Stanford Composites Design Group

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1 What criteria should be used to select technology focus areas

1.a Historical background

Advanced composites started in the US in the late 1950's. It was invented here. It was triggered by the discovery of boron fiber as one byproduct of a solid propellant, by Avco Corporation. The US government projected that it would revolutionize the structures of the world; e.g., bridge span to be 5 times longer, and sky scraper 10 times taller. Heavy investments were made by the USAF to introduce composites to war machines. The first production item was F-14 with its boron/epoxy horizontal stabilizer in the mid 1960's. One of our members (Pedro Marcal) took part in this effort.

In the late 1960's carbon fiber came along. Gradually it replaced boron and was used in the production of F-16 stabilizer, F-15 wings, and others followed. The design and manufacturing were developed by the US government, industry and academia. Prof. Tsai was the Chief Scientist of the AF Materials Laboratory that made the first and heaviest investment in many advanced development projects that funded all the major aerospace companies from the 1960's on.

1.b US leadership

Fast forward to the 21st Century, Boeing 787 is the first commercial airplane that has all its exterior surface made of carbon/epoxy composites. The failure of the Wing Fuselage intersection during the wing displacement test requiring a redesign with a Titanium interface points to the need for a project to improve our design capability in this area. Our group has all the necessary experience to help resolve this problem. General Electric furthered its pioneering carbon/epoxy fan blades for its GEnx engine that powers the Boeing 787. The importance of Civilian Aviation to our overall activity was reported as $1.3 trillion dollars with a contribution of $75 billion to our exports. According to the FAA Economic study , 2011, its the largest contributor to our export effort . Now composites are dominating industries sporting goods, medical devices, wind energy, Formula 1 racing cars and other areas where light weight and life-time durability are critical.

Thus composites are truly invented here in the US. The basic design and manufacturing processes like prepreg, automated tape laying, micromechanics, failure criterion, and damage tolerance can all be traced to some university, company or government agency in the US. But our leadership has been eroded in recent years. Airbus used more composites in its A380 than any airplane up to that point. The A350 will use as much as the B787. Bombardier and Embraer have all composites passenger jets. It is most timely that US should renew their commitment to capture world leadership again. We need to recognize that composites have helped to make Boeing and GE unique and are the top exporters of the US. A decision to include a Composites institute in the NNMI program will make composites great again for the US.

1.c Current market opportunities

Composites can be one of the most critical drivers for energy efficiency. Less weight and higher fatigue life can make many systems improve productivity, lower cost and more friendly to the environment. In particular, airplanes, cars, wind turbines can all be made more fuel efficient. For the aerospace industry alone, there is a huge demand. The new Federal fleet-wide Fuel Standards for 2025 of 54.5 m.p.g. can easily be achieved with large scale substitution of composites for metals in cars. For economic reasons, the automobile industry has focused on the use of short fiber reinforced composites. This is an area requiring additional technical expertize in Fracture Mechanics combined with a large dose of Statistics and Design of Experiments.

Aerospace industry analyst predicts $10.3 billion market in 2012

Market research firm Visongain's (London, U.K.) analysis indicates the demand for more fuel-efficient aircraft and refined manufacturing methods will power growth of aerospace composites for the next decade.

Author: Staff
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Source: CompositesWorld

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The Aerospace Composites Market 2012-2022, a new report released Sept 28 by market analyst Visiongain (London, U.K.) indicates that the global aerospace composites market will reach a value of $10.3 billion (USD) this year as the manufacturing process of composite materials into aircraft is refined and developed and the demand for new fuel efficient aircraft gathers pace.

According to Visiongain, the aerospace composites market is expected to record positive and continuous growth over the next decade, in large part due to a better understanding of the physical attributes of composite materials, which can be successfully integrated into the design and development process and the increasing demand for lighter and more fuel efficient aircraft. Visiongain credits a predicted "expansion of air travel, the importance attached to maintaining airline safety and the need by airlines to reduce operational costs" as the key forces that will shape the aerospace composites industry.

The report contains 101 tables, charts and graphs that add visual analysis in order to explain developing trends within the aerospace composites market. Visiongain provides forecasts for the period 2012-2022 in terms of value (figured in U.S. dollars) for the global aerospace composites market, as well as submarket forecasts for three reinforcement fiber types (glass, carbon and aramid) and four submarket forecasts by aircraft type (commercial jets, business jets, military, and commercial helicopters). In addition, 10 leading national aerospace composites markets are forecast and analyzed by Visiongain over the period 2012-2022.

The report provides profiles of 20 leading companies operating within the market, and includes two interviews that provide expert insight alongside the Visiongain analysis.

1.d Foreign competition

Composites is a generic game changer. Lighter weight means more fuel efficiency. Toyota had a prototype Prius that was 2/3 of the current model in weight and could do over 100 mpg. Wind turbine cannot be made without composites. Most blades are glass/epoxy up to now. As blades become 70 meter and longer carbon fibers will be needed. To maintain US competitiveness in this industry, investment must be made to improve manufacturing processes so more efficient blades can be made to stave off foreign competition. Blades must be made near the location of the wind turbine. Thus for domestic consumption US manufacturers must remain competitive so blades will be purchased from domestic companies that will create jobs and also improve the balance of trades. In addition, new technology in blade manufacturing can be exported through licensing. The same aggressive approach should be applied to other emerging markets for composites in the US. Examples include moving systems like cars, trucks and trains which must conserve energy, and stationary structures like bridges and buildings where life-time safety can be guaranteed. Our existing stationary infrastructure needs upgrading and repair (from earthquakes, floods etc.). The deployment of Composites in this effort has resulted in timely replacement and repair. The manufacture of large jetliner fuselages and wings, and large wind turbine blades requires huge investments in production facilities requiring the investment of over US $1 billion dollars. It is our intention to investigate less costly and more efficient methods using robotic automation and to pin point control of heating and pressurization.

