present. All team members shall wear the appropriate PPE.
6. Safety is the responsibility of all team members. The safety officer shall make all team members aware of any hazards, but individual team members shall be responsible for following all regulations and guidelines set forth by the safety officer.

Motors and Black Powder

1. All explosive materials shall be kept in the appropriate storage magazine located off-site on the property of Gary Brandt, the Team Official.
2. All extra black powder, e-matches, igniters, and any unused ejection charges will be stored in the magazine.
3. Any explosives being handled during launch day will be monitored by the safety officer.

Launch Operations

1. Check lists for Ground Support, Preparation, and Launching shall be used.
2. The area surrounding the launch pod shall be cleared of all flammable materials, such as dry vegetation, for a radius of at least 50 feet. The launch control box will be located at least 100 feet from the launch stand.
3. The launch rail shall not be inclined greater than 30 degrees from the vertical position.
4. An amplified audio system will be employed during launches.
5. Once everyone is a safe distance from the launch stand, the Range Safety Officer (RSO) will permit the Launch Control Officer (LCO) to connect the launch control system to the power source.
6. The RSO shall contact the appropriate aviation agencies 5-10 minutes prior to launch for clearance to launch.
7. After the RSO has received clearance and agrees that conditions are safe for launch, the system will be checked for continuity and then armed by the LCO.
8. The LCO shall check for aircraft and any other potential hazards and then commence counting down from 5 seconds.
9. The LCO shall activate the launch system when the countdown reaches zero.

Environmental Safety at the Northwest Indian College Launch Complex

1. All hazardous materials, such as black powder and epoxy, brought onto the field must be removed.
2. All trash will be removed prior to leaving the launch complex.
3. Motor remains must be disposed of properly.

4. All rockets shall be recovered. If a rocket is lost, the team will work with the appropriate Tribal office for further assistance.
5. The launch complex will be left as clean, or cleaner than it was prior to launching.

3. **Recognition of Federal, State, and Local Laws**

The Northwest Indian College Space Center USLI team recognizes and adheres to all Tribal, state, federal, and local laws relating to the use of high power rockets. Each team member is required to sign a Range Safety Regulations (Appendix F) form acknowledging that they are aware of these laws and regulations. All team members are briefed on safety hazards and risks that will be present at any build sessions or rocket launches. The RSO shall conduct a safety meeting before any launch day. This meeting will include information about predicted risks, weather conditions, minimum distances from launch pad, and any changes in the launch waiver.

The RSO or her designee shall contact the proper authorities at the appropriate times to activate the waiver for launching. Appendix G lists the time frame and contacts for waiver activation.

Each team member understands and fully complies with the following safety regulations. These regulations will be enforced by the Safety Officer.

- FAA- Federal Aviation Regulations 14 CFR, Subchapter F, Part 101, Subpart C
- NAR High Powered Rocketry Safety Code
- NFPA 1127 “Code for High Power Rocket Motors”
- NAR High Powered Safety Code
- CFR Title 27 “Commerce in Explosives”

4. **Interaction with Rocket Motors**

Motors will be purchased by either Bill Munds or one of the appropriately certified officers. After motors are received they will be placed in the team’s motor magazine which is located off-site on the property of the Team Official, Gary Brandt. This magazine is an ATF-approved Type 4 container. A second, smaller magazine box is an ATF-approved Type 3 container and will be used to transport motors to and from the launch.

Arrangements for purchase, delivery, and storage of our motors for the USLI launch in April at Huntsville, AL will be performed by our NAR Mentor, Bill Munds.

Technical Design

Initial Considerations

Safety and the science payload are the key determining factors in our rocket design. Safety requires a rocket of a certain size to allow for the redundancy for the recovery system. The size of our science payload will also determine the size of our rocket. Our design process involves conceptualizing an airframe that will carry the payload with a minimum of extraneous airframe and therefore weight. We also want to use the smallest motor that will achieve the altitude goal of 5280 feet and yet be large enough to carry parachutes that will meet the proscribed descent rates.

The rocket's avionics bay will have to be large enough to house the two altimeters used for the redundant recovery system as well as a third altimeter that will initiate and terminate events for the science payload. The respective recovery compartments will have to be large enough to house the drogue parachute and the main parachute as well as the appropriate ejection heat intervention material.

Our conceptual design has produced a relatively small airframe. This will permit us to build a full-scale prototype to test design and motor configurations thusly avoiding scaling issues.

Projected General Vehicle Dimensions

Since the payload is the defining factor for our rocket design, a least a portion of the rocket will have to be 7.5 inches in diameter. Our design is that the rocket will transition from a 4" cross section to a 7.5 inch cross section and then back to a 4 inch cross section. The fins will be large enough to not be adversely affected by the airflow "shadow" created by the payload bay.

We will be building our rocket from components available from LOC Precision Rockets as well as custom building some of own components such as the airframe transitions. Fiberglass reinforcing will be done along each fin as well as other critical areas such as the rail button standoff. The design also encompasses an anti-zipper design, meaning that the airframe will be constructed so that the recovery system shock cords will be attached in such a fashion that there will be minimum chances of airframe damage due to a high speed drogue deployment. A preliminary parts list is in Appendix B .

Preliminary dimensions using Apogee Components Rocksim 9.09 are as follows:

Fully loaded with recovery, avionics, science payload, and a typical K motor

- Length: 84.3inches
- Diameter: 7.67 inches
- Weight: 15.34 pounds
- Fin Span: 20.00 inches
- Center of Gravity: 54.08 inches
- Center of Pressure: 66.87 inches
- Stability Margin: 1.67

