Competitive Opportunity for Partnerships with Community Colleges and TechnicalSchools

MN SpaceGrantCommunity College Quadrotor Design Competition

(2014 – 2016)

Minnesota Space Grant Consortium
Director: Professor William L. Garrard
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A. Statement of Consortium Concurrence

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** received by e-mail from "Murr, David" <murrdl@augsburg.edu>, 5/16/14 at 4:25 p.m. **

I, David Murr, representing MnSGC affiliate AugsburgCollege, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation.

Regards,
David

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David Murr
Associate Professor of Physics
AugsburgCollege

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** received by from "Wehner, Elizabeth M." <ewehner@stthomas.edu>, 5/16/14 at 4:42 p.m. **

I, ElizabethWehner representing MnSGC affiliate the University of St. Thomas, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation.

— Elizabeth

****
** received by from “Tom Greenlee” <gretom@bethel.edu>5/16/14 at 8:48 p.m. **

I, Thomas Greenlee, representing MnSGC affiliate BethelUniversity, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation.

Thomas Greenlee

Thomas R. Greenlee
Professor of Physics
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****

** received by from Cindy Blaha<cblaha@carleton.edu>, 5/16/14 at 9:21 p.m. **

As representative of MnSGC affiliate CarletonCollege, I concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation.

Cindy Blaha

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Cindy Blaha
Professor of Physics and Astronomy
Marjorie CrabbGarbisch Professor of the Liberal Arts
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** received by from Alec T. Habig<habig@neutrino.d.umn.edu>, 5/19/14 at 8:22 a.m. **

"I, Alec Habig representing MnSGC affiliate UMD, concur with thesubmission of the MN Space Grant Design Competition proposal for theCommunity College solicitation."

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Alec Habig, University of MinnesotaDuluth Physics Dept.
habig@neutrino.d.umn.edu
http://neutrino.d.umn.edu/~habig/

****
** received by from Tim Kroeger<TKroeger@bemidjistate.edu>, 5/19/14 at 10:45 a.m. **

"I, Dr. Timothy Kroeger representing MnSGC affiliate BemidjiStateUniversity, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation."

Sincerely,
Tim

Tim Kroeger, Ph.D.
Professor of Geology and Director of CEEESS
BemidjiStateUniversity
#27, 1500 Birchmont Dr. NE
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** received by from Kelly MacGregor<macgregor@macalester.edu>, 5/19/14 at 11:49 a.m. **

I, Dr. Kelly MacGregor, representing MnSGC affiliate MacalesterCollege, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation.
best wishes - Kelly

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KellyMacGregor
GeologyDepartment
MacalesterCollege
1600 Grand Avenue
Saint Paul, MN55105
(651) 696-6441

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** received by from Heidi Manning <manning@cord.edu>, 5/19/14 at 1:32 p.m. **

I, Heidi Manning representing MnSGC affiliate ConcordiaCollege, concur with the submission of the MN Space Grant Design Competition proposal for the Community College Solicitation.

Heidi L. K. Manning Ph.D.
Professor of Physics
ConcordiaCollege
901 8th Street South
Moorhead, MN56562

218-299-3393 (office)
218-299-4308 (fax)

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** received by from StephenHighland<shighland@fdltcc.edu>, 5/19/14 at 9:35 p.m. **

I, StephenHighland representing Minnesota Space Grant Consortium affiliate Fond du Lac Tribal and Community College, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation.
Sincerely,

StephenHighland
Fond du Lac Tribal and Community College Minnesota Space Grant Principal Investigator

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** received by from Erick Agrimson<epagrimson@stkate.edu>, 5/20/14 at 3:52 p.m. **

I, Erick Agrimson representing MnSGC affiliate SaintCatherineUniversity, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation."
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Erick Agrimson
Associate Professor
St.CatherineUniversity
Department of Physics and Mathematics and Sonography
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** received by from Kelly Nipp<kelly.nipp@lltc.edu>, 5/21/14 at 10:40 a.m. **

"I, Kelly Nipp representing MnSGC affiliate LeechLakeTribalCollege, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation."

Thanks

Kelly Nipp
LeechLakeTribalCollege

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** received by from "Murphy, Ken" <Ken.Murphy@smsu.edu>, 5/21/14 at 11:05 a.m. **

I, Ken Murphy, representing MnSGC affiliate at SouthwestMinnesotaStateUniversity, concur with the submission of the MN Space Grant Design Competition proposal for the Community College Solicitation.

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** received by from "Dahlseide, Darlene (DOT)" <darlene.dahlseide@state.mn.us>, 5/21/14 at 1:27 p.m. **

I, Darlene Dahlseide representing MnSGC affiliate Minnesota Department of Transportation - Office of Aeronautics, concur with the submission of the MN Space Grant Design Competition proposal for the Community College solicitation.

DarleneDahlseide, MN/DOTAeronautics
222 PlatoBlvd E, St.Paul, MN 55107
651-234-7248
****

** received by from William Garrard <wgarrard@aem.umn.edu>, 5/21/14 at 3:23 p.m. **

I, Dr. William Garrard, Professor at the University of Minnesota and Director of the Minnesota Space Grant Consortium, concur with the submission of the MN Space Grant proposal entitled "MN Space Grant Community College Quadrotor Design Competition" for the Community College solicitation.

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William L. Garrard
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B. Consortium Abstract

Mission Statement

The mission of the Minnesota Space Grant Consortium (MnSGC) is to provide the driving force in Minnesota for higher education in aerospace sciences, aerospace engineering, and other scientific and engineering fields directly related to NASA's goals and the aerospace industry's workforce needs. To accomplish this mission, the MnSGChas assembled a diverse group of 14 affiliates, selected to provide geographical diversity and to address State and NASA needs.MnSGC's overarching objective is to support NASA's Strategic Goals and Outcomes in Education.

Major Goals and Objectives Derived from NASA Priorities

As a higher education program, our primary contribution in meeting NASA's Educational Outcomes is in the achievement of Outcome 1 (stated below). However, we also make significant contributions to Outcomes 2 and 3 (stated below), and our efforts extend across the entire NASA Education Strategic Framework. Our contributions to help achieve each Outcome are briefly summarized as follows:

Outcome 1:*Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals.* The MnSGC supports this outcome by funding scholarship and fellowship programs; student opportunities at NASA Centers; graduate and undergraduate research opportunities; and curricular development in physical sciences and engineering at the college level.
Outcome 2:*Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty.* This outcome is supported by in-service and pre-service teacher training and through our interactions with other NASA educational activities in Minnesota.
Outcome 3: *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.* This outcome is supported by informal educational activities offered around the state.

Particular emphasis has been given to including women, underrepresented minorities, and populations with special needs in all activities of the Consortium.

Program Specific Goals and Objectives

MnSGC Program-Specific Goals which support this current proposal are as follows. First is commitment to diversity. Second is our emphasis to hands-on, student hardware activities (many of which are student-led) such as high-altitude ballooning, high-power rocketry, plus CanSat and sub-orbital payload building. Third is our support of freshman seminars designed to attract and retain students in STEM disciplines. Fourth are our partnerships with community colleges (not necessarily MnSGC affiliates) on specific projects such as rocketry and ballooning. Fifth is our geographic diversity which allows us to achieve state-wide impact.

C. Consortium Profile

The needs, priorities, and demographics of Minnesota have been incorporated into the goals, objectives, and strategic plan for the MnSGC. The strategic plan incorporates the unique aspects of Minnesota, including both its opportunities and its challenges. The highest concentration of population, industry, and higher educational institutions are found in a limited geographical area in the southeast part of the state that includes the cities of Minneapolis and Saint Paul, plus surrounding communities. Overall, Minnesota has an excellent higher-educational infrastructure, including a major research university as well as nationally- and regionally-recognized private, four-year colleges. In addition there is an extensive community and technical college system comprised of 24 community institutions in the Minnesota State College and University System (MNSCU). These are geographically distributed throughout the State.

There is significant aerospace activity in the Twin Cities metro area, including a number of major aerospace contractors such as Honeywell, Alliant Tech Systems (ATK), and United Technologies Aerospace Systems. The area is a center for employment for the upper Midwest and there is high demand for individuals with degrees in science and engineering. Average income is high (in 2006 the Minnesota median household income was 12.5% greater than the national average). On the other hand, there are substantial numbers of recent immigrants and underrepresented minorities who have not yet begun to benefit from the opportunities available and who would benefit from enhanced opportunities for STEM education.

Some other regions of Minnesota, especially in the north-central and north-eastern parts of the state, are much less well-served in terms employment opportunities; however, this is changing. The economy of many areas used to depend mostly on agriculture, natural resources, and tourism; however, recently opportunities in technology-based industries have been growing. For example, there is a growing high-technology sector in Duluth including Cirrus Aircraft, one of the world's largest manufacturers of general aviation aircraft. Thus there is a growing need for individuals with a STEM education in all areas of the state.

MnSGC has the opportunity to build on a solid, well-funded state educational infrastructure and an economy which is oriented toward technological development. Our biggest challenges include serving populations living in areas where educational and economic opportunities are limited and serving underrepresented groups. This proposal is aimed at increasing the number of STEM students who successfully complete their community college education throughout the state.

Minnesota's needs align with NASA's priorities for a highly-trained, diverse, technical workforce, and the strategy of the MnSGC has been to develop a mix of program elements which satisfy the needs of Minnesota and NASA.Our mix of program elements responds to NASA's needs as follows: Our emphasis on diversity in all our programs has increased the involvement of women, underrepresented minorities, and disabled students in aerospace sciences and engineering. One of our themes which has directly contributed to the recruitment and retention of STEM students has been hands-on aerospace student projects (often sponsored by industry). Our STEM research activities also help attract and retain students in areas of interest to NASA. Our precollege programs focus on training of STEM teachers, especially those at schools with substantial enrollments of underrepresented students.