Institute for Advanced Manufacturing Unveiled

Wednesday 19th September saw the Rt Hon David Willetts MP, Minister of State for Universities and Science, welcome Atlas Composites Managing Director, Shaun Moloney, and a select group of guests to the official launch of Nottingham Universities new £3.5 million Institute for Advanced Manufacturing.

According to Atlas, the centre aims to develop cutting-edge technology in areas including aerospace, automotive, defence, medical, power engineering, textiles and clothing. Partners include Airbus, Rolls-Royce and BAE Systems.

Atlas Composites, who manufacturer composite components for aerospace, satellite communications and unmanned aerial systems, already have close links with the University, they are Advisory Group Board Members for the Aerospace Technology Centre.

With the UK composites industry - driven by growth sectors such as Aerospace - expected to grow by around 8% per annum to 2020, Atlas says the importance of collaborative research with SME's, such as itself, cannot be understated.

Speaking after formally opening the Institute, the Rt Hon David Willetts MP, Minister for Universities and Science said. "Nottingham could become home to the great engineers of the future. As set out in the Government's industrial strategy, it is vital that business benefits from the very best and latest technologies in order to compete in the global marketplace and be a driving force for growth."

Publication date: 02/10/2012

Link: http://www.atlascomposites.com

2 What technology focus areas that meet these criteria would you be willing to co-invest in?

2.a Criteria to co-invest

To be a focus area, several criteria must be met. First it must be broadly based in the industries that forms its eco-structure. For composites manufacturing we have supplier of the basic material components like carbon and glass fibers, matrix and prepreg (Hexcel), equipment supplier (MAG and Trilion), fabric supplier (Chomarat, Owens & Corning), fabricator (ICE, VX Aerospace, and TPI), and other small and medium size companies to be added to our team. An innovation is the recruitment of a team of developers of Advanced Finite Element Analysis software to develop specialized software to support the needs of the above industries.

In addition, these collaborating companies with our Stanford team are leaders in their respective industry. So we must have the best to be the best. Our research team and their excellence will be listed in the next sections.

2.b Academic background

Demand to achieve technical excellence goes far beyond having equipment and floor space. On key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and the quality of training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing often referred to as the "silicon valley culture". Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business.

2.c Excellence

The NIST RFP must make stringent requirements to ensure that its precious resources go to the most qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. Other leading universities should be ready to compete for their specialties with the highest quality of skills, innovations and business strategies.

2.d Measures for credibility

Composites technology has a startling evolution during the last 60 years. There are now books, courses, journals, societies, international symposia, standards, certifications, and awards all dedicated to composites. There is always a need to rethink our design and manufacturing standards to make our designs more rational and based on systematic modeling and optimization. Limitless applications in aerospace, transportation, energy and business enterprise can all derive from it. Advances can be measured in terms of systems performance, patents granted, number of companies and jobs, number of graduates, export, and revenue generated. NIST should keep these metrics to select the technologies with impact.

Several technologies were brought out during the NIST sponsored workshops. Most of them are nowhere in the level of impact composites offer. Unproven ideas and lack of track record of the professional staff must be unearthed in NIST's elimination process. High risk research from small and medium size business and universities is best handled through existing SBIR-STTR programs. They do not belong to the NIST plan to have entities that can compete on the world stage – to become the pride of our nation like the Internet, GPS, personal computers, Apple iPhones and the US graduate schools.

3 What measures could demonstrate that Institute technology activities assist US manufacturing

3.a Measures to assist US manufacturing

One measure is the extent and degree of collaboration that our team at Stanford can generate within the composites industry. Such collaboration must cover a broad range of companies like material supplier in Hexcel, equipment supplier like MAG and Trilion, fabric supplier in Chomarat, fabricators like ICE, VX Aerospace, and the list can go on and on. Our intention is to expand our collaboration to various industry such as aerospace, transportation, wind, off-shore, sporting goods and so on. One can see the list below the team and their functions will be.

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X
	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

US manufacturing in composites will be served by this team shown in the table. But we have not included end users like the Boeings, Fords, Exxon Mobil, and many wind energy companies to which our team members have extensive professional ties. US competitive and domestic job creation will be served by the quality of our team and its ability to rally among key supporting industries. In the next sections we will show some of the background of our team.

3.c Academic background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing often referred to as the "silicon valley culture". Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Thus a measure of products and services that an institute can generate is directly related to the academic background and professional experience. The degree of difficulty and the extent of the intellectual content that the group can bring to bear are a direct measure of its potential.

3.d Excellence

The NIST RFP must make stringent requirement to ensure that its precious resources go to the most qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. Other leading universities should be ready to compete for their specialties with skills, innovations and business strategies. One measure of these innovations is its generic breakthroughs that can be applied directly or indirectly to multiple applications in aerospace, automotive, wind turbines, off-shore engineering , and other systems where energy consumption and durability are the key drivers.