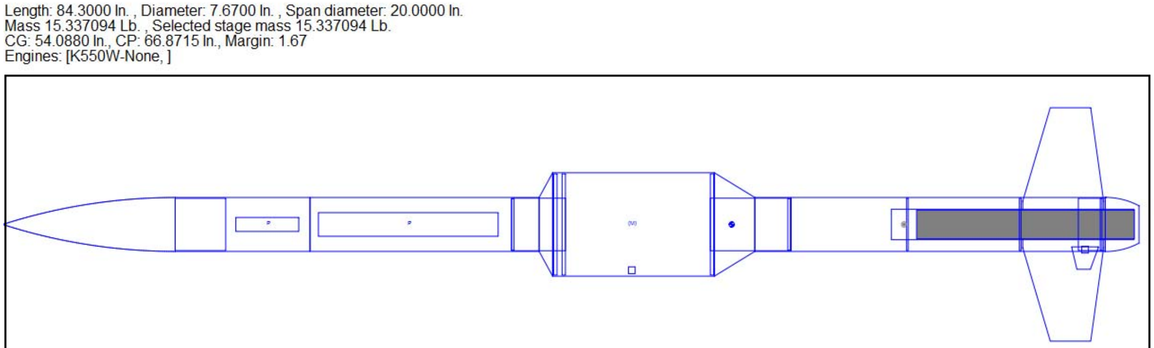


Figure 1 – General Design, Rocksim 9.09

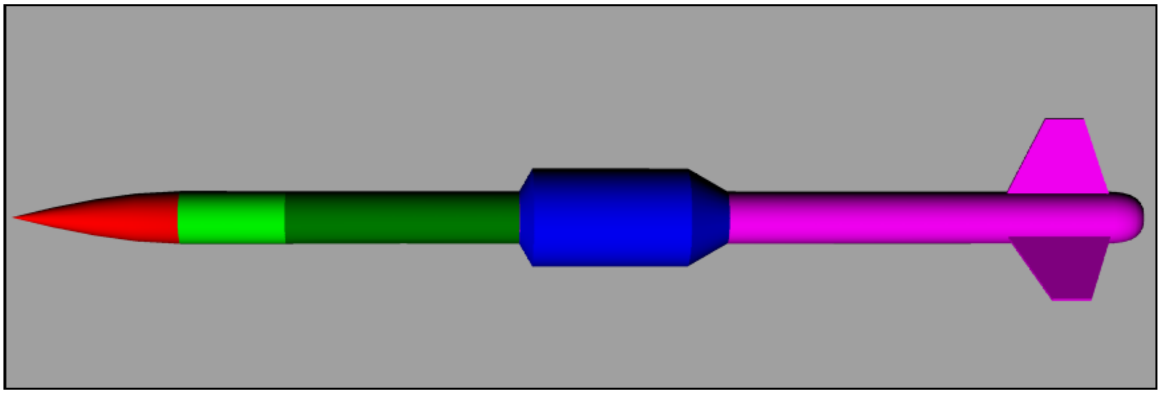


Figure 2 – Airframe Components
red, nosecone; light green, drogue; dark green, main; blue, payload; pink, fin can

Projected Motor Type and Size

The rocket shall use a commercially available high powered rocket motor certified under NAR regulations. The motor shall use a standard solid APCP (Ammonium Perchlorate Composite Propellant) in the “K” impulse range (1280 - 2560 Newton-seconds). The final motor will be selected based upon its’ ability to reach the altitude of 5280 feet AGL with greatest precision. We plan to use “K” motors in the 1594 – 1730 Newton-seconds range.

Motor	Diameter-mm	Length-Inches	Burn Time-Sec	Impulse N-Sec
K550W	54	16.1417	3.50	1594.464
K1100T	54	16.1417	1.60	1618.856
K805G	54	15.7717	2.40	1730.041

Figure 3 – Aerotech Motors for Initial Consideration

Our final selection will be made after three test flights.

Data from Rocksim with a K550W (assume apogee drogue deployment) is in Appendix C.

Project Science Payload

We are going to do the NASA Science Mission Directorate's scientific payload that monitors and transmits to a ground station many weather and atmospheric phenomena. Our intent is to do what Dr. Werner Von Braun did in the 1950's and what NASA is doing now; use proven technology to accomplish a goal. We intend to use a modified weather station for our data gathering and telemetry. We have a working relationship with the vendor in anticipation of overcoming any difficulties. The measurements that we'll be monitoring are:

- Barometric pressure
- Atmospheric temperature,
- Relative humidity
- Solar irradiance
- Ultraviolet radiation

The measurements shall be made at least every 5 seconds during descent and every 60 seconds after landing. Furthermore, surface data collection operations will terminate 10 minutes after landing. Data from the payload shall be stored onboard and transmitted to the ground station after completion of surface operations.

The secondary mission requires recording at least two pictures during descent and three after landing. The pictures need to portray the sky toward the top of the frame and the ground toward the bottom of the frame.

Our preliminary investigations for the design and construction of the scientific payload, indicate that the payload bay will have to be 7.5 inches in diameter and 12 inches long. It will have to descend as vertically as possible for both some of the atmospheric measurements and for the photography.

Recovery

To ensure a successful flight and recovery, the rocket shall be equipped with a double redundant recovery system. One PerfectFlite altimeter shall provide primary parachute deployment functionality. A second PerfectFlite altimeter will provide secondary deployment functionality. The rocket will carry a single drogue parachute and a single main parachute. Each flight computer shall control a separate set of ejection charges and shall have it own separate electrical system. Each set of ejection charges are to be ignited in sequence, with a short delay (~1 second) between ignitions. The primary drogue charge shall ignite in sequence, beginning at apogee followed closely by the secondary drogue charge, and then the main charges shall ignite (primary then secondary) at approximately 500 feet AGL. We will use progressively larger charges, in the event that the primary charge does not deploy the applicable parachute due to a blockage inside the rocket. Although the charges increase in power amount, all charges shall be calculated so as not to over pressurize the parachute bays of the rocket.

We want the science payload to remain as vertical as possible during the recovery phase. Therefore both the drogue and the main parachutes will be deployed forward of the payload bay. The drogue will follow the ejected nose cone and the main will follow the ejected upper airframe section. Preliminary descent rates are 56 fps and 19 fps for the drogue and the main respectively.

Major Challenges and Solutions

Our biggest challenge will be to keep the team together and functioning as a unit for the entire duration of this project. Native American culture often times requires individuals to participate in cultural activities that require absence from school and or work.

Personal Safety Hazards	***Potential Effects of Failure***	***Failure Prevention***
Individual health issues when working with epoxy, fiberglass, paint, etc.	Person will become sick or experience discomfort.	Wear appropriate safety clothing/equipment such as gloves and clothing to cover skin, face masks, etc. Have adequate ventilation. Have MSDS prominently posted.
Accidental injuries such as lacerations, bruises, etc.	Harm to team members (possible hospitalization).	Be attentive to task at hand. First aid kit is available.
Potential fire when working with flammable substances	Harm to team members (possible hospitalization).	Be aware of locations of nearest first-aid kit, fire extinguisher, and eye wash station
Untidy work area	Harm to team members (possible hospitalization). Loss of tools, hazardous working conditions	Everything has a place and everything in its place. Clean up debris during and after working.

Schedule Risks	***Potential Effects of Failure***	***Failure Prevention***
Team members have other obligations that interfere with presentations or launches.	Team participation decreases which results in lower membership.	Notify team members of any presentations, launches, or due dates well ahead of time.
Team has difficulties meeting set deadlines.	Deadlines will not be met.	Assign enough time for the completion of tasks.
Meeting times conflict with certain members' schedules.	Certain members will be unable to attend meetings and will miss important information.	Choose times that best fit the majority of the membership. The team shall also work with members that still have conflicts.
NWIC's exams overlap with deadlines set by USLI.	Reports or presentations might not be completed.	Check the dates of final exams, holidays, and major events against the USLI timeline.
NWIC sessions changes from fall to winter to spring quarter.	Team members' schedules will change.	Vote by majority for meeting times and plan accordingly.

Financial Support Failures	***Potential Effects of Failure***	***Failure Prevention***
Fundraising activities do not generate enough funds.	Team will be unable to purchase accessories such as shirts.	Hold several small-scale fundraisers to allow for more diverse interest in the team.
Incorrect parts or supplies are purchased.	Delay in build sessions, and possible milestones.	Ensure all orders are verified by team officers.
Problems could arise with space grant funding for the team.	Delays in purchasing needed supplies and parts.	Adhere to budget guidelines and discuss financial matters with team advisor.