D. Consortium Management

Consortium StructureThe MnSGC is comprised of 13 higher-education affiliates and one state governmental agency. Seven of the MnSGC higher-education affiliates are small, private, liberal-arts colleges or universities: Augsburg College, Bethel University, Carleton College, St. Catherine University (an all-women institution), Concordia College, Macalester College, and the University of St. Thomas (UST). Four of the MnSGC higher-education affiliates are state universities: Bemidji State University (BSU), Southwest Minnesota State University (SMSU), the University of Minnesota – Duluth (UMD), and the University of Minnesota – Twin Cities (UMTC) which is the lead institution of the MnSGC. Two MnSGC higher-education affiliates serve Native American populations in particular: Fond du Lac Tribal and Community College (FDLTCC) and Leech Lake Tribal College. Affiliates are located in all parts of Minnesota, achieving geographic diversity. The MnSGC also has one state governmental affiliate, the Minnesota Department of Transportation – Office of Aeronautics (MNDOT). MnSGC partners with other higher-educational institutions (and pre-college institutions and informal education institutions) in the State to achieve specific programmatic goals. In this proposal we are partnering with five community colleges, one of which, FDLTCC, is a MnSGC affiliate.

Management StructureThe management of the MnSGC is located in the Department of Aerospace Engineering and Mechanics at the lead institution, the University of Minnesota – Twin Cities (UMTC), and has the following responsibilities:

- Provide the infrastructure for management of funds. This includes financial reporting to NASA, invoicing, subcontracting, paying fellowship/scholarship recipients, and all other aspects of financial management of the grant.
- Work with NASA Space Grant Management and with MnSGC affiliates to ensure that the MnSGC meets the goals and expectations of the National Space Grant Program.
- Provide the means of allocating NASA funds to affiliates that is competitive and fair and which takes into account the different capabilities and objectives of various affiliates.
- Serve as the point of contact between the public and the MnSGC.
- Serve as a resource for affiliates in terms of questions related to administrative and programmatic aspects of the Grant.
- Initiate new programs to support the National Space Grant Program Objectives, including recruitment of new affiliates as necessary, to meet National Objectives.
- Serve as the point of contact between NASA Centers and consortium membership.
- Facilitate collaborations between affiliates and NASA Centers.
- Provide information and opportunities for professional development.
- Engage affiliates in strategies for improvement using collaborative decision-making.
- Provide feedback to affiliates in programmatic areas.

The MnSGC has been directed by Professor William Garrard since 1992. In addition to his duties as Director, Professor Garrard contributes to research and higher education activities. The MnSGC office is staffed by Associate Director Dr. James Flaten, who has served in this capacity since 2005. Dr. Flaten's background in experimental physics and as a college faculty member has allowed him to contribute significantly to higher education, precollege, and informal education activities. Each affiliate administers its own programs under the direction of its own

Affiliate Director.In addition to overseeing programmatic activities at his or her institution, each Affiliate Director has responsibility for administering funds awarded by subcontract.

Consortium OperationsNASA funds are distributed by the lead institution, the University of Minnesota – Twin Cities (UMTC), to MnSGCaffiliates by means of subcontracts awarded on the basis of competitive proposals. Matching funds remain with the affiliates. The Director is the Principal Investigator on the grant and is responsible for monitoring and approving all expenditures. The subcontracts require the affiliates to bill the University quarterly in order to assure timely reimbursement and the Associate Director and the Director work with affiliates to expedite billings and to ensure that matching obligations are met.

Policy- and decision-making is accomplished primarily at meetings of the Affiliate Directors which are held twice a year (fall and spring). At these meetings major decisions concerning allocation of funds and program directions are made and programmatic progress is reported. The Director makes day-to-day decisions regarding the consortium, in consultation with the affiliate(s) involved in specific decisions. The Associate Director plays a major role in initiating and coordinating many activities of the consortium. The Associate Director also serves as a point of contact for affiliates and helps coordinate many of the budgetary and other administrative activities of the consortium.

The affiliates are informed of NASA's Educational Outcomes and Objectives and are requested to orient their MnSGC-supported activities to align with these Outcomes and Objectives. There is an open process for establishing the annual budget. The Associate Director contacts each affiliate and requests a proposal for funding for the next Space Grant budget year. Affiliates are required to provide at least a dollar-per-dollar match on all non-scholarship funds.The affiliates submit proposals which are reviewed by the Director, Associate Director, and a review committee comprised of a subset of the affiliate directors. Membership on this committee rotates annually so that each affiliate director has an opportunity to serve about once every 3 years. The process of these reviews has a consultative component in which the affiliates are provided guidance regarding how they can align their programs with NASA's Outcomes and Objectives. Only high-quality programs which support these Outcomes and Objectives are funded.

Affiliate progress is closely monitored, both formally and informally. Formally, each affiliate is required to report orally on their activities at MnSGC Affiliate Directors Meetings. In addition, affiliates are required to provide data for annual reporting to NASA via OEPM. The Associate Director maintains close contact with the affiliates to provide them with guidance and to ensure that they are achieving their goals. The affiliates, in turn, provide feedback to the Director and Associate Director on improving the management structure. Affiliate Directors are encouraged to attend national and regional Space Grant meetings to become better-acquainted with the broader array of Space Grant activities.

Affiliate Directors are the principal investigators for the MnSGC subcontracts issued to their institutions. Subcontracts are awarded based upon competitive proposals and must be aligned with NASA Educational Objectives and Outcomes. Affiliate Directors are responsible for programmatic and budgetary aspects of all MnSGC activities at their institutions, including generation of promised match. Any substantial deviation from the Statement of Work approved

for a subcontract requires prior approval by the Director. Affiliate Directors are responsible for advertising Space Grant opportunities and are seen as the representatives of NASA on their respective campuses. Consortium communications are usually accomplished by e-mail and semi-annual Affiliate Directors Meetings.

Our Management Plan and Operational Policies have been very effective in achieving our objectives by using conferencing, semi-annual meetings, attendance at national and regional meetings, compliance with directives and requests from NASA Space Grant Management, national and regional collaborations, and industrial networking. We have developed formal methods using metrics for achieving our SMART goals, as discussed below. At the request of our affiliates, we have introduced more transparency in our budgetary processes and have demonstrated how budgetary decisions support NASA Educational Goals and Objectives for higher education programs.

Operations of MnSGC are guided by our Strategic Plan. This plan outlines broad goals and objectives for the MnSGC that are aligned with (1) the overall NASA Strategic Plan in each of the five Space Grant funding categories: higher education, research infrastructure, fellowships/scholarships, precollege, and informal education; (2) NASA Educational Outcomes and Objectives, as appropriate for a higher-education program; and (3) the original objectives and goals of the National Space Grant Program. As part of our continuous quality improvement, we have defined metrics associated with our SMART goals. We believe that emphasizing quantifiable results has helped us sharpen the focus of our SMART goals. We have worked with our affiliates to emphasize the importance of using appropriate metrics to measure performance.

Achieving both gender and ethnic diversity is an important management goal for MnSGC. The Director has overall responsibility for diversity in the MnSGC and works with the Associate Director to formulate strategies to achieve these goals. Our approach is to work with Affiliate Directors to develop approaches to achieve diversity goals appropriate to their institutions. All affiliates are engaged in efforts to recruit and retain students from underrepresented groups. Since diversity in all programs is one of our overarching goals, approaches and results are emphasized at every MnSGC Affiliate Directors Meeting. Affiliates are evaluated on their success in involving students from underrepresented groups in their Space Grant programs. MnSGC has consistently achieved its goals in involvement of underrepresented groups and usually meets or nearly-meets its goals in female participation.

Addition and Removal of AffiliatesAs provided for in the MnSGC Charter, an organization wishing to become an affiliate must submit a proposal to the MnSGC. In order to be accepted as an affiliate, the organization must be approved by a majority vote of the affiliates attending the next spring meeting following the receipt of the proposal. Quality and uniqueness of the proposed programming, ability to help the MnSGC achieve its overall goals, and geographic location are particularly important in the approval of new affiliates. Affiliates may also be removed by a majority vote of the affiliates attending a spring meeting. The MnSGC Charter requires that affiliates must participate in semi-annual meetings on a regular basis in order to receive programmatic funds.MnSGC has added 10 affiliates and removed 1 affiliate (at their own request) during its existence.

E. Proposal Body

Detailed Proposed program description

We propose a program to (1) increase the number of community college students who graduate with STEM degrees and/or transfer to STEM programs at four year institutions, (2) increase the ability of community college faculty members to deliver aerospace-related content in areas of interest to NASA, and (3) enhance the diversity of students pursing STEM education at Minnesota community colleges. We propose to accomplish these objectives by the use of small multi-rotor model helicopters (often called "drones" or "UAVs" (unmanned aerial vehicles) but we will use the more-descriptive name "quadrotors") in competitions between student design groups at five Minnesota community colleges. These design groups will be led by faculty advisors at the various community colleges. The design competitions will consist of having the students build and then modify commercially-available quadrotor kits to incorporate additional electronics and sensors required to perform a mission in which the quadrotor is required to fly to a specified location, collect data related to a simulated precision-farming or environmental-science task, and return with the data. The students will be required to analyze the data and provide written and oral reports of their results.

Each year seven student teams of five students will participate, each advised by a community college faculty member. Thus over the two-year period of the program, fourteen teams (a total of seventy students) and seven or more community college faculty advisers will participate. The community colleges participating in the program are different locations in Minnesota, in order to provide geographic diversity. Student teams will include at least 40% women and 19% underrepresented minority students – the overall diversity goals for this solicitation as they apply to Minnesota. All student participants will achieve "significant funding/engagement" status by a combination of financial support (over $2500 in scholarships) plus contact hours (at least 80 hours, over two semesters).