3.e Measures for credibility

Composites technology has a startling evolution during the last 60 years. There are now books, courses, journals, societies, international symposia, standards, certifications, and awards all dedicated to composites. There is always a need to rethink our design and manufacturing standards to make our designs more rational and based on systematic modeling and optimization. Limitless applications in aerospace, transportation, energy and business enterprise can all derive from it. Advances can be measured in terms of systems performance, patents granted, number of companies and jobs, number of graduates, export, and revenue generated. NIST should keep these metrics to select the technologies with the largest economic impact. Several technologies were brought out during the NIST sponsored workshops. Most of them are nowhere in the level of impact composites offer. Unproven ideas and lack of track record of the professional staff must be unearthed in NIST elimination process. High risk research from small and medium size business and universities is best handled through existing SBIR-STTR programs. They do not belong to the NIST plan to have entities that can compete on the world stage – to become the pride of our nation like the Internet, GPS, personal computers, Apple iPhones and the US graduate schools.

4 What measures could assess the performance and impact of Institutes

4.a Performance and impact

Measures would include the revenue that our team can generate for both domestic and international markets, the number of graduates (engineers and technicians) employed by composites industry, and the recognition of the team as the leader in the world. Our Stanford team has already achieve a fair degree of recognition for its work but with the NNMI the challenge will be much greater. It will be judged by its management skills and in how well it can interact with a large number of companies, small and large, and it must also deal with revenue and cost that the usual R&D contracts do not call for. But judging from the background of our team in the next sections, we believe that we will be ready to face the challenge.

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	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
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Trilion	Tim Schmidt		X	X	X			X						X	X
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VX Aerospace	Bob Skillen	X		X					X					X	X
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4.b Academic background

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4.c Excellence

The NIST RFP must make stringent requirement to ensure that its precious resources go to the best qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. A measure of success of the institute will include short term items like revenue generation through products and services and exports, and long term items like graduates who become the captains of industry.

4.d Measures for credibility

Composites technology has had a startling evolution during the last 60 years. There are now books, courses, journals, societies, international symposia, standards, certifications, and awards all dedicated to composites. There is always a need to rethink our design and manufacturing standards to make our designs more rational and based on systematic modeling and optimization. Limitless applications in aerospace, transportation, energy and business enterprise can all derive from it. Advances can be measured in terms of systems performance, patents granted, number of companies and jobs, number of graduates, export, and revenue generated. NIST should keep these metrics to select the technologies with the largest economic impact. Several technologies were brought out during the NIST sponsored workshops. Most of them are nowhere in the level of impact composites offer. Unproven ideas and lack of track record of the professional staff must be unearthed in NIST's evaluation process. High risk research from small and medium size business and universities is best handled through existing SBIR-STTR programs. They do not belong to the NIST plan to have entities that can compete on the world stage – to become the pride of our nation like the Internet, GPS, personal computers, Apple iPhones and the US graduate schools. Again, the market penetration, technological leadership, and financial dominance are all measures of success for a self-sustaining institute.

5. What business models would be effective for the institutes to manage business decisions

5.a Collaboration with industry

To be a business entity, we must generate products and services that the industry needs today as well as it will need in the future for the companies to be competitive. We also need to train technicians and engineers with skills in composites technology for a new generation of workforce. We must work with industry to define their needs and what we as a leading composites group can offer.

5.b Intellectual properties

Stanford University derived 75 million dollars of revenue from royalty of their patents in 2011. For composites manufacturing, Stanford with Chomarat have a patented on bi-angle thin-ply non crimp fabric (with a trade mark C-Ply) that has a great potential of reducing weight and cost of composites structures. Thus patents and licensing provides revenue streams for our group. This is the best measure how well our group is serving industry.

There are several products and services that our group is currently developing and will be included in our NIST program. These items fall into the categories of the need by industry today because such capabilities do not exist. With them, the competitiveness will increase for domestic companies and can be exported for additional revenue.

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5.d Examples of products and services

On top of the list is the evolution of C-Ply into a factory to be located in the US. A market in the US and the world must be developed first. Such effort has been ongoing for the last two years, and will continue as major part of our NIST program. Dozens of companies, large, medium and small sizes, have seen and heard about C-Ply. Many are evaluating it as we speak. One bicycle company (American Artisan) has agreed to use C-Ply for their unique bicycle frame (the lightest in the world at 724 grams). It is hoped that in the coming months others will follow. Having a production facility will also create jobs in the US, and products can be exported to the world. Additional revenue in the millions can come from training company engineers on design and manufacturing processes of C-Ply.

5.e Examples of revenue sources

Revenue sources that our composites group can do include a new solution for design allowable generation. The current approach calls for thousands of specimens and two years of effort at an expense over 20 million dollars. Even a small sample of design allowables offered by a testing center at the Wichita State University cost $500,000 and 6 months time. We intend to provide a new system that combines numerical simulation of a coupon under test and a digital image correlation (DIC) so many data points can be generated from a single coupon. Such data will include stiffness, damage initiation and propagation leading to ultimate strength. Statistical variations within the coupon can also be observed and recorded. Thus the number of coupons for replication can be significant reduced with proportionally reduced time and dollars. This new testing systems can either be sold to companies or we provide allowables generation as a service at a cost in the order of $100,000 for each set of data, in days and weeks instead months. We may wish to try franchise our testing system with small or medium size business and derive both revenue and royalty. We foresee dozens of such test sites in the US and equal number around the world. This can bring over one million of dollars each year. We can reduce Wichita States's time and cost by a factor of 5, but more importantly material supplier and end users of composites can have the necessary database to use to promote new materials and manufacturing processes without waiting for 2 years. The current process discourages innovations. Ours will increase our competitiveness and create jobs.