Structural Failures	***Potential Effects of Failure***	***Failure Prevention***
Fins fail during flight due to shear forces or inadequate use of adhesive.	Rocket will experience an unstable and unpredictable flight trajectory.	Use suitable building materials, through-the-wall fin mounting, and ample application of adhesive and fillets.
Rocket experiences drag separation during flight.	Rocket will prematurely separate, leading to early parachute deployment and a mission failure.	Ensure that all joints are secure and shall drill a hole in the body tube to equalize pressure between the interior of the rocket and the atmosphere.
Joints of the rocket do not separate at parachute deployment.	Parachute bay will experience over-pressurization from the ejection charge but will not deploy the parachute.	Conduct pre-launch separation testing.
Parachute deploys too early or too late in flight.	Oscillation of the shock cord produces a zippering" effect. "	Ensure strong connections of the shock cord bulkheads to the body. The team shall also calculate the altitude of apogee and program parachute deployment accordingly.
Rocket components are lost or damaged during transport to launch site.	Team risks not launching the rocket unless repairs can be made.	Pack components safely and securely for transport and have replacement components and needed tools available at the launch site.
Rocket structure is crushed due to in-flight forces.	Rocket will have a ballistic trajectory, and the mission is a failure.	Compression-test materials to ensure that material and structure is strong enough to withstand appropriate amounts of force.
Center of gravity is too high or too low.	Rocket will be unstable or overstable.	Adjust weight so that center of gravity is 1-2 calibers ahead of center of pressure.
Center of pressure is too high or too low.	Rocket will be unstable or over stable.	Adjust fin sizing and position so that the center of pressure is 1-2 calibers behind the center of gravity.

Payload Failures	***Potential Effects of Failure***	***Failure Prevention***
Battery power supply fails prior to launch.	Avionics will fail to record data, resulting in the inability of the ARTS to eject the parachutes.	Check batteries prior to launch and have extra batteries located at the launch site. The team shall also use separate power supplies for each section containing electronic devices to prevent the failure of all electronics.
Wire connections in the rocket loosen during transport or flight.	Data will not be complete, causing a payload objective failure. Ejection electronics may not deploy parachutes, causing a ballistic recovery.	Secure wires with wiring loom and ensure that all wires are properly connected prior to launch.
Altimeter or ARTS fails to record data during flight.	Altitude may not be properly measured and ARTS will not deploy parachutes properly.	Test the ARTS and altimeter for functionality prior to launch. The team shall also properly calibrate the altimeter and ARTS before launch.
GPS system fails to record the position of the rocket.	Recovery of the rocket will become more difficult. The rocket may possibly be lost.	Test the GPS before launch and use a secondary tracking system.
Avionics are broken during the transport, storage, or flight.	Data will not be collected, and the payload objective will be considered a failure.	Store equipment in a safe, dry place during both storage and transport.
Static discharge to electronics.	Electronic instruments are damaged.	Team members should properly ground themselves before handling electronics.
Individual sensor fails	Incomplete data acquisition	Test, test, test, and test again
Transceivers malfunction	No data transmission	Ensure adequate on-board data storage system so that mission is not a total loss

Recovery Failures	*Potential Effects of Failure*	*Failure Prevention*
Drogue and main parachute bays experience separation during flight.	Parachutes will deploy early, causing the rocket to miss the target altitude. A zippering effect may also occur.	Ensure strong connections at joints and proper pressure equalization in parachute bays.
Shock cords snap upon parachute deployment.	Rocket will experience an uncontrolled descent.	Test shock cords to ensure that they are sufficiently strong enough to withstand expected loads.
ARTS fails to deploy the drogue and main parachutes.	Rocket will experience an uncontrolled descent.	Ensure that the ARTS is functioning properly prior to launch. A triple-redundant ejection system shall be utilized.
Drogue and main parachutes are packed too tightly to release.	Rocket experiences uncontrolled descent.	Test efficiency of the packing technique before launch.
Parachute melts or chars due to ejection charge heat.	Parachute becomes partially or entirely ineffective, causing an uncontrolled descent.	Use flame/heat retardant material between the parachute/shock cord and the ejection charge.
Parachute lines tangle upon deployment.	Parachutes will be ineffective, causing an uncontrolled descent.	Test deployment prior to launch and use a parachute/shock cord packing procedure that minimizes tangling.

Propulsion Failures	***Potential Effects of Failure***	***Failure Prevention***
Propellant fails on the launch pad.	Launch will be unsuccessful.	Test the ignition system and ensure that the connection points and the installation of the igniters are correct.
Igniter fails on the launch pad.	Motor of the rocket will fail to ignite.	Ensure that the igniter is secure before attempting ignition.
Motor centering rings fail.	Thrust vector is will not be aligned with the axis of symmetry, causing erratic and unpredictable flight.	Use strong centering rings that are well mounted and have holes in the true center.
Motor mount fails.	Rocket and the payload might be destroyed by the motor traveling up through the rocket body.	Test the motor mount system for correct construction. The team shall also conduct an inspection of the mounting system prior to launch.
Motor retention system fails.	Free-falling ballistic objects could be produced, possibly harming people around the launch site.	Use an adequate motor retention system to ensure that the motor will remain in the rocket.
Motor explodes on the launch pad.	Rocket will explode and the mission will be a failure.	Use appropriate casings for motors and stand an appropriate distance away from the launch pad at the time of ignition.

Launch Operation Failures	***Potential Effects of Failure***	***Failure Prevention***
Power supply for the ignition fails.	Rocket will fail to launch, and the mission will be a failure.	Ensure that the power supply is fully charged.
Launch buttons malfunction.	Launch will be unsafe, and the rocket could have an unpredictable trajectory.	Ensure that the launch buttons are securely attached to the rocket body and that they are correctly aligned with one another.
Igniters are faulty.	Motor will not ignite and the rocket will not launch.	Bring extra igniters to the launch site.
Rocket snags on the launch rail.	Launch buttons will strip off, causing the rocket to have an unpredictable trajectory.	Clean the launch rail and apply a lubricant, such as WD-40, prior to the launch.
Structural damage to launch pad due to previous catastrophic malfunction.	Launch rail unusable for future flights until repaired or new rail acquired.	Proper safety precautions (fire extinguisher). Have a secondary launch rail for backup.
Grass at the launch site catches on fire after launch.	Equipment will be destroyed and people at the launch site will possibly be harmed.	Ensure that the grass near the launch site is not excessively dry. The team will also have a fire extinguisher readily available.
Rocket is carried out of range by the wind.	Rocket will be lost.	Not fly in heavy or unsafe winds.
Catastrophic motor malfunction on launch pad	Rocket is damaged, possibly destroyed.	Ensure proper fire safety devices are on hand to prevent any accidents.

Educational Engagement

The Northwest Indian College Space Center is officially recognized by the Northwest Indian College administration as a student activity group and club. Since its inception in November 2009, the NWIC Space Center has been actively engaged in community and education outreach. We have presented activities to such diverse groups as the Summer Native Youth Project at the University of Washington, a water rocket workshop at the Native Women/Girls, Men/Boys Conference, the NWIC Career Fair that included John Harrington, a former astronaut, and a water rocket unit with the Lummi Head Start.

We already have commitments; some more firm than others for the upcoming school year.

Our schedule for this year includes the following:

October	water bottle rocket unit with Lummi Nation Head Start Opening Ceremony and HPR launch at the NWIC Space Center Launch Complex
November	Rocketry presentation to Lummi Nation Elementary School
January	Water Bottle Rocketry unit and launch with Kulshan Elementary School
February	Water Bottle and Model Rocketry unit and Launch with Lummi Nation Middle School
March	Northwest Indian College Career Fair presentation

The vast majority of our engagement projects involve hands-on activities designed to engage the students physically as well as mentally. We have had considerable success with this approach in previous outreach activities.

Community and Outside Support

Our Space Center has been quite successful in obtaining support, both from the Native Community and the community of Bellingham. We will build upon that support by soliciting funds and materials from the local businesses. We have a multi-stage sponsorship plan that netted us $1384 over a period of two months for our first major rocketry project.

We are also designing a fund raising plan to reach out to the other Native Reservations and Tribes in our area.