Our community college partners are Central Lakes College in Brainerd (North Central MN), Century College in White Bear Lake (Minneapolis/St Paul Metro Area), Fond du Lac Tribal and Community College which is a MnSGC affiliate located in Cloquet (North East MN), Minnesota West Community and Technical College in Worthington (South Western MN), and Itasca Community College in Itasca (North Central MN). MnSGC has explicitly partnered with faculty from all of these institutions, with the exception of Itasca Community College, in the past. All of these colleges are part of the Minnesota State College and University System (MNSCU) which is comprised of seven institutions which grant bachelor's degrees and 24 community and technical colleges which grant associate degrees and certificates. MNSCU is separate from the University of Minnesota system to which the lead institution of the MnSGC, the University of Minnesota – Twin Cities (UMTC), belongs. The transfer and graduation rates for the five community college partners and for all 24 community colleges in the MNSCU system are shown in the following table.

College	Entering Students	Transfer Rate	Graduation Rate	Completion Rate
Central Lakes College	947	11.2%	37.7%	48.9%
Century College	1,845	21.8%	19.2%	41.0%
Fond du Lac Tribal and Community College	335	15.8%	30.1%	45.9%
Minnesota West Community and Technical College	650	11.2%	49.8%	61.0%
Itasca Community College	455	21.8%	38.9%	70.7%
State Wide Totals (24 Institutions)	25,509	19.3%	30.4%	49.7%

Completion Rates for Full-Time Degree and Certificate Seeking Students, Fall 2010 Entering Students by Spring Term 2013
Source: Systems Office Research – Academic and Student Affairs Division, Minnesota State College and University System

Nearly all of the faculty advisers already recruited have experience in one or more hands-on, student aerospace hardware projects such as high-altitude ballooning, high-power rocketry, and/or quadrotors. In addition to the community college partners, we have a NASA partner, Armstrong Flight Research Center, and an industrial partner, FourthWing Sensors, (see Section G for letters of commitment). FourthWing is a Minnesota company which designs and manufactures small, unmanned aircraft systems for use in precision agriculture. Armstrong Flight Research Center will provide input by teleconference and may help in judging student competitions as their budget permits. FourthWing will provide advice and assistance in creating rules and challenges for the competition, specification and selection of the quadrotor kits, guest lectures to students, and assistance in judging the competition.

Advances in micro-controllers, miniaturized sensors, small brushless electric motors, and light-weight batteries have revolutionized small unmanned aircraft. It is now possible for students to build a flight vehicle with a level of sophistication unimaginable even a few years ago. Articles about building DIY (Do It Yourself) quadrotors appear regularly in popular magazines such as *Homegrown Drones – Special Section* (multiple articles), Make magazine, February/March 2014, pp. 32-57 and *Build Your Own Drone*, Ed Darack, Air & Space, June/July 2014, pp.54-59.

A small, student-built quadrotor is shown in the two pictures below. This particular quadrotor was designed, built, and successfully flown in May 2014 by a team of senior aerospace engineering undergraduate students at the University of Minnesota – Twin Cities for their

required capstone senior design project. The project was directed by Professor Garrard and Mr. Todd Colten of FourthWing, but was essentially a student-led project. This particular quadrotor was designed to provide a method for firefighters to monitor a wild fire. It has an empty weight 1.6 kg. and can carry a maximum payload of 400 grams, with a flight time of about 10 minutes. This quadrotor was designed and built from 'scratch' (rather than from a kit) and took the student team one full academic year to complete.

Student-Built Quadrotor.*The picture on the left shows a quadrotorwith a 12 inch ruler to indicate the scale. There are four electric motors and propellers mounted on the arms to provide thrust for flight and for stabilization and control. The picture on the right is a close-up of the avionics and sensors. On the top shelf is an external GPS and magnetometer used for heading and waypoint navigation, integrated with the flight controller. The middle shelf holds a flight controller that contains an inertial measurement unit (IMU) used to automatically stabilize the aircraft. Underneath the flight controller is a high capacity Lithium-Polymer battery which is the primary power source. On one side of the battery is a RC receiver for receiving commands from the pilot ground station. On the other side is a telemetry device for transmitting flight data down to the ground station in real time. In between the two aluminum center plates are electronic speed controllers (ESC's) which control the speeds of the motors, and a power distribution board which routes the main power source to all of the motors. The payload consists of two camera systems. The first, on the bottom, is a GoPro Hero 3 camera for wide-angle video recording in high definition. The second is a First Person View live video transmission system. This transmits a live video feed to a portable HD display for the pilot to use. Telemetry data is superimposed onto this display, creating a heads up display (HUD) for fully remote piloting capabilities.*

We will use quadrotors for this competition because quadrotor kits are readily available, experience has shown that compared to fixed-wing radio-controlled airplanes students can quickly learn to pilot quadrotors, and quadrotors can be operated in small spaces (including indoors) with no infrastructure, which is not the case with fixed-wing radio-controlled airplanes. We have decided to have each student team start by building and learning to fly a basic

quadrotor from a commercially-available kit (each team will start with the same kit, for uniformity). Our experience has shown that building a quadrotor from 'scratch' would take too long for an inexperienced team and we could not be sure that each team would have a flyable vehicle in the end. Instead, students will have to significantly modify their kit-quadrotors in order to mount additional sensors, actuators, and electronics necessary for the competition challenges. This will also involve some mechanical design and fabrication, giving the students experience with computer-aided design (CAD) software and 3-D printing. In addition, the students will have to learn microcontroller programming and integration of electronics, sensors, actuators, and data-logging to ensure that they function properly.

All faculty advisers have had some experience with student hardware projects; however two in particular, one at Itasca Community College and one at Century College, already have experience with quadrotors. These two advisers will work along with faculty from the University of Minnesota to train the other faculty advisors and serve as resources for all the student teams. Over the course of each academic-year-long activity the advisers will attend a 2-day faculty training (to be held at Fond du Lac Tribal and Community College) then bring their student teams to a 1-day student kick-off/training (to be held at Century College). The remainder of the year will devoted to having the student teams build and test their quadrotor kits, then modifying them for specific competition challenges. The competition itself will take place in the spring at the Aerospace Engineering Department at the UMTC in Minneapolis.

One Century College faculty adviser, J. Abel, will serve as a CAD software and 3-D printing resource (using the "Fab Lab" at Century College) to all the teams in the competition. In this capacity, he will instruct advisers and students about CAD and Fab Lab capabilities at training meetings, offer advice about CAD software to purchase for teams at institutions that may not have their own already, offer additional CAD instruction (as requested by individual teams), and assist teams in placing orders remotely for 3-D printing of quadrotor custom parts at the Fab Lab. Teams will pay for Fab Lab services out of their supplies budget.

The Itasca Community College faculty adviser, M. Hansen, will serve as a general quadrotor consultant to all the teams in the competition. In this capacity, he will help select the common quadrotor starter kit for the competition, work with FourthWing and the other advisers to finalize the selection of competition challenges (which might not be identical for the two years of the competition), instruct advisers and students about quadrotor construction techniques and performance capabilities (and limitations) at training meetings, offer advice to teams about the feasibility of proposed modifications and about where to purchase supplies for their quadrotor project, and also offer additional quadrotor construction/flying instruction (as requested by individual teams).

During the academic year the student teams will meet regularly to build their quadrotor kits, learn to fly them, learn to program Arduino microcontrollers, and learn to draw custom pieces in CAD software and submit them for 3-D printing. They will then design, fabricate, integrate, and test electronics and structural modifications to their quadrotor kits allowing them to accomplish the competition challenges. Teams will participate in all-team videocons about once a month and also check in by telecon about every two weeks with the TAs at the U of MN working with the quadrotor project. Student teams will generate design reviews as described in the competition

timeline, hold at least one on-campus and one off-campus outreach event, and do an oral presentation to the judges (and possibly to the other teams) at the competition itself.

Students will complete on-line surveys both before and after the project about their academic and career aspirations and about their expectations/experiences with the competition, especially as they relate to their attitudes about STEM and progress toward completion of their course of studies. Students will also be interviewed individually as part of overall program evaluation. Near the end of the competition timeline students will be involved in helping recruit additional students to get involved in quadrotor activities, competitive or merely extracurricular. Faculty advisers will also regularly, though informally, "take the pulse" of the students on the team, offering them advice and encouragement as need be to persevere in their (STEM) higher education studies.

Advisers will take pre- and post-program surveys about their expectations/experiences regarding the effectiveness, impact, and organization of the overall competition program. Faculty will also share their aspirations about the long-term benefits of the program to themselves personally, and to their institution, then regularly discuss their progress toward achieving those benefits with other advisers (beginning at the opening training workshop and then continuing in all-adviser videocons at least twice a year).

Advisers will also organize "educational-enhancement" activities for their team at least once (preferably twice) per semester. Following the successful model of the North Star STEM Alliance, these extra events might focus on issues related to succeeding in college (including peer mentoring and where to find extra academic support), engaging with a specific (STEM) major, making the transition from community college to a STEM baccalaureate program or to the STEM workforce, learning about professional STEM organizations, touring STEM departments at local 4-year schools (such as at U of MN campuses or at state institutions of higher learning offering accredited engineering degrees) and/or local STEM employers, and discussing undergraduate research opportunities and internship opportunities such as NASA Center internships. U of MN (and MN Space Grant) professors W. Garrard and J. Flaten will be open to touring student teams around the aerospace engineering department and talking about the U of MN's College of Science and Engineering (CSE) more generally.

All faculty advisers will receive salary and fringe benefits for attending (and some for helping to instruct) adviser and student training events and for advising their student teams during the two academic years of the program. J. Abel and M. Hansen will receive additional support serving as competition-wide resource persons as described above. Each faculty adviser will contribute an amount of effort at about the 1-to-2-credit-per-semester level, which is consistent with faculty adviser stipends in the subcontracts. A detailed description of the timeline for the proposed program is given in Section F.

Benchmarks for success and progress

These benchmarks, listed in approximate chronological order (some overlap), are as follows:

1. Recruitment of faculty advisers at participating institutions (already accomplished!)
2. Recruitment of sufficient students with desired demographics

3. Pre-competition evaluation by students and faculty advisers
4. Successful completion of adviser training followed by student/faculty kick-off
5. Successful building of quadrotor kit; learning to fly it
6. Successful completion of Preliminary Design Review by each team
7. Designing, building, integrating, and testing modifications for the competition
8. Successful completion of Critical Design Review for by each team
9. Successful completion of outreach by each team
10. Participation in competition by each team, including a Flight-Readiness Review
11. Completion of final report by each team
12. Post-competition evaluation by students and faculty advisers

More details are provided in Section F.