Two of our team members (Alan Nettles and Doug Cairns) have been active members of CMH-17 (an organization dedicated to test methods and certification of composites) will coordinate our new design generation method with this organization to gain its support and acceptance.

The same combined simulation and DIC can be used for a new quantitative non destructive evaluation (NDE). Current weakness of NDE is the inability to assess the effect of defects from manufacturing. Whether a less-than-perfect component should pass, be repaired or scrapped is often decided by a vote in a committee. We intend to build an NDE system that will give quantitative values such as the probability of failure of defects as well as the probability of strength recovery if the component is repaired. A cost-benefit analysis can be done and presented to the decision maker. Voting by a committee as a means to spread the responsibility on a tough decision is no longer necessary. With our tool a far more rational decision can be made. Such quantitative evaluation can be fed back to improve the original material, processing and design so the occurrence of the effect can be reduced. This NDE system can also generate revenue for our team either through direct sales, licensing, or some consulting arrangement with large and small companies.

At the same time, we will emphasize as part of our research to increase damage tolerance of impact and other environmental effects, as well as to increase the defect tolerance of the manufacturing process. Several approaches will be explored. They include the use of thin plies to increase delamination resistance of laminates, and homogenization of tape design for automated tape laying (ATL) machines. If the same tape (with multiple ply orientations) is laid with deliberate laps and overlaps the finished panel will be highly homogenized thus insensitive to defects from geometric deviations such as voids, misalignment and wrinkles.

Other revenue opportunities include an integrated design-ply layup-cure software to replace the current thrown-over-the wall process between design and manufacturing. Bonded joints are the most efficient assembly method for composites. But they are not used because the concern of not having a solid connection that bolted joints offer. Such fear must be overcome. The much needed NDE of bonded joints may be enhanced by embedded nano particles. Such advance can make designers more confident to use bonded joints. Advances in software and NDE can be game changers and leading to additional revenue streams. These are all generic technologies that can impact directly to aerospace, transportation, off-shore, wind energy, and deep submericibles.

5.e Cost side

On the cost side of the business model, our major items of salary for 20 top flight professionals who will train a cadre of 40 students and postdocs. It is an important asset of the Department of Aeronautics & Astronautics for having been judged by the *US World* in the last 3 years as the best in the nation. In 2012 it leads Caltech, MIT and Georgia Tech in that order. Being arguably the best is a powerful recruiting tool for the best talents in students and postdoc around the world. With NIST support, generous stipends can be offered, and also financial assistance for internship at various industrial and government collaborators of the program. A cadre of graduates with academic training plus industrial experience will have direct effect on our national competitiveness of composites manufacturing.

"Between 1995 and 2005, foreign-born and technically trained entrepreneurs founded half the firms in Silicon Valley." (WSJ: Crovitz, October 1, 2012) We propose to assist all our graduates to get work permit with jobs with companies of all sizes. This is just another piece of the puzzle to make our industry competitive. Under our program, our graduates will not only have the top technical training but will also have spent some time with composites industry, particularly in small and medium size companies whose hiring policy is often more flexible than the large companies.

5.f Other cost items

Other cost items will include financial bonus to professional revenue units (any combinations of university and industrial partners within our team) that generates revenues over and beyond the medium level. Revenues can be from inventions of products and services, licensing, consulting, export, and leveraging direct contracts from the federal and state governments, and industry. We intend to support winners among our team members.

5.g NIST support

Our business model will call for substantial support from NIST for the first 3 years of our operation while we are developing products and services that industry wants today or needs in the future. As these items are developed and marketed, reliance of NIST support can begin to phase out starting the 3rd years. By the end of 5th years, our group should be a self-sustaining entity, recognized by the world as a center of excellence.