J&B Fiberglass, a prominent fiberglass/composite repair business has committed to supporting us should we decide to fabricate our own rocket airframe, or any portions of the airframe. Several of the businesses that supported our First Nations Rocket Launch entry have indicated that they will support us again at the same or higher level of funding or materials.

Barry Lynch of LOC Precision Rocketry has volunteered to provide additional technical and construction assistance.

Sustainability

The Northwest Indian College Space Center has been embraced by not only the college community but also the Tribal community. The College has offered its first physics classes in nearly five years because of the interest generated by the rocketry program.

The Space Center is often asked to provide demonstrations and mini-units to educational institutions. For example we did a afternoon water rocket activity with the Native Youth Enrichment Program at the University of Washington and we received an email on September 28th with the following request:

> Hi Gary,
>
> This is Kyle Tiffany from the Native Youth Enrichment Program; it was great to see you again at the opening of NWIC's new Science building. I wanted to ask your thoughts on hosting a convention for our summer program students. We would love to work with you on putting together a "Science Symposium" where our students could learn more about their educational options as well as network themselves within the Native STEM community. We believe that the opportunity to see NWIC and meet scientists such as you would have a profound impact on the students. Please let us know if there is an opportunity for collaboration here.
>
> Best regards,
> Kyle Tiffany
> --
> Kyle Tiffany
> Curriculum Developer, Native Youth Enrichment Program
> Indigenous Wellness Research Institute
> 4101 15th Avenue NE
> Campus Mail Box 354900
> Seattle WA 98105-6299
> Cell: 425-736-6123

Project Plan

Schedule and Time Line (milestones in bold italics)

October 2010:

1 One electronic copy of the completed proposal due to NASA MSFC.
4 Web presence established
4 Post proposal and MSDS on website
5 Parts ordered for scale rocket
12 Schools notified of selection
12 Order altimeters
13 Construct scale rocket
14 Order science payload components
20 Meet with Bill Munds, mentor
25 Trip to Mansfield, WA for L2 certification flights
21 USLI team teleconference (tentative)
21 Test recovery ejection systems

November 2010:

3 Assemble and test payload components
6 Launch scale rocket
19 Preliminary Design Review (PDR) report and PDR presentation slides posted on the team Web site
20 Launch scale rocket
29 Construct competition rocket

December 2010:

6-10 Preliminary Design Review Presentations (tentative)

January 2011:

15 launch competition rocket
24 Critical Design Review (CDR) reports and CDR presentation slides posted on the team Web site.

February 2011:

2-8 Critical Design Review Presentations (tentative)
19 launch competition rocket

March 2011:

12 launch competition rocket
21 Flight Readiness Review (FRR) reports and FRR presentation slides posted on the team Web site.
28-31 Flight Readiness Review Presentations (tentative)

April 2011:

13 Travel to Huntsville
14-15 Flight Hardware and Safety Checks (tentative)
16 Launch Day

May 2011:

9 Post-Launch Assessment Review (PLAR) posted on the team Web site.
20 Announcement of winning USLI team

Budget

Qty	Description		Total Price
	Scale Model Rocket		
2	3.90" (98mm) Airframe Tubing	$10.45	$20.90
1	7.51" Airframe Tube - 2x30" + TC	$26.95	$26.95
1	3.90" (98mm) Plastic Nose Cone	$20.95	$20.95
1	54mm Motor Mount Tube	$7.35	$7.35
3	Tube Coupler 3.90" (98mm) Tube	$4.50	$13.50
2	Centering Ring CR-7.51-3.90	$10.50	$21.00
6	1/4" Plywood	$6.99	$41.94
3	Pair of Centering Rings CR-3.90-2.14	$8.10	$24.30
2	3.90" (98mm) Bulkhead Assembly	$4.05	$8.10
			$184.99

	Competition Rocket		
2	3.90" (98mm) Airframe Tubing	$10.45	$20.90
1	7.51" Airframe Tube - 2x30" + TC	$26.95	$26.95
1	54mm Motor Mount Tube	$7.35	$7.35
3	Tube Coupler 3.90" (98mm) Tube	$4.50	$13.50
2	Centering Ring CR-7.51-3.90	$10.50	$21.00
6	1/4" Plywood	$6.99	$41.94
3	Pair of Centering Rings CR-3.90-2.14	$8.10	$24.30
2	3.90" (98mm) Bulkhead Assembly	$4.05	$8.10
			$164.04

	Motors		
4	K1100T-L // Blue Thunder	$109.99	$439.96
1	RMS-54/1706 MOTOR	$190.00	$190.00
			$629.96

	Miscellaneous Parts		
1	Misc Construction Supplies - paint, glue	$200.00	$200.00
1	Misc hardware - bolts, nuts, links	$50.00	$50.00
			$250.00

	Recovery System		
1	Recovery materials, nomex, nylon, kevlar	$60.00	$60.00
1	Black Powder	$40.00	$40.00
1	78" Parachute	$79.95	$79.95
1	28" Parachute	$16.75	$16.75
1	RDAS-Tiny altimeter	$300.00	$300.00
2	MAWD Altimeter	$99.95	$199.90
2	Safety switches for electronics	$15.00	$30.00
			$726.60

Payload and Tracking System			
1	GPS Unit	$295.00	$295.00
1	Payload camera	$9.95	$9.95
1	Science Payload	$2,000.00	$2,000.00
			$2,304.95
		Total	**$4,260.54**

Travel			
6	travel to Mansfield for 3000'+ launches	$75.00	$450.00
6	travel to Atlanta	$412.00	$2,472.00
6	lodging Atlanta	$200.00	$1,200.00
			$4,122.00

Project Income			
	NASA SMD		$5,000.00
	Outreach		$1,500.00
	Washington State Space Grant		$500.00
	Tribal Support		$3,000.00
			$10,000.00

Budget Summary	
Scale Rocket	$184.99
Competition Rocket	$164.04
Propulsion	$629.96
Construction Supplies	$250.00
Recovery	$726.60
Electronics & Payload	$2,304.95
	$4,260.54

Travel & Lodging	$4,122.00

Project Income	
	$10,000.00

Conclusion

The Northwest Indian College Space Center USLI Team would like to officially declare their intent to compete in the NASA University Student Launch Initiative for the 2010/2011 Academic year. Our team has fully read and understood all expectations of the program as described in the Request for Proposals and Guidelines sent out on August 14th 2009. We agree to follow all guidelines set forth by the Lummi Nation, NASA and the governing bodies in regards to safety standards, rules, and regulations. If there are any questions concerning any portion of this document please contact the Team Leader via the contact information below.