Explanation of past performance and collaboration with community colleges

One of the partners, Fond du Lac Tribal and Community College (FDLTCC), is an affiliate of MnSGC and we have regularly supported both programmatic and scholarship programs at this institution. In recent years we have provided $2500 annually in scholarships to FDLTCC and have supported programs there in high-power rocketry, robotics, teacher professional development, and astronomy (from a Native American perspective) at a rate of $5K to $10K annually. We also have worked with the faculty adviser at Minnesota West Community and Technical College, Paul Seifert, on high-altitude ballooning, as well as with Century College's Tim Grebner on their successful rocket entry in the NASA-sponsored Undergraduate Student Launch Initiative (USLI) at Huntsville AL. We provided Century students with access to the University of Minnesota Low Speed Wind Tunnel and assistance in using this facility in determining the aerodynamics of their rocket entry. Adviser Nate Peterson from Central Lakes College in Brainerd has seen colleagues collaborating with MnSGC-affiliate Bemidji State University on high-altitude ballooning for Earth Science students and pre-service teachers.

Central Lakes College speaks for the group stating that the long-term benefits of this funding include the visibility of participating community colleges to have high-level STEM resources for students. This will increase the ability of these institutions to help ensure that they can meet regional STEM-skill needs. The increased visibility of a NASA grant will allow the participating institutions to support new models of STEM education. The students will serve as faces of the rewards STEM course-completion can offer. Additionally, with the spotlight drawn to STEM, such a program can assist in continuing emphasis on support for more-effective mathematics remediation. Finally, it is programs like these that bring four-year partners and industry partners together with a guarantee that credits and credentials are recognized as fully transferable and stackable. After the first year of this program the three inter-related components key to STEM student experience and success including 1) student support services and mentoring, 2) better preparation and increased diversity of entering students, and 3) reformed pedagogy and corresponding reward structure will grow out of this program and will allow the culture of the STEM students to be competitive in their awareness of this and other programs which to follow.

Plans for Reporting, Longitudinal Tracking, and Program Evaluation

MnSGC Associate Director J. Flaten will organize Longitudinal Tracking of student participants using both OEPM and the National Space Grant Foundation's Longitudinal Tracking system. Professor Flaten will also oversee evaluation of the program. Near the start of Year 1, and then again at the beginning of Year 2, on-line "pre-program" surveys will be distributed to student participants and faculty advisers. The students will be asked about their academic progress and future academic/career aspirations, especially as they relate to STEM fields. Students and faculty will be asked about their hopes/expectations for the design competition project.

Part way through the spring semester, after the quadrotor kits have been built but before the final competition, there will be a second round of evaluation for student participants and advisers, this time in the form of in-person oral interviews, with J. Flaten paying visits to participating schools. This will give teams the opportunity to show off their accomplishments, as will two required outreach events to promote visibility for the program, one for college student peers and one at an off-campus venue for either pre-college students or the general public.

After the competition one more round of on-line "post-program" surveys will be conducted to ascertain from students their evolving attitude toward STEM, progress toward academic/career goals, and to better-understand the overall impact of this program on participants. Faculty will also be polled about what worked well and what could use improvement in the program (at the end of Year 1) and about overall program impact and progress toward plans for sustainability (at the end of both Year 1 and Year 2). J. Flaten will oversee collecting, analyzing, and summarizing evaluation results and writing evaluation reports.

Recruitment Plan for Community College Students and Faculty

Faculty advisers were recruited by MN Space Grant personnel while developing this proposal and faculty adviser input regarding program organization and scheduling was solicited by telecon and by e-mail correspondence. The faculty advisers, all of whom are likely to participate for both years, are Elizabeth Jones and Steven Highland at Fond du Lac Tribal and Community College (2 teams), Paul Seifert at MN West Technical and Community College, Tim Grebner and Jeff Abel at Century College (2 teams), Nate Peterson at Central Lakes College (Brainerd campus), and Mason Hansen at Itasca Community College. Faculty members come from fields ranging from Engineering to Physics to Earth Science to GIS (Geographic Information Systems).

Participating institutions were tasked with developing and implementing their own mechanisms for recruiting student participants with appropriate aptitude, aspirations, and demographics. The percentage of minority students recruited must equal or exceed the percentage of minority students enrolled in Minnesota Institutions of Higher Learning (19% in the most-current data available) and the number of women must be greater than or equal to 40%. Central Lakes College maintains close working relationships with many local high school math and physics programs, including that of the Mille Lacs Band of Ojibwe. The Fond du Lac Band of the Lake Superior Chippewa is a partner of Fond du Lac Tribal and Community College. These connections may assist in recruiting Native American students as participants. Century College is located in a large urban area with a relatively large population of African-Americans, Hispanics,

and Native Americans. Participating community college faculty will work with their administrations to identify qualified women and members of underrepresented groups and contact these students individually to make them aware of the program.

Our program only engages given students for one year, so 2nd-year students will be recruited rather than incoming 1st-year students. Year 1 recruiting will take place early in the fall of 2014, or as soon as funding is secured, so the students have the remainder of that fall plus the spring semester of 2015 to prepare to build and modify their quadcopter and compete. Year 2 recruiting will startin the spring semester of 2015 so Year 2 fall events can start closer to the beginning of the fall semester in 2015. Year 1 students may be involved in helping recruit Year 2 participants; Year 2 students may become involved in implementing sustainability plans on their campuses.

Sustainability Plan

All of the participating institutions have plans to integrate the hardware and softwarethey develop in this competition into courses in their standing academic programs after this 2-year project is completed. For example, unmanned aerial flight is seeing increased utility for remote sensing in geosciences and faculty at some of the participating community colleges have already discussed collaborations that would involve physics and geoscience students working together with the engineering students in this area. Because the participating institutions are spread throughout the state, this program will also serve as a state-wide model for hands-on student aerospace hardware projects. The faculty members will receive training in CAD, 3-D printing, microcontrollers, and other technologies important to NASA and the aerospace industry, and they will then transmit this knowledge to students in their classes even after this project ends.

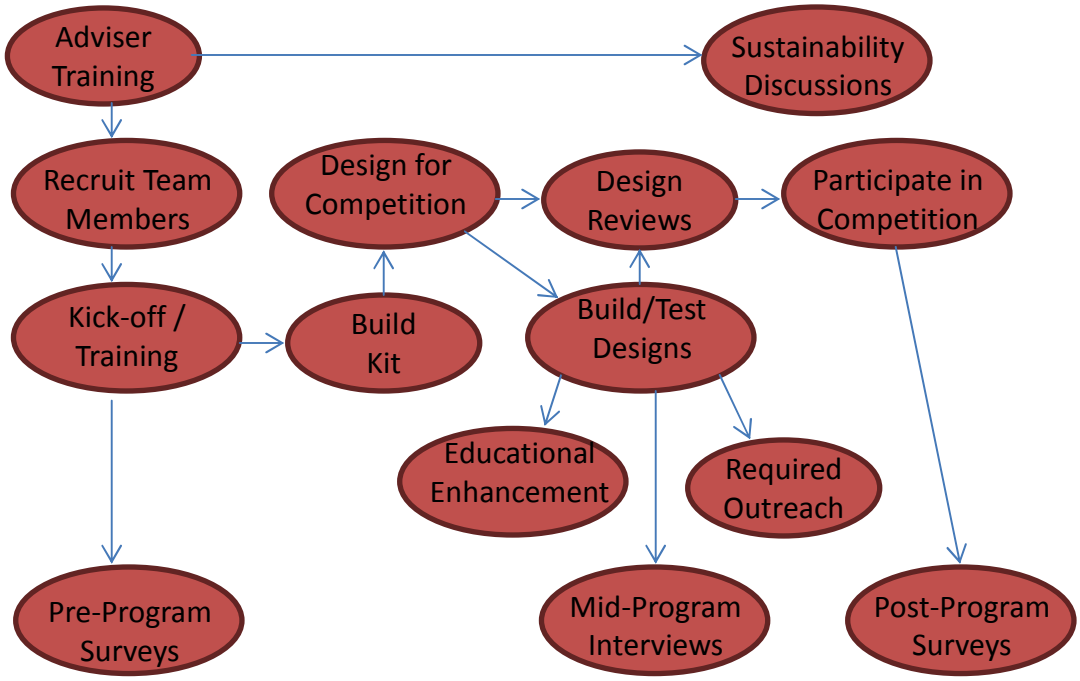
Contribution to Agency Performance Goals

- 2.4.1: Assure that students participating in NASA higher education projects are representative of the diversity of the Nation.
  The percentage of minority participants will be required to be greater than or equal to the percentage of minority students enrolled in institutions of higher education in Minnesota (currently 19%) and the number of women participants will equalor exceed 40%.
- 2.4.2 Continue to support STEM educators through the delivery of NASA education content and engagement in educator professional development opportunities.
  The training sessions for faculty will enhance theirabilities with CAD, 3-D printing, and the use ofmicrocontrollers. NASA is heavily involved in unmanned aerial vehicles and their use in remote sensingand the involvement of NASA's Armstrong Flight Research Center as well as our industry partner, FourthWing, will introduce the participatingfaculty to NASA content in this important area of aerospace technology.
- 2.4.3 Assure that the institutions NASA engages will represent the diversity of institution types and category levels in the Nation as defined by the U. S. Department of Education.
  This proposal is specifically for community colleges geographically spread around MN.
- 2.4.5 Continue to provide opportunities for learners to engage in STEM education engagement activities that capitalize on NASA unique assets and content.
  The emphasis on unmanned aerial vehicles and associated aeronautical technology as well as remote sensing capitalizes on NASA's assets in these areas.