Revenue, in $000's	Unit/yr	FY2013	FY2014	FY2015	FY2016	FY2017	Sub-total	% total
NIST	$12,500	$12,500	$12,500	$12,500	$8,000	$4,000	$49,500	37.9%
Company support	$200	$1,000	$1,000	$3,000	$5,000	$7,000	$17,000	13.0%
State & local contracts	$250		$500	$500	$1,500	$2,000	$4,500	3.4%
Federal agency contracts	$500	$1,000	$2,000	$2,000	$3,000	$4,000	$12,000	9.2%
Product: C-Ply (1)			$500	$500	$1,000	$1,000	$3,000	2.3%
Product: Allowables syst (2)	$250	$500	$1,000	$1,500	$1,500	$2,000	$6,500	5.0%
Service: Testing (3)	$100	$500	$1,500	$2,000	$2,500	$3,000	$9,500	7.3%
Product: Digital NDE syst (4)	$250	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: Design-Lay-Cure (5)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: B & B joints (6)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Service: Consulting	$100	$1,000	$1,000	$2,000	$2,000	$2,000	$8,000	6.1%
Service: Training	$20	$500	$500	$1,000	$1,000	$1,000	$4,000	3.1%
Sub-total		$18,500	$22,000	$28,000	$30,000	$32,000	$130,500	100.0%
Cost, in $000's								
Salary & Fringe: Professors	$200	$4,000	$4,000	$6,000	$6,000	$6,000	$26,000	21.7%
Salary & Fringe: Students	$100	$2,000	$3,000	$4,000	$4,000	$4,000	$17,000	14.2%
Supporting staff		$1,500	$1,500	$1,500	$2,000	$2,500	$9,000	7.5%
Materials & Supplies		$1,000	$1,000	$1,500	$2,000	$2,500	$8,000	6.7%
Equipment		$2,000	$1,000	$1,500	$1,500	$2,000	$8,000	6.7%
Office/Lab rental		$500	$1,000	$1,000	$1,400	$1,500	$5,400	4.5%
Travel: Fare and Subsistance		$500	$1,000	$1,000	$1,200	$1,400	$5,100	4.3%
Legal and Patents			$300	$300	$400	$400	$1,400	1.2%
Indirect		$5,000	$7,000	$8,000	$10,000	$10,000	$40,000	33.4%
Sub-total		$16,500	$19,800	$24,800	$28,500	$30,300	$119,900	100.0%
Surplus/Loss		$2,000	$2,200	$3,200	$1,500	$1,700	$10,600	8.8%
Percent Surplus/Revenue		11%	10%	11%	5%	5%	8%	
(1) C-Ply is a patented bi-angle thin-ply non scrim fabric by Stanford University and Chomarat								
(2) Allowable Generation System is a proprietary digital testing system that can provide data in weeks, not years								
(3) Testing service to be offered to industrial clients for allowable generation using Item 2, for a mere $100k								
(4) Proprietary digital evalutation of warpage, voids, wrinkles and delamination, and their disposal								
(5) Proprietary software that spans FEA, FiberSim, and cure model to optmize design and manufacturing								
(6) Bonded and bolted joints: their design, manufacturing and inspection to achieve desired strength and life								

While we rely heavily on support from NIST in the first 3 years, our sustainability depends on the revenue from our products and services more so than from industry directly. We believe that this is more realistic and as time moves on requirements for maintaining our cutting edge technology will change. New products and services will be needed to maintain our sustainability. Looking at the last column of revenue, NIST share is 38%, industry 13% and the remaining 49 percent will come from our products and services to industry. On the cost side, we hope to have between 5 and

11% surplus to cover unexpected cost and to have ability to invest in high risk research.

6 What governance models would be effective for the institutes to manage governance decisions

6.a Governance philosophy

Having multiple revenue units within our team is the philosophy of our governance. We encourage entrepreneurship and reward those who are technically and financially successful. On top of our organization chart is an advisory board consisting principally of representatives from industry. Strategy and deployment of resources will require board consultation and agreement. Implementation and day-to-day operations are to be carried out by multiple revenue units, each is built around one or more professors tasked for a given technology goal. Students and postdocs may be recruited or assigned in any of the universities on our team. Some initial financial support can be expected from the NIST program.

6.b Academic background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as the 'silicon valley culture'. Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business.

The NIST RFP must make stringent requirement to ensure that its precious resources go to the most qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. Other leading universities should be ready to compete for their specialties with skills, innovations and business strategies.

6.c Collaboration with industry

Collaboration with companies of all sizes is encouraged. Such collaboration is expected to generate revenue from companies in both cash and in-kind support. A minimum cash support calls for a fee to become the Industrial Affiliates of the Department of Aeronautics & Astronautics at Stanford. This annual fee is $30,000 for large companies, $20,000 for medium size companies, and $10,000 for small companies. Affiliates have direct access to all professors of our department, not just those associated with composites. An annual meeting of the affiliates will facilitate the interactions with professors and students of our department.

6.d NIST support

NIST support for the startup of our Stanford team is critical in the first 3 years. It allows our team to assume leadership in taking on high-risk, high-impact research with a running start. By the end of the 3rd year, many products and services that can bring in revenues should be in place. The first wave of hundreds of technicians, graduates with MS, Ph.D. and postdocs all have industrial experience and ready for jobs with companies.

Revenue, in $000's	Unit/yr	FY2013	FY2014	FY2015	FY2016	FY2017	Sub-total	% total
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Travel: Fare and Subsistance		$500	$1,000	$1,000	$1,200	$1,400	$5,100	4.3%
Legal and Patents			$300	$300	$400	$400	$1,400	1.2%
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(1) C-Ply is a patented bi-angle thin-ply non scrim fabric by Stanford University and Chomarat								
(2) Allowable Generation System is a proprietary digital testing system that can provide data in weeks, not years								
(3) Testing service to be offered to industrial clients for allowable generation using Item 2, for a mere $100k								
(4) Proprietary digital evalutation of warpage, voids, wrinkles and delamination, and their disposal								
(5) Proprietary software that spans FEA, FiberSim, and cure model to optmize design and manufacturing								
(6) Bonded and bolted joints: their design, manufacturing and inspection to achieve desired strength and life								

With our team at Stanford, we have a patented product that we can promote, plus a number of products and services that industry can use today and/or will need to remain competitive. These products and services will bring revenue for our team to sustain or expand as our contributions to composites manufacturing increase.

6.e Examples of governance of interdisciplinary collaboration

On top of the list is the evolution of C-Ply into a factory to be located in the US. A market in the US and the world must be developed first. Such effort has been ongoing for the last two years, and will continue as major part of our NIST program. Dozens of companies, large, medium and small sizes, have seen and heard about C-Ply. Many are evaluating it as we speak. One bicycle company (American Artisan) has agreed to use C-Ply for their unique bicycle frame (the lightest in the world at 724 grams). It is hoped that in the coming months others will follow. Having a production facility will also create jobs in the US, and products can be exported to the world. Additional revenue in the millions can come from training company engineers on design and manufacturing processes of C-Ply.