Cathy Ballew, Team Leader
Ph: 360-441-5606

Email: **usli@nwic.edu** with Cathy Ballew in the subject line

Appendices

Appendix A
Resumes

William Munds
3481 Victory Dr SW, Port Orchard, WA 98367
206-335-0196, APpusher@q.com
NAR 83502 L2 - Washington Aerospace Club # 578

OBJECTIVE:	Share my experience and enthusiasm of rocket design with the members of Northwest Indian College Students.
QUALIFIED BY:	NAR membership since 2005 Washington Aerospace membership since 2005 NAR L1, L2 certifications May 2005 Owner of rocketry vending business since January 2005 38 Years in the construction field
EXPERIENCE:	;
2007 to present:	Working closely with TARC teams from Colville High School, Ingraham High School, Kentwood High School to get them started with the fundamentals. I am also working with Earth and Space Sciences at University of Washington. After certifying NAR Level 2, in May 2007, I broke 10,313 feet with a 62” long 3” airframe and a K700W that incorporated a Gwiz 800 Deluxe altimeter that was designed for dual deployment.
2005 to present:	I opened Puget Sound Propulsion as an onsite rocketry vendor, supplying reloads and hardware to Club fliers, TARC Teams, University Structural Engineering Aerospace Teams. The Company started with reloads and hardware and has grown it’s inventory to include a wide variety of inventory. PSP continues to support education of the related sciences involving rocketry.
1972 to present:	I am a Journey Level Drywall finisher working mostly in the commercial smooth wall area of the trade. I have worked as support personnel in company warehouses organizing tool and material inventories. I have worked as a Crew Leader to accomplish segments of the larger project. I have held the position of Foreman that was responsible for accessing labor and material needs for tenant improvement jobs. Also, I have held positions of Field Supervisor overseeing labor and material for up to 5 separate jobs with up to 15 employees.
1984 – 1987	I held a Maintenance Supervisor position with and assistant for 2 properties, 115 units and 230 units. I scheduled and was involved in apartment turnover, kept a repair parts inventory, maintained relevant equipment, maintained and repaired swimming pools and hot tubs, worked with local inspectors regarding health codes for swimming pools and hot tubs, completed training and acquired certificates to hold the position. While working with Lincoln Properties in Bellevue, WA, was awarded Maintenance Supervisor of the 3rd Qtr in 1986.

Gary L. Brandt

2630 Walnut St
Bellingham, WA 98225
360-734-0383
gary@macy-brandt.com

CREDENTIALS

California & Idaho Secondary Teaching Credential, endorsements in science, math, earth science, agricultural science

California & Idaho Elementary Teaching Credential

PROFESSIONAL TRAINING & EDUCATION

2009 Adobe Certified Technician
2001 Microsoft Certified Professional training in Windows 2000 field
1996-99 Western Washington University, Bellingham, WA, MEd Adult Education/Instructional Technology
1993 IBM RS/6000 and Unix training through IBM educational services
1990-93 System and College Administrator training for Datatel Colleague integrated software
1988-89 IBM System Manager and programming courses for IBM System 36
1980-83 Graduate work in education, University of Idaho
1979 Computer programming languages and applications courses
1977 California State University, San Bernardino, elementary credential, M.A. work in reading and work toward reading specialist credential
1974-76 University of California, Riverside, secondary credential, M.A. work, reading
1973-74 University of California, Riverside, computer programming and statistics
1971-75 University of California, Riverside Extension, Human Services
1963-68 University of California, Los Angeles, B.S., geology

WORK EXPERIENCE

Bellingham, Washington

2001- *Faculty*, Northwest Indian College, Information Technology, Robotics, Web Design, Electronics Programs
2001-08 *Network Administrator & MIS*, Nooksack Indian Tribe
1997-00 *Technical Solutions Provider*, MediaSeek Technologies, Inc.
1997, 98 *Lecturer*, Western Washington University, Computer Science 101 and CS 110 lab TA
1996-99 *Instructo*r, Whatcom Community College Community Ed Program, computer operations
1996-08 *Gary L. Brandt Consulting*
1989-96 *Director*, Computer Center, Northwest Indian College
1989-96 *Computer Instructor*, Northwest Indian College
1989-94 *Director*, MIS development under United States Department of Education Title III grant
1989-96 *Graphics consultant and programmer*, Distance Learning Center, Northwest Indian College
1990-92 *Registrar*, Northwest Indian College

Coeur d'Alene, Idaho

1984-89 *Director*, Technology Department, School District #271
1984-87 *Director*, Project CABLE, United States Department of Education Secretary's Discretionary Grant to Improve Education through Technology
1984-87 *Assistant Director*, READ:S Lighthouse Project, United States Department of Education National Diffusion Network Developer Demonstrator grant
1984-89 *Director*, Chapter 2 ECIA, School District #271
1983-84 *Coordinator*, Project CABLE, United States Department of Education Secretary's Discretionary Grant to Improve Education through Technology
1983-89 *Technical consultant and programmer*, Project READ:S and READ:S Lighthouse Project, United States Department of Education National Diffusion Network Developer Demonstrator grant
1982-87 *Computer programming instructor*, North Idaho College
1979-89 *Computer inservice instructor*, School District #271
1978-83 *Teacher*, fifth grade, Ramsey Elementary School

California

1975-78 *Teacher*, fifth grade, Lake Arrowhead Elementary, Rim of the World Unified School District
1975-78 *Teacher*, remedial reading/math inter-session Program, Rim of the World Unified School District
1974-75 *Student teacher*, Alessandro Jr. High School (Moreno Unified), agricultural science, earth science, math (7-8), Moreno Valley High School (Moreno Unified), general math (9-12)
1973 *Tutor/teacher*, Upward Bound Project, Riverside

OTHER EXPERIENCE

1996-08 *Owner*, Gary L. Brandt Consulting
1984-89 *Member*, Idaho State Department of Education Technology Advisory Committee
1982-87 *Vice-President*, Micro-Serve, Inc., microcomputer system analyst, programmer, and consultant
1971-73 *Education Officer, Instructor, and Counselor*, Human Relations, Drug Abuse Prevention and Education, United States Marine Corps
1968-73 *Naval Aviator*, United States Marine Corps

DAVID W.C. OREIRO
3265 Lummi Shore Road
Bellingham, WA 98226
(360) 3937546 cell
(360) 392-4249 work

EDUCATION: Med Student Personnel Administration, WWU 1995
BS Environmental Planning & Policy, WWU 1976

EXPERIENCE: Northwest Indian College, Vice President for Administration & Facilities current 4 years, and current Interim Director for National Indian Center Marine Research and Education, 21 years at the college in administrative and supervisory positions including Dean of Students & Soar Director, Math & Science Department Director, Registrar, Admissions and Recruitment Director, and Extension Office Co-coordinator.

- Oversee Campus Master Planning and facilities development and construction
- Supervise Instructional Technology, Maintenance and Construction departments
- Implementing NOAA –NICMERE Memorandum of Agreement
- Administrative and Leadership Team member for Institutional Capacity Building
- Co-Chair for Self-Study Accreditation Review Process for Bachelor of Science Degree

Planning Director, Lummi Indian Business Council, 12 years in Economic, Community, and Land Use planning activities for the Lummi Nation.

- Development of the Lummi Nation Overall Economic Plan
- Implement Infrastructure plans for community development
- Coordinated all environmental, land use, forestry, solid waste, coastal zone planning
- Instituted land consolidation and acquisition programs to increase tribal land base

Commercial Fisherman in Puget Sound, 10 years.

ACTIVITIES: WWU – Huxley Advisory Board current 2 years.
Rocketry: Tripoli membership 12761 & Nat'l Assoc. of Rocketry NAR: 91812 SR

~Cu-se-ma-at~ Cathy Ballew

Program of Study: Associate of Arts and Sciences Degree, General Direct Transfer.

Sophomore: Northwest Indian College.

Future Goals: Continue Education for a lifetime, Sustainable Project for Tribes.

Hobbies: Sewing, Cultural gatherings, walking on the beach, historic & bargain shopping.