F. Time Line/Schedule/Strategic Plan

"Year 1"	*Minimum of 80 hours for student participants.*
Early-Mid. Sept. 2014	Recruitment of student participants for Year 1 teams
Mid-Late Sept. 2014	2-3-day Training of Faculty Advisers (7 faculty from 5 institutions plus UMTC): pre-programming faculty evaluations, introduction to quadrotors, some kit building and flying, introduction to CAD and 3-D printing support, Arduino programming, finalization of Year 1 competition challenge list
Late-Sept. 2014 *(~8 hours for particip. students)*	1-day (in-person) Kick-off/Training (35 students on 7 teams plus 7 faculty advisers): pre-programming student evaluations, student intro to quadrotors and flying demonstrations, CAD and 3-D printing options, Arduino programming, videocon with Armstrong Flight Research Center, announcement of Year 1 competition challenges
Oct. – Dec. 2014 *(32+ hrs for partic. students)*	Quadrotor Kit Build and Plan/Design for Competition Challenges: all-team monthly videocons and individual-team telecon updates with U of MN, additional training from TAs and resource advisers (upon request), educational enhancement event(s), **Preliminary Design Review** on quadrotor kit build and on designs for competition modifications, mid-year adviser Videocon
Jan. – Mar. 2015 *(32+ hrs for partic.)*	Build/Implement Quadrotor Modifications & Practice for Competition: continue monthly all-team videocons and telecon updates, educational enhancement event(s), on-campus and off-campus outreach events (1 of each), mid-program evaluation interviews, **Critical Design Review** on modifications and testing
Apr. 2015 *(~8 hrs for particip. students)*	Year 1 Competition & Final Report: competition at U of MN (includes **Flight-Readiness Review** and videocon with NASA Armstrong), plus **Final Report** on competition performance, post-programming student evaluations, post-Year-1 faculty evaluations, year-end adviser videocon to discuss potential changes for Year 2, impact, sustainability progress, begin longitudinal tracking of Year 1 participants
"Year 2"	*Minimum of 80 hours for student participants; same distribution as Year 1.*
Spring 2015	Recruitment of student participants for Year 2 teams
Late-Sum. or Early Fall 2015	1-2-day Additional Training of Faculty Advisers (assume the same faculty): Advanced topics, finalization of Year 2 schedule changes and challenge list
Early/Mid-Sept. 2015	1-day In-Person Kick-off/Training (35 new students plus advisers): content similar to Year 1 Kick-off (see above) but with possibly-new Year 2 challenge list
Late-Sept. – Dec. 2015	Quadrotor Kit Build; Plan/Design for Competition Challenges: schedule similar to Year 1 (see above) with **Preliminary Design Review**, educational enhancement
Jan. – Mar. 2016	Build/Implement Quadrotor Modifications & Practice for Competition: schedule similar to Year 1 (see above) with **Critical Design Review**, outreach events
Apr. 2016	Year 2 Competition & Final Report: schedule similar to Year 1 (see above), **Flight-Readiness Review** and **Final Report**, year-end evaluations, longitudinal tracking, final adviser videocon about overall program impact and sustainability progress

MN Space Grant Quadrotor Design Competition
Graphical Schedule/Timeline (for each year)



Strategic Plan

Our goals for this proposal are to (1) increase the number of community college students who graduate with STEM degrees and/or transfer to STEM programs at four year institutions, (2) increase the ability of community college faculty members to deliver aerospace-related content in areas of interest to NASA, and (3) enhance diversity in the population student in STEM education in Minnesota community colleges. To this end our plan is to involve community colleges strategically located in various parts of the State. Student teams, led by faculty advisers at each institution, will build small radio-controlled helicopters (AKA quadrotors) and fly these in annual competitions which will involve all of the participating community colleges. In order to maximize the impact of NASA funding, we will provide all of these funds to the community colleges except for a small amount of U of MN (lead institution of the MnSGC) Indirect (see details in budget section). Our plan is to develop a program which will train community college faculty in areas such as computer aided design (CAD), 3-D printing, and the use of microcomputers/controllers in which they may not be familiar. We will use community college faculty who are already familiar with these technologies, as well as University of Minnesota faculty, to teach workshops to the other community college faculty. These faculty members will then be equipped to lead student teams at their own institutions. Our plan is to have a program which can serve as model for other community colleges throughout the country. The details of our plan are given in the Time Line / Schedule table and figure above.

G. Consortium Director Endorsement and Statement of Collaboration

Letter from Garrard (on this page)
Letter from Century (on separate page)
Letter from Fond du Lac (on separate page)
Letter from Itasca (on separate page)
Letter from MN West (on separate page)
Letter from Central Lakes (on separate page)
Letter from Fourth Wing (on separate page)
E-mail from NASA Armstrong (on separate page)

H. Space Grant Director Curriculum Vita

William L. Garrard

Education

B. S. Mechanical Engineering, University of Texas at Austin, 1962

Ph. D. Engineering Mechanics, University of Texas at Austin, 1968

Employment

1967-1973 Assistant Professor, Aerospace Engineering and Mechanics, University of Minnesota – Twin Cities

Summer 1973 Principal Research Engineer, Honeywell Systems and Research Center, Minneapolis Minnesota

1973-1986 Associate Professor, Aerospace Engineering and Mechanics, University of Minnesota – Twin Cities

1983-1991 Associate Department Head, Aerospace Engineering and Mechanics, University of Minnesota – Twin Cities

1986-present Professor, Aerospace Engineering and Mechanics, University of Minnesota – Twin Cities

1991-present Director, Minnesota Space Grant Consortium, University of Minnesota – Twin Cities

1991-2006 Department Head, Aerospace Engineering and Mechanics, University of Minnesota – Twin Cities

1995 Visiting Scientist, CERT/ONERA (Centre d'Etude et de Recherches de Toulouse/Office National d'Etudes et RecherchesAe'rospatiales) Toulouse,France

Honors

1996 Educational Award for Excellence from the U. S. Army Soldier Systems Command

2005 Fellow, American Institute of Aeronautics and Astronautics (AIAA)

2003 AIAA Certificate of Appreciation from Aerodynamic Decelerator Committee

2006-07 Aerospace Division ASEE/AIAA John Leland Atwood Award. The Atwood Award is bestowed annually upon an outstanding aerospace engineering educator.

Professional Service

Evaluator for Aerospace Engineering Programs, Engineering Accreditation Commission and Accreditation Commission for Engineering and Technology of ABET, 1995 – present. As evaluator for Engineering and Technology Programs has been involved in accrediting two year, Associate Degree Programs as well as four year Bachelor's Degree Programs

Alternate AIAA Commissioner, Engineering Technology Accreditation Commission of ABET, 2004-15

AIAA Commissioner, Engineering Accreditation Commission of ABET, 2001-2006.

AIAA Society Liaison, Accreditation Board for Engineering and Technology (ABET), 2008-present

Chair, National Council of NASA Space Grant Directors, 2006-2008

Research

Mathematical modeling and control of aerospace vehicles.Dynamics of parachute systems.

Teaching

Graduate and undergraduate courses in dynamics, control and performance of aerospace vehicles, feedback control theory, aeroelasticity, analysis and design of parachute systems, aerospace vehicle design.

Short Courses Organized and Taught

Short Courses in Parachute Systems Technology: Fundamentals, Concepts, and Applications. University of Minnesota, Minneapolis MN, 1982, Sandia Labs, Albuquerque NM, 1985, DFVLR, Munich, West Germany, 1987, Natick MA, 1990.Toulouse, France, 1992, Cocoa BeachFL, 1992, JohnsonSpaceCenterHoustonTX, 1994, MinneapolisMN, 1998.

Recent Publications

VibhorBageshwar, William Garrard, and Rajesh Rajamani, "Model Predictive Control of Transitional Maneuvers for Adaptive Cruise Control Systems," IEEE Transactions on Vehicular Technology, vol. 53, number 5, pp. 1573-1586, Sept 2004.

VibhorBageshwar, DemozGebre-Egziabher, William L. Garrard, and Tryphon T. Georgiou, "Stochastic Observability Test for Discrete-Time Kalman Filters," AIAA Journal of Guidance, Control and Dynamics, May/June 2009.

Joseph Mueller, Yiyuan Zhao, and William L. Garrard, "Optimal Ascent Trajectories for Stratospheric Airships Using Wind Energy," AIAA Journal of Guidance, Control and Dynamics May/June 2009.

Yiyuan Zhao, William L. Garrard, and Joseph Mueller, "Benefits of Trajectory Optimization in Airship Flights," AIAA Paper-2004-6257, AIAA ATIO Conference, Chicago, IL, Sept. 20-23, 2004.

J. Hammer, D. Gebre-Egziabher, W. Garrard, and S. Morgan, "Sky Spirit: Integration of UAV Design into an Aerospace Design Course," AIAA Paper 2005-6959. Infotech@Aerospace Conference, Arlington, VA. Sep. 2005.

V. L. Bageshwar, D. Gebre-Egziabher, and W. Garrard, et al "Minnesat: Attitude Estimation, Filters, and Experiments Onboard a Nanosatellite" AIAA/Utah State University Conference on Small Satellites, Logan Utah, August 14-17, 2006.

Travis Drayna, Michael Barnhardt, Graham Candler, and William Garrard,"Detached Eddy Simulations of the MSL Parachute at Supersonic Conditions," AIAA Paper 2007-2529, AIAA Aerodynamic Decelerator Systems Conference, Williamsburg, VA, May 21-24, 2007.

Bageswhar, Vibhor, Gebre-Egziabher, Demoz, Garrard, William, Shestople, Paul, and Adams, Michael, "Inertially-Aided Vector Matching Algorithm for Attitude Determination of Spin Stabilized Satellites," AIAA 2008-6295, 2008 AIAA Guidance, Navigation and Control Conference, August 2008.

VladimyrGidzak, Michael Barnhardt, Travis Drayna, IoannisNompelis, Graham V. Candler, and William Garrard, "Comparison of Fluid-Structure Interaction Simulations of the MSL Parachute with Wind Tunnel Tests," AIAA 2009-2971, AIAA Aerodynamic Decelerator Systems Conference, Seattle, WA, May 4-7, 2009.