Revenue sources that our composites group can generate, include a new solution for design allowable generation. The current approach calls for thousands of specimens and two years of effort at an expense over 20 million dollars. Even a small sample of design allowables offered by a testing center at the Wichita State University cost $500,000 and 6 months time. We intend to provide a new system that combines numerical simulation of a coupon under test and a digital image correlation (DIC) so many data points can be generated from a single coupon. Such data will include stiffness, damage initiation and propagation leading to ultimate strength. Statistical variations within the coupon can also be observed and recorded. Thus the number of coupons for replication can be significant reduced with proportionally reduced time and dollars. This new testing systems can either be sold to companies or we provide allowables generation as a service at a cost in the order of $100,000 for each set of data, in days and weeks instead months. We may wish to try to franchise our testing system with small or medium size businesses and derive both revenue and royalty. We foresee dozens of such test sites in the US and equal number around the world. This can bring over one million dollars each year. We can reduce Wichita States's time and cost by a factor of 5, but more importantly material suppliers and end users of composites can have the necessary database to use to promote new materials and manufacturing processes without waiting for 2 years. The current process discourages innovations. Ours will increase our competitiveness and create jobs.

Two of our team members (Alan Nettles and Doug Cairns) have been active members of CMH-17 (an organization dedicated to test methods and certification of composites) will coordinate our new design generation method with this organization to gain its support, acceptance and eventual certification. The chart below shows our team members from Stanford, other universities and collaborating companies. It is a powerful team with wide ranging talents in manufacturing of composites. Each column after the names of individuals are the principal activities that they will engage in.

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X
	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

7 What membership and participation structures would be effective for the institutes, such as financial and intellectual property obligations, access and licensing?

7.a Stanford royalty

Stanford University derived 75 million dollars of revenue from royalty of their patents in 2011. For composites manufacturing, Stanford with Chomarat have a patented on bi-angle thin-ply non crimp fabric (with a trade mark C-Ply) that has a great potential of reducing weight and cost of composites structures. It is being introduced to companies in aerospace, automotive, wind turbine and off-shore engineering. It is in our business and governance models to rely heavily on developing intellectual properties with our own work as well as collaborative work with industry. Such patents and licensing provides revenue streams for our group. This is the best measure how well our group is serving industry.

7.b Academic background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as "silicon valley culture". Stanford University being the main provider of Technological and

Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Measured to assess performance will include all of the above in traditional academic achievements plus the collaborative projects with industry. In particular focus must be applied to revenue generation through products and services for industrial need today as well as for the future so our national competitiveness can be maintained.

The NIST RFP must make stringent requirements to ensure that its precious resources go to the most qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. A measure of success of institute will include short term items like revenue generation through products and services and exports, and long term items like graduates become the captains of industry.

7.c Examples of products and services

There are several products and services that our group is currently developing and will be included in our NIST program. These items fall into the categories of the need by industry today because such capabilities do not exist. With them, the competitiveness will increase for domestic companies and can be exported for additional revenue.

On top of the list is the evolution of C-Ply into a factory to be located in the US. A market in the US and the world must be developed first. Such effort has been ongoing for the last two years, and will continue as major part of our NIST program. Dozens of companies, large, medium and small sizes, have seen and heard about C-Ply. Many are evaluating it as we speak. One bicycle company (American Artisan) has agreed to use C-Ply for their unique bicycle frame (the lightest in the world at 724 grams). It is hoped that in the coming months others will follow. Having a production facility will also create jobs in the US, and products can be exported to the world. Additional revenue in the millions can come from training company engineers on design and manufacturing processes of C-Ply. Our horizontal organizations of multiple revenue centers can be seen in the chart below:

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X
	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
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N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
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American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
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8 How should a network of institutes optimally operate?

8.a Institute background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as the "silicon valley culture". In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Measured to assess performance will include all of the above in traditional academic achievements plus the collaborative projects with industry. In particular focus must be applied to revenue generation through products and services for industrial need today as well as for the future so our national competitiveness can be maintained.

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8.b Network

Networking among institutes will depend on the demonstrated leadership in technology and business. Only with such attractions mutually beneficial link among institute will work. Leveraging the successes of multiple institutes can be a win-win situation. Again such network can only be built on successes. The measurements of such optimal operation will be based on the number of graduates placed with industry, number of licensing, revenues generated from products and services, exports, and a highly recognized world ranking of the institutes. Through such leadership the national competitiveness becomes apparent. Measures in the jobs and formation of small and medium size companies are equally important. It is recognized that the 15 manufacturing Institutes will constitute an unprecedented concentration of resource of technology, education and skilled talent. Our director will be charged with the task to ensure that Stanford's vast IT resources will be used to keep the whole network informed of every institute's progress and needs. Our team members will be encouraged to collaborate with institutes which can impact directly with our charter. For example , we will wish to tap the expertize of an institute of manufacturing automation. As an example of reverse flow of expertize, we can offer fiber composites know-how, experimental and theoretical analysis capabilities to the institute of Additive Manufacturing to improve the strength of their products. To be consistent with Metcalf's law where the power of a network is proportional to the exponential power of the number of its nodes, we propose to piggy-back off one of the social networks in order to enable every member of the 15 Institutes to have equal access to our proposed IT Network. It would be extremely helpful if NIST would adopt a similar sharing principle that the world-wide genomic researchers have access to any Bioinformatic resource world-wide and where the cost is absorbed by the sponsoring Institute without regard to the affiliation of a particular user. This has encouraged a massive flow of information that has contributed significantly to the understanding of the human genome (for the latest example, please google the ENCODE project)

8.c Examples of products and services

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MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

9 What measures could assess effectiveness of Network structure and governance

9.a Academic background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as the "silicon valley culture". Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Measured to assess performance will include all of the above in traditional academic achievements plus the collaborative projects with industry. In particular focus must be applied to revenue generation through products and services for industrial need today as well as for the future so our national competitiveness can be maintained.