Work experience: Lummi Indian Business Council, Family Services, Social/Case manager/Counselor/Justice worker

Phone: (360) 758-7957
E-mail: cballew@stu.nwic.edu
Web site: blogs.nwic.edu/usli

Mariya Williams

(360) 888-0957
mcw_713_33@hotmail.com

Education

May 2008 | High School Diploma

Expected Graduation Date: May 2011 | Associates of Direct Transfer Degree

Experience

03/09 – 10/09 | Sales Representative
Cutco/Vector Marketing | 4200 Meridian St Ste 104. Bellingham, *WA 98226*

Calling customers and setting up appointments for Cutlery demonstration at their residence.

07/09 – 09/09 | Courtesy Clerk
A&P Market/Williams Inc. | 3816 Tongass Avenue Ketchikan, AK 99901

Assisted the customers with what they needed, grabbed items in the back, packed groceries for various trips and brought groceries out to their car.

01/10 – 03/10 | Assistance-Computers
Gary Brandt-NWIC | 2522 Kwina Rd Bellingham, WA 98226

Helped students with basic computer problems and assisted the computer teacher.

06/21/10 – 08/13/10 | Summer Intern
Brian Compton-NWIC | 2522 Kwina Rd Bellingham, WA 98226

Worked with other interns on learning about Native Environmental Science and collecting and identifying plant specimen.

Personal

- Self motivated
- Good Communication skills
- Team worker
- Good writing skills
- Basic Computer skills

References

Gary Brandt,	Bellingham WA	(360) 392-4312
Wayne Woods,	Bellingham WA	(360) 392-4318
Justin Johnny,	Bellingham WA	(360) 739-1248

Appendix B

Parts List

Nose cone LOC Precision - LOC PNC-3.90 - Plastic nose cone, Material: Polystyrene PS

- Nose shape: Hollow Ogive, Len: 12.8000 In., Dia: 4.0000 In. Wall thickness: 0.1250 In. Body insert: OD: 3.8800 In., Len: 3.7500 In.
- CG: 8.2500 In. , Mass: 0.312501 Lb. Radius of gyration: 0.108005 (m) , 10.8005 (cm) Moment of inertia: 0.00165351 (kgm^2) , 16535.1 (gcm^2) , RockSim XN: 5.9259 In. , CNa: 2

Drogue Recovery Bay LOC/Precision - LOC BT-3.9 - Airframe tube, Material: Paper

- OD: 4.0000 In. , ID: 3.9000 In. , Len: 10.0000 In.
- CG: 5.0000 In. , Mass: 0.251346 Lb. Radius of gyration: 0.0815459 (m) , 8.15459 (cm) Moment of inertia: 0.000758127 (kgm^2) , 7581.27 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

Parachute LOC Precision - LP-28 - 28 In. 8 lines, Material: Rip stop nylon

- 1 parachute, Shape: Round Dia: 27.9921 In., Spill hole: 0.0000 In.
- CG: 0.0000 In. , Mass: 0.062611 Lb. Radius of gyration: 0.0395755 (m) , 3.95755 (cm) Moment of inertia: 4.44804e-05 (kgm^2) , 444.804 (gcm^2)

Main Recovery Bay LOC/Precision - LOC BT-3.9 - Airframe tube, Material: Paper

- OD: 4.0000 In. , ID: 3.9000 In. , Len: 17.0000 In.
- CG: 8.5000 In. , Mass: 0.427287 Lb. Radius of gyration: 0.129745 (m) , 12.9745 (cm) Moment of inertia: 0.00326264 (kgm^2) , 32626.4 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

Parachute LOC Precision - LP-78 - 78 In. 16 lines, Material: Rip stop nylon

- 1 parachute, Shape: Round Dia: 80.0000 In., Spill hole: 0.0000 In.
- CG: 0.0000 In. , Mass: 0.687844 Lb. Radius of gyration: 0.0998642 (m) , 9.98642 (cm) Moment of inertia: 0.00311154 (kgm^2) , 31115.4 (gcm^2)

FWD Transition LOC Precision - AR-3.90-3.00 - Airframe Reducer from 3.90 to 3.00, Material: Basswood

- Solid transition: Fwd. Dia: 4.0000 In., Len: 1.0000 In., Rear Dia: 7.6700 In. Font body insert: Len: 0.0000 In., OD: 0.0000 In., Rear body insert: Len: 0.0000 In., OD: 0.0000 In.,
- CG: 4.7500 In. , Mass: 0.624999 Lb. Radius of gyration: 0.0553831 (m) , 5.53831 (cm) Moment of inertia: 0.00086956 (kgm^2) , 8695.6 (gcm^2) , RockSim XN: 40.3524 In. , CNa: 5.35364

Fed Tranisition Connection LOC/Precision - LOC TC-3.90 - Tube coupler, Material: Paper

- OD: 3.9000 In. , ID: 3.8300 In. , Len: 4.0000 In.
- CG: 2.0000 In. , Mass: 0.068862 Lb. Radius of gyration: 0.0454935 (m) , 4.54935 (cm) Moment of inertia: 6.46464e-05 (kgm^2) , 646.464 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

Fwd Centering ring LOC Precision - LOC CR-7.51-3.9 - Centering Ring, Material: Aircraft plywood (LOC)

- Centering ringOD: 7.5100 In., ID: 4.0800 In., Len: 0.2500 In. Location: 3.1250 In. From the front of Fed Tranisition Connection
- CG: 0.1250 In. , Mass: 0.290055 Lb. Radius of gyration: 0.0543638 (m) , 5.43638 (cm) Moment of inertia: 0.000388835 (kgm^2) , 3888.35 (gcm^2)

Aft Centering ring LOC Precision - LOC CR-7.51-3.9 - Centering Ring, Material: Aircraft plywood (LOC)

- Centering ringOD: 7.5100 In., ID: 4.0800 In., Len: 0.2500 In. Location: 3.7500 In. From the front of Fed Tranisition Connection
- CG: 0.1250 In. , Mass: 0.290055 Lb. Radius of gyration: 0.0543638 (m) , 5.43638 (cm) Moment of inertia: 0.000388835 (kgm^2) , 3888.35 (gcm^2)

Bulkhead LOC Precision - LOC BP-3.90 - Bulkhead Plate, Material: Aircraft plywood (LOC)

- BulkheadOD: 3.8300 In., Len: 0.1880 In. Location: 0.0000 In. From the front of Fed Tranisition Connection
- CG: 0.0940 In. , Mass: 0.056730 Lb. Radius of gyration: 0.0243869 (m) , 2.43869 (cm) Moment of inertia: 1.53037e-05 (kgm^2) , 153.037 (gcm^2)

Payload LOC/Precision - LOC BT-7.51 - Airframe tube, Material: Paper

- OD: 7.6700 In. , ID: 7.5100 In. , Len: 12.0000 In.
- CG: 6.0000 In. , Mass: 0.927291 Lb. Radius of gyration: 0.111428 (m) , 11.1428 (cm) Moment of inertia: 0.00522238 (kgm^2) , 52223.8 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

Science Payload Estes - Engine hook - Standard size, Material:

- CG: 0.0000 In. , Mass: 4.999996 Lb. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Fwd Rail Button, Material: Delerin

- OD: 0.5000 In., ID: 0.4000 In., Len: 0.5000 In., Loc: 5.6250 In.
- CG: 0.2500 In. , Mass: 0.001432 Lb. Radius of gyration: 0.00548093 (m) , 0.548093 (cm) Moment of inertia: 1.95088e-08 (kgm^2) , 0.195088 (gcm^2)

AFT Transition LOC Precision - AR-3.90-3.00 - Airframe Reducer from 3.90 to 3.00, Material: Polystyrene PS