I. Budget: Narrative, Details, and Sub-contract Information

To maximize the impact on community college students and faculty, all NASA funds will go out to the community colleges in the form of subcontracts except for U of MN Indirect which is charged on the first $25K of each subcontract, totaling $41,250 (all collected in Year 1). As described in the Statements of Work and subcontract budgets below, funding will be used by the five community colleges to field seven 5-person student teams each year (a total of 14 teams over the 2-year program) in the following areas:

- stipend plus fringe for one faculty adviser per team
- travel for the faculty to the 2-day adviser training
- travel for the whole team (students plus adviser) to the 1-day "kick-off" training
- travel for the whole team to the 1-day competition itself
- quadrotor kit plus materials/supplies (spare hardware, software, 3-D printing costs, etc.)
- student scholarships ($2860 per participant, hence exceeding $200,000 in scholarships for 70 student participants over the course of the 2-year program)
- a small amount of funding to FDLTCC and Century College for expenses associated with hosting training events (advisers-only training at FDLTCC, all-team kick-off at Century)

The University of Minnesota has agreed to provide a cash match equal to ¾ of the indirect costs mentioned above – see letter on the following page. We appreciate the willingness of the U of MN administration to provide this match, which allowed us to maximize the amount of NASA funding available to the community colleges through subcontracts. U of MN matching funds will support the costs associated with the University of Minnesota's participation in this program including:

- salary and fringe for Professor W. Garrard (1% of academic year salary) and J. Flaten (3% of academic year salary)to administer the program, plan and help instruct the training sessions, and host the annual competition
- TA support (serving all teams) by U of MN aerospace engineering undergraduates, especially in the area of Arduino microcontroller programming
- travel for W. Garrard, J. Flaten, plus two TAs each year to all training events
- quadrotor hardware and supplies for use in training workshops and by the TAs as they advise student teams
- travel for program evaluator J. Flaten for site visits toparticipating institutions for in-person interviews of team members and advisers each year

Mos letter here (on separate page)

OVERALL QUADROTOR DESIGN COMPETITION BUDGET

	"Year 1" (09/01/14 - 08/31/15)		"Year 2" (09/01/15 - 08/31/16)	
	Budget	Match	Budget	Match
Salaries	**0**	**0**	**0**	**0**
William Garrard, PI, Administrator	0	*See Note*	0	*See Note*
James Flaten, Co-PI, Administrator, Evaluator	0	*See Note*	0	*See Note*
Two TAs for each of two years	0	*See Note*	0	*See Note*
Fringe Benefits	**0**	**0**	**0**	**0**
Faculty @ 36%	0	*See Note*	0	*See Note*
Subtotal Salaries and Benefits	**0**	**0**	**0**	**0**
U of MN Programs Cost Share (3/4 of Indirect)		**30938**		**0**
Note -- Cost share to be spent (over 2 years) on				
> TA support (about $9K)				
>Quadrotor hardware (about $6K)				
> Training and Evaluator travel (about $6K)				
> Garrard 1% salary/fringe (about $4K)				
>Flaten 3% salary/fringe (about $6K)				
Travel	**0**	**0**	**0**	**0**
1. Faculty/TA training (2 days * 2 years)	0	*See Note*	0	*See Note*
2. Program evaluator (visit each school each yr)	0	*See Note*	0	*See Note*
Other Direct Costs	**229,375**	**0**	**229,375**	**0**
1. Quadrotor materials and supplies	0	*See Note*	0	*See Note*
2. Subcontract to Fond du Lac	68,020	0	68,020	0
Scholarships (20 students over 2 years)	*28,600*	*0*	*28,600*	*0*
2 advisers pay/fringe, materials, travel, IDC	*39,420*	*0*	*39,420*	*0*
3. Subcontract to Century College	62,434	0	62,434	0
Scholarships (20 students over 2 years)	*28,600*	*0*	*28,600*	*0*
2 advisers pay/fringe, materials, travel, IDC	*33,834*	*0*	*33,834*	*0*
4. Subcontract to MN West	34,642	0	34,642	0
Scholarships (10 students over 2 years)	*14,300*	*0*	*14,300*	*0*
1 adviser pay/fringe, materials, travel, IDC	*20,342*	*0*	*20,342*	*0*
5. Subcontract to Central Lakes	30,086	0	30,086	0
Scholarships (10 students over 2 years)	*14,300*	*0*	*14,300*	*0*
1 adviser pay/fringe, materials, travel, IDC	*15,786*	*0*	*15,786*	*0*

6. Subcontract to Central Lakes	34,193	0	34,193	0
Scholarships (10 students over 2 years)	*14,300*	*0*	*14,300*	*0*
1 adviser pay/fringe, materials, travel, IDC	*19,893*	*0*	*19,893*	*0*
Total Direct Costs	**229,375**	**30,938**	**229,375**	**0**
Indirect Costs 33% (on first $25K of subcontr.)	**41,250**	**0**	**0**	**0**
TOTAL DIRECT AND INDIRECT COSTS	**270,625**	**30,938**	**229,375**	**0**

2-Year Total Budget	**2-Year Total Match**
500,000	**30,938**

Statement of Work and Budget for Fond du Lac Tribal and Community College
(2-year subcontract of $136,040)

Minnesota Space Grant Consortium
Fond du Lac TCC Proposed Statement of Work
MN Space Grant Community College Quadrotor Design Competition
September 2014 to August 2016
Co-PIs: Elizabeth Jones and Steve Highland

STATEMENT OF WORK

We propose to recruit two teams of five 2nd-year students at Fond du Lac Tribal and Community College, one advised by E. Jones and one by S. Highlad, to participate in each of the two years of the MN Space Grant Quadrotor Design Competition. Over the course of this academic-year activity the advisers will attend a 2-day faculty training (to be held at Fond du Lac Tribal and Community College) then bring their student teams to a 1-day student kick-off/training (to be held at Century College) then bring their student teams to the competition near the end of the spring semester (to be held at the University of Minnesota – Twin Cities).

During the academic year the student teams will meet regularly to build the quadrotor kit, learn to fly it, learn to program Arduino microcontrollers, and learn to draw custom pieces in CAD software and submit them for 3-D printing, then design, fabricate, integrate, and test electronics and structural modifications to the quadrotor kit allowing it to accomplish the competition challenges. Teams will participate in all-team videocons about once a month and also check in by telecon with the TAs at the U of MN working with the quadrotor project about every second week. Student teams will generate written reports as described in the competition timeline, hold at least one on-campus and one off-campus outreach event, and do an oral presentation to the judges (and possibly to the other teams) at the competition itself.

Students will complete on-line surveys both before and after the project about their academic and career aspirations and about their expectations/experiences with the competition, especially as they relate to their attitudes about STEM and progress toward completion of their course of studies. Students will also be interviewed individually as part of overall program evaluation. Near the end of the competition timeline students will be involved in helping recruit additional students to get involved in quadrotor activities, competitive or merely extracurricular. Faculty advisers will also regularly, though informally, "take the pulse" of the students on the team, offering them advice and encouragement as need be to persevere in their (STEM) higher education studies.

Advisers will also take pre- and post-program surveys about their expectations/experiences regarding the effectiveness, impact, and organization of the overall competition program. Faculty will also share their aspirations about the long-term benefits of the program to them personally, and to their institution, then regularly discuss their progress toward achieving those benefits with other advisers (at the opening training workshop and then during all-adviser videocons at least twice a year).

Advisers will also organize "educational-enhancement" activities for the team at least once (preferably twice) per semester. Following the successful model of the North Star STEM Alliance, these extra events might focus on issues related to succeeding in college (including peer mentoring and where to find extra academic support), engaging with a specific (STEM) major, making the transition from community college to a STEM baccalaureate program or to the STEM workforce, learning about professional STEM organizations, touring STEM

departments at nearby 4-year schools (potentially the U of MN – Duluth) and/or local STEM employers, and discussing undergraduate research opportunities and internship opportunities such as NASA Center internships.

E. Jones and S. Highland will both receive salary and fringe benefits for attending adviser and student training events and for advising their student teams during the two academic years of the program. FDLTCC pays faculty per credit taught, not per hour. Each will contribute an amount of advising effort at about the 1.125-credits-per-semester level, which is consistent with their stipend in the subcontract.

FOND DU LAC TRIBAL AND COMMUNITY COLLEGE SUBCONTRACT BUDGET

	"Year 1" (09/01/14 - 08/31/15)		"Year 2" (09/01/15 - 08/31/16)	
	Budget	Match	Budget	Match
Salaries	**11,200**	**0**	**11,200**	**0**
2 Faculty advisors (1 for each team)	11,200		11,200	
Fringe Benefits	**4,480**	**0**	**4,480**	**0**
Faculty @ 40.0%	4,480		4,480	
Subtotal Salaries and Benefits	**15,680**	**0**	**15,680**	**0**
Travel	**6,520**	**0**	**6,520**	**0**
1. 10 students & 2 advisers to 1-day kick-off, 1 hotel night, per diem	2,760		2,760	
2. 10 students & 2 advisers, educational enhancement travel expenses	1,000		1,000	
3. 10 students & 2 advisers to 1-day competition, 1 hotel night, per diem	2,760		2,760	
Other Direct Costs	**35,600**	**0**	**35,600**	**0**
1. Quadrotor materials and supplies (for 2 teams each year)	6,000		6,000	
2. Student scholarships (for 10 students each year)	28,600		28,600	
3. Host faculty adviser 2-day training	1,000		1,000	
Total Direct Costs	**57,800**	**0**	**57,800**	**0**
Indirect Costs 35% on all but scholarships	**10,220**		**10,220**	
TOTAL DIRECT AND INDIRECT COSTS	**68,020**	**0**	**68,020**	**0**

2-Year Total Subcontract to FDLTCC	**2-Year Match Total from FDLTCC**
136,040	**0**

Statement of Work and Budget for Century College
(2-year subcontract of $124,868)

Minnesota Space Grant Consortium
Century College Proposed Statement of Work
MN Space Grant Community College Quadrotor Design Competition
September 2014 to August 2016
Co-PIs: Tim Grebner and Jeffry Abel

STATEMENT OF WORK

We propose to recruit two teams of five 2nd-year students at Century College, one advised by T. Grebner and one by J. Abel, to participate in each of the two years of the MN Space Grant Quadrotor Design Competition. Over the course of this academic-year activity the advisers will attend a 2-day faculty training (to be held at Fond du Lac Tribal and Community College) then bring their student teams to a 1-day student kick-off/training (to be held at Century College) then bring their student teams to the competition near the end of the spring semester (to be held at the University of Minnesota – Twin Cities).