The NIST RFP must make stringent requirement to ensure that its precious resources go to the most qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. A measure of success of institute will include short term items like revenue generation through products and services and exports, and long term items like graduates become the captains of industry.

9.b Network

Networking among institutes will depend on the demonstrated leadership in technology and business. Only with such attractions mutually beneficial link among institute will work. Leveraging the successes of multiple institutes can be a win-win situation. Again such network can only be built on successes. The measurements of such successes will be based on the number of graduates placed with industry, number of licensing, revenues generated from products and services, exports, and recognition in the world ranking of the self-sustaining institutes. Through such leadership the national competitiveness becomes apparent. Jobs created and new startups are also measures of success. Our director will be charged with the task to ensure that Stanford's vast IT resources will be used to keep the whole network informed of every institute's progress and needs. Our team members will be encouraged to collaborate with institutes which can impact directly with our charter. For example , we will wish to tap the expertize of an institute of manufacturing automation. As an example of reverse flow of expertize, we can offer fiber composites know-how, experimental and theoretical analysis capabilities to the institute of Additive Manufacturing to improve the strength of their products. To be consistent with Metcalf's law where the power of a network is proportional to the exponential power of the number of its nodes, we propose to piggy-back off one of the social networks in order to enable every member of the 15 Institutes to have equal access to our proposed IT Network. It would be extremely helpful if NIST would adopt a similar sharing principle that the world-wide genomic researchers have access to any Bioinformatic resource world-wide and where the cost is absorbed by the sponsoring Institute without regard to the affiliation of a particular user. This has encouraged a massive flow of information that has contributed significantly to the understanding of the human genome (for the latest example, please google the ENCODE project)

9.c Examples of products and services

There are several products and services that our group is currently developing and will be included in our NIST program. These items fall into the categories of the need by industry today because such capabilities do not exist. With them, the competitiveness will increase for domestic companies and can be exported for additional revenue.

On top of the list is the evolution of C-Ply into a factory to be located in the US. A market in the US and the world must be developed first. Such effort has been ongoing for the last two years, and will continue as major part of our NIST program. Dozens of companies, large, medium and small sizes, have seen and heard about C-Ply. Many are evaluating it as we speak. One bicycle company (American Artisan) has agreed to use C-Ply for their unique bicycle frame (the lightest in the world at 724 grams). It is hoped that in the coming months others will follow. Having a production facility will also create jobs in the US, and products can be exported to the world. Additional revenue in the millions can come from training company engineers on design and manufacturing processes of C-Ply. Our horizontal organizations of multiple revenue centers can be seen in the chart below:

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X
	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

10 How should initial funding co-investments of the Ferderal government and others be organized by types and proportions

10.a Academic background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as the "silicon valley culture". Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business.

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10.b Timing for co-invest

Our national team of professionals and key industrial collaborators will give us a head start on a number of revenue-generating products and services. Feasibility test-cases of these offerings to industry is underway and the status of various case studies will be included in the proposal to NIST in the spring of 2013. At the anticipated start of this NIST program in October 2013 we would expect the beginning of our revenue streams. The first product that our team is expected to sell will be the revolutionary C-Ply, a jointly patented multi-directional fabric and tape by Stanford University and a medium sized company, Chomarat. With funding from NIST, the development and marketing of this and other products and services will accelerate. NIST funding will be critical to kick start our research tasks, recruiting of students and postdocs, and training and education programs. Positive advances in these activities will promote co-investment from industry. Quality and practicality of these advances will determine their impact on industrial competitiveness, and our ability to recruit top talents.

10.c Intellectual properties

Intellectual properties will be an important inducement for industry to join forces with our group. Such ownership will encourage professionals in our group and companies to seek patentable ideas for not only personal gain in royalty but also ability to induce industry to collaborate on joint projects. Such projects can bring both cash and in-kind contributions to our group as part of the industrial matching fund. Our existing joint patent between Stanford and Chomarat is a good example.

Our program goals to encourage co-investment must include what industry needs today, as well as what it will need in the future to enhance its competitiveness. University research is targeted to make an order of magnitude advance, while industry is focused on solution of current problems. Thus a close collaborative research can strike a balance between the long and short term needs for the benefit to all parties. It is our business plan to address this challenge that will have direct impact on our long term sustainability.

10.d Co-investment goals

We foresee a NIST funding profile of 12.5 millions for the first 4 years with declining funding thereafter and reaching zero funding at the end of the 7th year. Thus the first 4 years must be devoted to research and teaching tasks that must lead to sustainable revenue-generating products and services. For our team, we see several products line in addition to C-Ply. Examples include design allowable generating system, quantitative NDE system, nano-particle enhanced inspections system, and increased confidence in bonded joints. Some of these services and software may be leased to industry instead of direct sales. Additional revenues will include research contracts from industry, federal, state, and local governments, and export of our technology for revenue. All of our professionals have excellent track records in competing for research funds from the federal government. Others have also been successful in receiving support from state governments. We need to learn to compete in all levels of governments and companies of all sizes to sustain our operation.