- Solid transition: Fwd. Dia: 7.6700 In., Len: 3.0000 In., Rear Dia: 4.0000 In. Font body insert: Len: 0.0000 In., OD: 0.0000 In., Rear body insert: Len: 0.0000 In., OD: 0.0000 In.,
- CG: 4.7500 In. , Mass: 0.624999 Lb. Radius of gyration: 0.0590186 (m) , 5.90186 (cm) Moment of inertia: 0.000987466 (kgm^2) , 9874.66 (gcm^2) , RockSim XN: 54.1428 In. , CNa: -5.35364

Aft Tranisition Connection LOC/Precision - LOC TC-3.90 - Tube coupler, Material: Paper

- OD: 3.9000 In. , ID: 3.8300 In. , Len: 6.0000 In.
- CG: 3.0000 In. , Mass: 0.103293 Lb. Radius of gyration: 0.0561012 (m) , 5.61012 (cm) Moment of inertia: 0.000147463 (kgm^2) , 1474.63 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

Fwd Centering ring LOC Precision - LOC CR-7.51-3.9 - Centering Ring, Material: Aircraft plywood (LOC)

- Centering ringOD: 7.5100 In., ID: 4.0800 In., Len: 0.2500 In. Location: 0.0000 In. From the front of Aft Tranisition Connection
- CG: 0.1250 In. , Mass: 0.290055 Lb. Radius of gyration: 0.0543638 (m) , 5.43638 (cm) Moment of inertia: 0.000388835 (kgm^2) , 3888.35 (gcm^2)

Bulkhead LOC Precision - LOC BP-3.90 - Bulkhead Plate, Material: Aircraft plywood (LOC)

- BulkheadOD: 3.8300 In., Len: 0.1880 In. Location: 5.7500 In. From the front of Aft Tranisition Connection
- CG: 0.0940 In. , Mass: 0.056730 Lb. Radius of gyration: 0.0243869 (m) , 2.43869 (cm) Moment of inertia: 1.53037e-05 (kgm^2) , 153.037 (gcm^2)

Fin Can LOC/Precision - LOC BT-3.9 - Airframe tube, Material: Paper

- OD: 4.0000 In. , ID: 3.9000 In. , Len: 26.0000 In.
- CG: 13.0000 In. , Mass: 0.653497 Lb. Radius of gyration: 0.194132 (m) , 19.4132 (cm) Moment of inertia: 0.0111713 (kgm^2) , 111713 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

Fin set, Material: .25 inch aircraft plywood

- Planform: trapezoidal, Root chord: 6.0000 In., Tip chord: 3.0000 In., Semi-span: 8.0000 In., Sweep: 2.0427 In., Mid-Chord: 8.0184 In. Misc: Location: 19.8750 In. From the front of Fin Can Thickness: 0.0625 In. Profile: square
- CG: 3.2107 In. , Mass: 0.531979 Lb. Radius of gyration: 0.0742946 (m) , 7.42946 (cm) Moment of inertia: 0.00133191 (kgm^2) , 13319.1 (gcm^2) , RockSim XN: 77.7495 In. , CNa: 26.7962

Standoff, Material: .25 inch aircraft plywood

- Planform: trapezoidal, Root chord: 2.0000 In., Tip chord: 1.0000 In., Semi-span: 2.0000 In., Sweep: 0.3933 In., Mid-Chord: 2.0028 In. Misc: Location: 23.5000 In. From the front of Fin Can Thickness: 0.0625 In. Profile: square
- CG: 0.9526 In. , Mass: 0.012906 Lb. Radius of gyration: 0.0184956 (m) , 1.84956 (cm) Moment of inertia: 2.00257e-06 (kgm^2) , 20.0257 (gcm^2) , RockSim XN: 79.8637 In. , CNa: 1.54328

Aft Rail Button, Material: Delerin

- OD: 0.5000 In., ID: 0.4000 In., Len: 0.5000 In., Loc: 24.2500 In.
- CG: 0.2500 In. , Mass: 0.001432 Lb. Radius of gyration: 0.00548093 (m) , 0.548093 (cm) Moment of inertia: 1.95088e-08 (kgm^2) , 0.195088 (gcm^2)

54 mm Motor Mount LOC/Precision - LOC MMT-2.14 - Motor mount tube, Material: Paper

- OD: 2.2600 In. , ID: 2.1402 In. , Len: 18.0000 In. Location: 10.1250 In. From the front of Fin Can
- CG: 9.0000 In. , Mass: 0.301887 Lb. Radius of gyration: 0.133604 (m) , 13.3604 (cm) Moment of inertia: 0.00244428 (kgm^2) , 24442.8 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

FWD Centering ring LOC Precision - LOC CR-3.9-2.14 - Centering Ring, Material: Aircraft plywood (LOC)

- Centering ringOD: 3.9000 In., ID: 2.2598 In., Len: 0.1250 In. Location: 1.1250 In. From the front of 54 mm Motor Mount
- CG: 0.0625 In. , Mass: 0.039111 Lb. Radius of gyration: 0.0286689 (m) , 2.86689 (cm) Moment of inertia: 1.4581e-05 (kgm^2) , 145.81 (gcm^2)

MID Centering ring LOC Precision - LOC CR-3.9-2.14 - Centering Ring, Material: Aircraft plywood (LOC)

- Centering ringOD: 3.9000 In., ID: 2.2598 In., Len: 0.1250 In. Location: 9.5000 In. From the front of 54 mm Motor Mount
- CG: 0.0625 In. , Mass: 0.039111 Lb. Radius of gyration: 0.0286689 (m) , 2.86689 (cm) Moment of inertia: 1.4581e-05 (kgm^2) , 145.81 (gcm^2)

AFT Centering ring LOC Precision - LOC CR-3.9-2.14 - Centering Ring, Material: Aircraft plywood (LOC)

- Centering ringOD: 3.9000 In., ID: 2.2598 In., Len: 0.1250 In. Location: 15.5000 In. From the front of 54 mm Motor Mount
- CG: 0.0625 In. , Mass: 0.039111 Lb. Radius of gyration: 0.0286689 (m) , 2.86689 (cm) Moment of inertia: 1.4581e-05 (kgm^2) , 145.81 (gcm^2)

Tail Cone LOC Precision - PTC-3.90 - Tail Cone, Material: Polystyrene PS

- Solid transition: Fwd. Dia: 4.0157 In., Len: 2.5000 In., Rear Dia: 2.7717 In. Font body insert: Len: 2.0000 In., OD: 3.8819 In., Rear body insert: Len: 0.0000 In., OD: 0.0000 In.,
- CG: 1.8034 In. , Mass: 0.301749 Lb. Radius of gyration: 0.0458057 (m) , 4.58057 (cm) Moment of inertia: 0.000287178 (kgm^2) , 2871.78 (gcm^2) , RockSim XN: 83.4266 In. , CNa: -1.05541

Appendix C

Aerotech K550W Simulation Results

Launch conditions

- Altitude: 0.00000 Ft.
- Relative humidity: 50.000 %
- Temperature: 59.000 Deg. F
- Pressure: 29.9139 In.

  Wind speed model: Calm (0-2 MPH)
- Wind starts at altitude: 0.00000 Ft.
- Launch guide angle: 0.000 Deg.