In addition to serving as one Century team adviser, J. Abel will serve as a CAD software and 3-D printing resource (using the "Fab Lab" at Century College) to all the teams in the competition. In this capacity he will instruct advisers and students about CAD and Fab Lab capabilities at training meetings, offer advice about CAD software to purchase for teams at institutions that may not have their own, offer additional CAD instruction (as requested by individual teams), and assist teams in remotely placing orders for 3-D printing of quadrotor custom parts at the Fab Lab. Teams will pay for Fab Lab services out of their supplies budget.

During the academic year the student teams will meet regularly to build the quadrotor kit, learn to fly it, learn to program Arduino microcontrollers, and learn to draw custom pieces in CAD software and submit them for 3-D printing, then design, fabricate, integrate, and test electronics and structural modifications to the quadrotor kit allowing it to accomplish the competition challenges. Teams will participate in all-team videocons about once a month and also check in by telecon with the TAs at the U of MN working with the quadrotor project about every second week. Student teams will generate written reports as described in the competition timeline, hold at least one on-campus and one off-campus outreach event, and do an oral presentation to the judges (and possibly to the other teams) at the competition itself.

Students will complete on-line surveys both before and after the project about their academic and career aspirations and about their expectations/experiences with the competition, especially as they relate to their attitudes about STEM and progress toward completion of their course of studies. Students will also be interviewed individually as part of overall program evaluation. Near the end of the competition timeline students will be involved in helping recruit additional students to get involved in quadrotor activities, competitive or merely extracurricular. Faculty advisers will alsoregularly, though informally, "take the pulse" of the students on the team, offering them advice and encouragement as need be to persevere in their (STEM) higher education studies.

Advisers will also take pre- and post-program surveys about their expectations/experiences regarding the effectiveness, impact, and organization of the overall competition program. Faculty will also share their aspirations about the long-term benefits of the program to them personally, and to their institution, then regularly discuss their progress toward achieving those benefits with

other advisers (at the opening training workshop and then during all-adviser videocons at least twice a year).

Advisers will also organize “educational-enhancement” activities for the team at least once (preferably twice) per semester. Following the successful model of the North Star STEM Alliance, these extra events might focus on issues related to succeeding in college (including peer mentoring and where to find extra academic support), engaging with a specific (STEM) major, making the transition from community college to a STEM baccalaureate program or to the STEM workforce, learning about professional STEM organizations, touring STEM departments at local 4-year schools (potentially the U of MN – Twin Cities) and/or local STEM employers, and discussing undergraduate research opportunities and internship opportunities such as NASA Center internships. U of MN (and MN Space Grant) aerospace engineering professors W. Garrard and J. Flaten will be open to talking to the students about aerospace engineering, and the College of Science and Engineering (CSE) at the U of MN more generally.

T. Grebner and J. Abel will both receive salary and fringe benefits for attending (and for helping to instruct) adviser and student training events and for advising their student teams during the two academic years of the program. J. Abel will receive additional support serving as the CAD software and Fab Lab resource person to the entire competition. The hourly pay rate for both T. Grebner and J. Abel will be $50/hour, and each will contribute the number of hours consistent with their stipend, or more.

CENTURY COLLEGE SUBCONTRACT BUDGET

	"Year 1" (09/01/14 - 08/31/15)		"Year 2" (09/01/15 - 08/31/16)	
	Budget	Match	Budget	Match
Salaries	**12,700**	**0**	**12,700**	**0**
2 Faculty advisors (1 for each team)	11,200		11,200	
1 Faculty stipend for providing CAD and Fab Lab support (for all teams)	1,500		1,500	
Benefits	**4,318**	**0**	**4,318**	**0**
Faculty @ 34.0%	4,318		4,318	
Subtotal Salaries and Benefits	**17,018**	**0**	**17,018**	**0**
Travel	**4,881**	**0**	**4,881**	**0**
1. 2 advisers to 2-day faculty training, 2 hotel nights, per diem	1,220		1,220	
2. 10 students & 2 advisers, educational enhancement travel expenses	1,000		1,000	
3. 10 students & 2 advisers to 1-day competition, 1 hotel night, per diem	2,661		2,661	
Other Direct Costs	**35,600**	**0**	**35,600**	**0**
1. Quadrotor materials and supplies (for 2 teams each year)	6,000		6,000	
2. Student scholarships (for 10 students each year)	28,600		28,600	
3. Host kick-off (AKA all-teams 1-day training)	1,000		1,000	
Total Direct Costs	**57,499**	**0**	**57,499**	**0**
Indirect Costs 29% on Faculty Stipend and Benefits	**4,935**		**4,935**	
TOTAL DIRECT AND INDIRECT COSTS	**62,434**	**0**	**62,434**	**0**

2-Year Total Subcontract to Century	**2-Year Match Total from Century College**
124,868	**0**

Statement of Work and Budget for Itasca Community College
(2-year subcontract of $68,386)

Minnesota Space Grant Consortium
Itasca Community College Proposed Statement of Work
MN Space Grant Community College Quadrotor Design Competition
September 2014 to August 2016
PI: Mason Hansen

STATEMENT OF WORK

We propose to recruit one team of five 2nd-year students at Itasca Community College, advised by M. Hansen, to participate in each of the two years of the MN Space Grant Quadrotor Design Competition. Over the course of this academic-year activity the adviser will attend a 2-day faculty training (to be held at Fond du Lac Tribal and Community College) then bring the student team to a 1-day student kick-off/training (to be held at Century College) then bring the student team to the competition near the end of the spring semester (to be held at the University of Minnesota – Twin Cities).

In addition to serving as the Itasca team adviser, M. Hansen will serve as a general quadrotor consultant to all the teams in the competition. In this capacity he will help select the common quadrotor starter kit for the competition, be central to the selection of competition challenges (which might not be identical for the two years of the competition), instruct advisers and students about quadrotor construction techniques and performance capabilities (and limitations) at training meetings, offer advice to teams about the feasibility of proposed modifications and about where to purchase supplies for their quadrotor project, and also offer additional quadrotor construction/flying instruction (as requested by individual teams).

During the academic year the student teams will meet regularly to build the quadrotor kit, learn to fly it, learn to program Arduino microcontrollers, and learn to draw custom pieces in CAD software and submit them for 3-D printing, then design, fabricate, integrate, and test electronics and structural modifications to the quadrotor kit allowing it to accomplish the competition challenges. Teams will participate in all-team videocons about once a month and also check in by telecon with the TAs at the U of MN working with the quadrotor project about every second week. Student teams will generate written reports as described in the competition timeline, hold at least one on-campus and one off-campus outreach event, and do an oral presentation to the judges (and possibly to the other teams) at the competition itself.

Students will complete on-line surveys both before and after the project about their academic and career aspirations and about their expectations/experiences with the competition, especially as they relate to their attitudes about STEM and progress toward completion of their course of studies. Students will also be interviewed individually as part of overall program evaluation. Near the end of the competition timeline students will be involved in helping recruit additional students to get involved in quadrotor activities, competitive or merely extracurricular. Faculty advisers will also regularly, though informally, “take the pulse” of the students on the team, offering them advice and encouragement as need be to persevere in their (STEM) higher education studies.

Advisers will also take pre- and post-program surveys about their expectations/experiences regarding the effectiveness, impact, and organization of the overall competition program. Faculty will also share their aspirations about the long-term benefits of the program to them personally, and to their institution, then regularly discuss their progress toward achieving those benefits with

other advisers (at the opening training workshop and then during all-adviser videocons at least twice a year).

Advisers will also organize “educational-enhancement” activities for the team at least once (preferably twice) per semester. Following the successful model of the North Star STEM Alliance, these extra events might focus on issues related to succeeding in college (including peer mentoring and where to find extra academic support), engaging with a specific (STEM) major, making the transition from community college to a STEM baccalaureate program or to the STEM workforce, learning about professional STEM organizations, touring STEM departments at nearby 4-year schools (potentially Bemidji State University) and/or local STEM employers, and discussing undergraduate research opportunities and internship opportunities such as NASA Center internships.

M. Hansen will receive salary and fringe benefits for attending (and for helping to instruct) adviser and student training events and for advising the student team during the two academic years of the program. M. Hansen will receive additional support serving as the quadrotor resource person to the entire competition. M. Hansen will contribute an amount of effort at about the 2-credit-per-semester level, which is consistent with his stipend in the subcontract.

ITASCA COMMUNITY COLLEGE SUBCONTRACT BUDGET

	"Year 1" (09/01/14 - 08/31/15)		"Year 2" (09/01/15 - 08/31/16)	
	Budget	Match	Budget	Match
Salaries	**7,100**	**0**	**7,100**	**0**
1 Faculty advisor	5,600		5,600	
1 Faculty stipend for providing quadrotor expertise/advising (for all teams)	1,500		1,500	
Fringe Benefits	**2,840**	**0**	**2,840**	**0**
Faculty @ 40.0%	2,840		2,840	
Subtotal Salaries and Benefits	**9,940**	**0**	**9,940**	**0**
Travel	**4,070**	**0**	**4,070**	**0**
1. Adviser to 2-day faculty training, 2 hotel nights, per diem	810		810	
2. 5 students & adviser to 1-day kick-off, 1 hotel night, per diem	1,380		1,380	
3. 5 students & adviser, educational enhancement travel expenses	500		500	
4. 5 students & adviser to 1-day competition, 1 hotel night, per diem	1,380		1,380	
Other Direct Costs	**17,300**	**0**	**17,300**	**0**
1. Quadrotor materials and supplies (for 1 team each year)	3,000		3,000	
2. Student scholarships (for 5 students each year)	14,300		14,300	
Total Direct Costs	**31,310**	**0**	**31,310**	**0**
Indirect Costs 29% on Faculty Stipend and Benefits	**2,883**		**2,883**	
TOTAL DIRECT AND INDIRECT COSTS	**34,193**	**0**	**34,193**	**0**

2-Year Total Subcontract to Itasca	**2-Year Match Total from Itasca**
68,386	**0**

Statement of Work and Budget for Central Lakes College – Brainerd
(2-year subcontract of $60,172)

Minnesota Space Grant Consortium
Central Lakes College Proposed Statement of Work
MN Space Grant Community College Quadrotor Design Competition
September 2014 to August 2016
PI: Nathan Peterson

STATEMENT OF WORK

We propose to recruit one team of five 2nd-year students at Central Lakes College – Brainerd, advised by N. Peterson, to participate in each of the two years of the MN Space Grant Quadrotor Design Competition. Over the course of this academic-year activity the adviser will attend a 2-day faculty training (to be held at Fond du Lac Tribal and Community College) then bring the student team to a 1-day student kick-off/training (to be held at Century College) then bring the student team to the competition near the end of the spring semester (to be held at the University of Minnesota – Twin Cities).

During the academic year the student teams will meet regularly to build the quadrotor kit, learn to fly it, learn to program Arduino microcontrollers, and learn to draw custom pieces in CAD software and submit them for 3-D printing, then design, fabricate, integrate, and test electronics and structural modifications to the quadrotor kit allowing it to accomplish the competition challenges. Teams will participate in all-team videocons about once a month and also check in by telecon with the TAs at the U of MN working with the quadrotor project about every second week. Student teams will generate written reports as described in the competition timeline, hold at least one on-campus and one off-campus outreach event, and do an oral presentation to the judges (and possibly to the other teams) at the competition itself.

Students will complete on-line surveys both before and after the project about their academic and career aspirations and about their expectations/experiences with the competition, especially as they relate to their attitudes about STEM and progress toward completion of their course of studies. Students will also be interviewed individually as part of overall program evaluation. Near the end of the competition timeline students will be involved in helping recruit additional students to get involved in quadrotor activities, competitive or merely extracurricular. Faculty advisers will also regularly, though informally, "take the pulse" of the students on the team, offering them advice and encouragement as need be to persevere in their (STEM) higher education studies.

Advisers will also take pre- and post-program surveys about their expectations/experiences regarding the effectiveness, impact, and organization of the overall competition program. Faculty will also share their aspirations about the long-term benefits of the program to them personally, and to their institution, then regularly discuss their progress toward achieving those benefits with other advisers (at the opening training workshop and then during all-adviser videocons at least twice a year).

Advisers will also organize "educational-enhancement" activities for the team at least once (preferably twice) per semester. Following the successful model of the North Star STEM Alliance, these extra events might focus on issues related to succeeding in college (including peer mentoring and where to find extra academic support), engaging with a specific (STEM) major, making the transition from community college to a STEM baccalaureate program or to the STEM workforce, learning about professional STEM organizations, touring STEM

departments at nearby 4-year schools (potentially Bemidji State University) and/or local STEM employers, and discussing undergraduate research opportunities and internship opportunities such as NASA Center internships.

N. Peterson will receive salary and fringe benefits for attending adviser and student training events and for advising the student team during the two academic years of the program. N. Peterson will contribute an amount of effort at about the 2-credit-per-semester level, which is consistent with his stipend in the subcontract.

CENTRAL LAKES COLLEGE – BRAINERD SUBCONTRACT BUDGET

	"Year 1" (09/01/14 - 08/31/15)		"Year 2" (09/01/15 - 08/31/16)	
	Budget	Match	Budget	Match
Salaries	**5,600**	**0**	**5,600**	**0**
1 Faculty advisor	5,600		5,600	
Fringe Benefits	**848**	**0**	**848**	**0**
Faculty @ 15.15%	848		848	
Subtotal Salaries and Benefits	**6,448**	**0**	**6,448**	**0**
Travel	**4,070**	**0**	**4,070**	**0**
1. Adviser to 2-day faculty training, 2 hotel nights, per diem	810		810	
2. 5 students & adviser to 1-day kick-off, 1 hotel night, per diem	1,380		1,380	
3. 5 students & adviser, educational enhancement travel expenses	500		500	
4. 5 students & adviser to 1-day competition, 1 hotel night, per diem	1,380		1,380	
Other Direct Costs	**17,300**	**0**	**17,300**	**0**
1. Quadrotor materials and supplies (for 1 team each year)	3,000		3,000	
2. Student scholarships (for 5 students each year)	14,300		14,300	
Total Direct Costs	**27,818**	**0**	**27,818**	**0**
Indirect Costs 35.18% on Faculty Stipend and Benefits	**2,268**		**2,268**	
TOTAL DIRECT AND INDIRECT COSTS	**30,086**	**0**	**30,086**	**0**

2-Year Total Subcontract to Central Lakes	**2-Year Match Total from Central Lakes**
60,172	**0**

Statement of Work and Budget for MN West Community & Technical College
(2-year subcontract of $69,284)

Minnesota Space Grant Consortium
MN West Comm. & Tech. College Proposed Statement of Work
MN Space Grant Community College Quadrotor Design Competition
September 2014 to August 2016
PI: Paul Seifert

STATEMENT OF WORK

We propose to recruit one team of five 2nd-year students at MN West Community and Technical College, advised by P. Seifert, to participate in each of the two years of the MN Space Grant Quadrotor Design Competition. Over the course of this academic-year activity the adviser will attend a 2-day faculty training (to be held at Fond du Lac Tribal and Community College) then bring the student team to a 1-day student kick-off/training (to be held at Century College) then bring the student team to the competition near the end of the spring semester (to be held at the University of Minnesota – Twin Cities).

During the academic year the student teams will meet regularly to build the quadrotor kit, learn to fly it, learn to program Arduino microcontrollers, and learn to draw custom pieces in CAD software and submit them for 3-D printing, then design, fabricate, integrate, and test electronics and structural modifications to the quadrotor kit allowing it to accomplish the competition challenges. Teams will participate in all-team videocons about once a month and also check in by telecon with the TAs at the U of MN working with the quadrotor project about every second week. Student teams will generate written reports as described in the competition timeline, hold at least one on-campus and one off-campus outreach event, and do an oral presentation to the judges (and possibly to the other teams) at the competition itself.

Students will complete on-line surveys both before and after the project about their academic and career aspirations and about their expectations/experiences with the competition, especially as they relate to their attitudes about STEM and progress toward completion of their course of studies. Students will also be interviewed individually as part of overall program evaluation. Near the end of the competition timeline students will be involved in helping recruit additional students to get involved in quadrotor activities, competitive or merely extracurricular. Faculty advisers will also regularly, though informally, "take the pulse" of the students on the team, offering them advice and encouragement as need be to persevere in their (STEM) higher education studies.

Advisers will also take pre- and post-program surveys about their expectations/experiences regarding the effectiveness, impact, and organization of the overall competition program. Faculty will also share their aspirations about the long-term benefits of the program to them personally, and to their institution, then regularly discuss their progress toward achieving those benefits with other advisers (at the opening training workshop and then during all-adviser videocons at least twice a year).

Advisers will also organize "educational-enhancement" activities for the team at least once (preferably twice) per semester. Following the successful model of the North Star STEM Alliance, these extra events might focus on issues related to succeeding in college (including peer mentoring and where to find extra academic support), engaging with a specific (STEM) major, making the transition from community college to a STEM baccalaureate program or to the STEM workforce, learning about professional STEM organizations, touring STEM

departments at nearby 4-year schools (potentially MN State University – Mankato) and/or local STEM employers, and discussing undergraduate research opportunities and internship opportunities such as NASA Center internships.

P. Seifert will receive salary and fringe benefits for attending adviser and student training events and for advising the student team during the two academic years of the program. P. Seifert will contribute an amount of effort at about the 2-credit-per-semester level, which is consistent with his stipend in the subcontract.

MN WEST COMMUNITY & TECHNICAL COLLEGE SUBCONTRACT BUDGET

	"Year 1" (09/01/14 - 08/31/15)		"Year 2" (09/01/15 - 08/31/16)	
	Budget	Match	Budget	Match
Salaries	**5,600**	**0**	**5,600**	**0**
1 Faculty advisor	5,600		5,600	
Fringe Benefits	**1,912**	**0**	**1,912**	**0**
Faculty @ 34.14%	1,912		1,912	
Subtotal Salaries and Benefits	**7,512**	**0**	**7,512**	**0**
Travel	**4,070**	**0**	**4,070**	**0**
1. Adviser to 2-day faculty training, 2 hotel nights, per diem	810		810	
2. 5 students & adviser to 1-day kick-off, 1 hotel night, per diem	1,380		1,380	
3. 5 students & adviser, educational enhancement travel expenses	500		500	
4. 5 students & adviser to 1-day competition, 1 hotel night, per diem	1,380		1,380	
Other Direct Costs	**17,300**	**0**	**17,300**	**0**
1. Quadrotor materials and supplies (for 1 team each year)	3,000		3,000	
2. Student scholarships (for 5 students each year)	14,300		14,300	
Total Direct Costs	**28,882**	**0**	**28,882**	**0**
Indirect Costs 39.5% on all but scholarships	**5,760**		**5,760**	
TOTAL DIRECT AND INDIRECT COSTS	**34,642**	**0**	**34,642**	**0**

2-Year Total Subcontract to MN West	**2-Year Match Total from MN West**
69,284	**0**