Launch guide data:

- Launch guide length: 72.0000 In.
- Velocity at launch guide departure: 63.5800 ft/s
- The launch guide was cleared at : 0.194 Seconds
- User specified minimum velocity for stable flight: 43.9993 ft/s
- Minimum velocity for stable flight reached at: 33.7856 In.

Max data values:

- Maximum acceleration:Vertical (y): 593.202 Ft./s/sHorizontal (x): 1.316 Ft./s/sMagnitude: 593.202 Ft./s/s
- Maximum velocity:Vertical (y): 647.0010 ft/s, Horizontal (x): 2.5859 ft/s, Magnitude: 647.4160 ft/s
- Maximum range from launch site: 349.94354 Ft.
- Maximum altitude: 5496.91415 Ft.

Recovery system data

- P: Parachute Deployed at : 21.501 Seconds
- Velocity at deployment: 15.66756 ft/s
- Altitude at deployment: 5497.20654 Ft.
- Range at deployment: -349.94354 Ft.

Time data

- Time to burnout: 3.500 Sec.
- Time to apogee: 18.354 Sec.
- Optimal ejection delay: 14.854 Sec.

Landing data

- Successful landing
- Time to landing: 268.231 Sec.
- Range at landing: -166.40925
- Velocity at landing: Vertical: -20.7601 ft/s , Horizontal: 0.4715 ft/s , Magnitude: 20.7654 ft/s

Appendix D

Material Safety Data Sheets

The material Safety Data Sheets for all hazardous materials the team will be utilizing are located on the team website, blogs.nwic.edu/usli.

Isopropyl Alcohol
Rosin Core Solder
Wood Dust
Super Glue
Krylon – Grey Primer
Krylon – Black
Krylon – cherry
JB Weld
Acetone
AeroTech Motor Reload
Black Powder
Epoxy Resin and Hardener
Fiberglass
Ammonium Perchlorate

High Power Rocket Safety Code

1. **Certification.** I will only fly high power rockets or possess high power rocket motors that are within the scope of my user certification and required licensing.
2. **Materials.** I will use only lightweight materials such as paper, wood, rubber, plastic, fiberglass, or when necessary ductile metal, for the construction of my rocket.
3. **Motors.** I will use only certified, commercially made rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer. I will not allow smoking, open flames, nor heat sources within 25 feet of these motors.
4. **Ignition System.** I will launch my rockets with an electrical launch system, and with electrical motor igniters that are installed in the motor only after my rocket is at the launch pad or in a designated prepping area. My launch system will have a safety interlock that is in series with the launch switch that is not installed until my rocket is ready for launch, and will use a launch switch that returns to the "off" position when released. If my rocket has onboard ignition systems for motors or recovery devices, these will have safety interlocks that interrupt the current path until the rocket is at the launch pad.
5. **Misfires.** If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher's safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.
6. **Launch Safety.** I will use a 5-second countdown before launch. I will ensure that no person is closer to the launch pad than allowed by the accompanying Minimum Distance Table, and that a means is available to warn participants and spectators in the event of a problem. I will check the stability of my rocket before flight and will not fly it if it cannot be determined to be stable.
7. **Launcher.** I will launch my rocket from a stable device that provides rigid guidance until the rocket has attained a speed that ensures a stable flight, and that is pointed to within 20 degrees of vertical. If the wind speed exceeds 5 miles per hour I will use a launcher length that permits the rocket to attain a safe velocity before separation from the launcher. I will use a blast deflector to prevent the motor's exhaust from hitting the ground. I will ensure that dry grass is cleared around each launch pad in accordance with the accompanying Minimum Distance table, and will increase this distance by a factor of 1.5 if the rocket motor being launched uses titanium sponge in the propellant.
8. **Size.** My rocket will not contain any combination of motors that total more than 40,960 N-sec (9208 pound-seconds) of total impulse. My rocket will not weigh more at liftoff than one-third of the certified average thrust of the high power rocket motor(s) intended to be ignited at launch.
9. **Flight Safety.** I will not launch my rocket at targets, into clouds, near airplanes, nor on trajectories that take it directly over the heads of spectators or beyond the boundaries of the launch site, and will not put any flammable or explosive payload in my rocket. I will not launch my rockets if wind speeds exceed 20 miles per hour. I will comply with Federal Aviation Administration airspace regulations when flying, and will ensure that my rocket will not exceed any applicable altitude limit in effect at that launch site.
10. **Launch Site.** I will launch my rocket outdoors, in an open area where trees, power lines, buildings, and persons not involved in the launch do not present a hazard, and that is at least as large on its smallest dimension as one-half of

the maximum altitude to which rockets are allowed to be flown at that site or 1500 feet, whichever is greater.

11. **Launcher Location.** My launcher will be 1500 feet from any inhabited building or from any public highway on which traffic flow exceeds 10 vehicles per hour, not including traffic flow related to the launch. It will also be no closer than the appropriate Minimum Personnel Distance from the accompanying table from any boundary of the launch site.
12. **Recovery System.** I will use a recovery system such as a parachute in my rocket so that all parts of my rocket return safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.
13. **Recovery Safety.** I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places, fly it under conditions where it is likely to recover in spectator areas or outside the launch site, nor attempt to catch it as it approaches the ground.

MINIMUM DISTANCE TABLE				
Installed Total Impulse (Newton-Seconds)	**Equivalent High Power Motor Type**	**Minimum Diameter of Cleared Area (ft.)**	**Minimum Personnel Distance (ft.)**	**Minimum Personnel Distance (Complex Rocket) (ft.)**
0 -- 320.00	H or smaller	50	100	200
320.01 -- 640.00	I	50	100	200
640.01 -- 1,280.00	J	50	100	200
1,280.01 -- 2,560.00	K	75	200	300
2,560.01 -- 5,120.00	L	100	300	500
5,120.01 -- 10,240.00	M	125	500	1000
10,240.01 -- 20,480.00	N	125	1000	1500
20,480.01 -- 40,960.00	O	125	1500	2000

Note: A Complex rocket is one that is multi-staged or that is propelled by two or more rocket motors

Appendix F

Range Safety Regulations

I , ____, have fully read and fully understand the following regulations relating to operating high powered rockets:

1. The National Association of Rocketry High Powered Rocketry Safety Code
2. The National Fire Protection Association (NFPA) 1127: “Code for High Powered Rocket Motors".
3. The Federal Aviation Regulations 14 CFR, Subchapter F Subpart C “Amateur Rockets”.

Also, I understand that the Range Safety Officer has the right to deny any rocket from launch. Before launch I will check with the RSO about:

1. Safety inspection of my rocket
2. Checking the stability of my rocket (center of pressure and center of gravity locations).
3. Weather conditions at the launch pad and predicted altitude
4. Electronics such as altimeters, timers, flight computers, etc.
5. Best recovery options including: Descent rates, launch pad inclination, etc.

Safety is the number one priority for the NWIC Space Center. I hereby reaffirm my commitment to keeping myself, my teammates, launch participants, and the environment safe from risk, harm, and damage.

Signed:

____

Appendix G

Launch Wavier Activation

Date	Time	Initials	Agency	Phone	Timing
			NOTAM	877-487-6867	24-72 hrs
			BLI ATC	360-734-2745	24-48 hrs
			Vancouver ACC	604-586-4560	24-48 hrs
			BLI ATC	360-734-2745	30-45 min
			Vancouver ACC	604-586-4560	5-10 min
			NOTAM	**877-487-6867**	**Operations Concluded**
			BLI ATC	**360-734-2745**	
			Vancouver ACC	**604-586-4560**	