Offering top training of young and established engineers is an important function of our group and can be made serious revenue generating ventures as well. We intend to establish ourselves as the best in the world, our training programs with teaching staff drawn from research universities, community colleges, industry and government, we can charge 5 to 10 thousand dollars per registrant, which is the norm for business schools at Stanford and other leading universities

We will of course engage in other activities which as not always revenue generating. Training technicians of veterans and other hardship cases can be our contribution to society. We should have resource to offer such services. We also have North Carolina A&T State University as a team member. Having this minority university can teach us how we can enhance motivation and environment for productive research. This strategy is reflected in our business plan, shown below:

Revenue, in $000's	Unit/yr	FY2013	FY2014	FY2015	FY2016	FY2017	Sub-total	% total
NIST	$12,500	$12,500	$12,500	$12,500	$8,000	$4,000	$49,500	37.9%
Company support	$200	$1,000	$1,000	$3,000	$5,000	$7,000	$17,000	13.0%
State & local contracts	$250		$500	$500	$1,500	$2,000	$4,500	3.4%
Federal agency contracts	$500	$1,000	$2,000	$2,000	$3,000	$4,000	$12,000	9.2%
Product: C-Ply (1)			$500	$500	$1,000	$1,000	$3,000	2.3%
Product: Allowables syst (2)	$250	$500	$1,000	$1,500	$1,500	$2,000	$6,500	5.0%
Service: Testing (3)	$100	$500	$1,500	$2,000	$2,500	$3,000	$9,500	7.3%
Product: Digital NDE syst (4)	$250	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: Design-Lay-Cure (5)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: B & B joints (6)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Service: Consulting	$100	$1,000	$1,000	$2,000	$2,000	$2,000	$8,000	6.1%
Service: Training	$20	$500	$500	$1,000	$1,000	$1,000	$4,000	3.1%
Sub-total		$18,500	$22,000	$28,000	$30,000	$32,000	$130,500	100.0%
Cost, in $000's								
Salary & Fringe: Professors	$200	$4,000	$4,000	$6,000	$6,000	$6,000	$26,000	21.7%
Salary & Fringe: Students	$100	$2,000	$3,000	$4,000	$4,000	$4,000	$17,000	14.2%
Supporting staff		$1,500	$1,500	$1,500	$2,000	$2,500	$9,000	7.5%
Materials & Supplies		$1,000	$1,000	$1,500	$2,000	$2,500	$8,000	6.7%
Equipment		$2,000	$1,000	$1,500	$1,500	$2,000	$8,000	6.7%
Office/Lab rental		$500	$1,000	$1,000	$1,400	$1,500	$5,400	4.5%
Travel: Fare and Subsistance		$500	$1,000	$1,000	$1,200	$1,400	$5,100	4.3%
Legal and Patents			$300	$300	$400	$400	$1,400	1.2%
Indirect		$5,000	$7,000	$8,000	$10,000	$10,000	$40,000	33.4%
Sub-total		$16,500	$19,800	$24,800	$28,500	$30,300	$119,900	100.0%
Surplus/Loss		$2,000	$2,200	$3,200	$1,500	$1,700	$10,600	8.8%
Percent Surplus/Revenue		11%	10%	11%	5%	5%	8%	
(1) C-Ply is a patented bi-angle thin-ply non scrim fabric by Stanford University and Chomarat								
(2) Allowable Generation System is a proprietary digital testing system that can provide data in weeks, not years								
(3) Testing service to be offered to industrial clients for allowable generation using Item 2, for a mere $100k								
(4) Proprietary digital evalutation of warpage, voids, wrinkles and delamination, and their disposal								
(5) Proprietary software that spans FEA, FiberSim, and cure model to optmize design and manufacturing								
(6) Bonded and bolted joints: their design, manufacturing and inspection to achieve desired strength and life								

11 What arrangements for co-investment proportions and types could help an institute become self-sustaining?

11.a Institute background

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11.b NIST support

NIST support for the startup of our Stanford team is critical in the first 3 years. It allows our team to assume leadership in taking on high-risk research with a running start. By the end of the 3rd year, many products and services that can bring in revenues should be in place. The first wave of hundreds of technicians, graduates with MS, Ph.D. and postdocs all have industrial experience and ready for jobs with companies.

Revenue, in $000's	Unit/yr	FY2013	FY2014	FY2015	FY2016	FY2017	Sub-total	% total
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(6) Bonded and bolted joints: their design, manufacturing and inspection to achieve desired strength and life

While we rely heavily on support from NIST in the first 3 years, our sustainability depends on the revenue from our products and services more so than from industry directly. We believe that this is more realistic and as time moves on requirements for maintaining our cutting edge technology will change. New products and services will be needed to maintain our sustainability. Looking at the last column of revenue, NIST share is 38%, industry 13% and the remaining 49 percent will come from our products and services to industry. On the cost side, we hope to have between 5 and 11% surplus to cover unexpected cost and to have ability to invest in high risk, high-impact research.

12 What measures could assess progress of an institute towards being self-sustaining?

12.a Institute background

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12.b Progress assessment

First measure for assessing progress is the financial status of the institute. The projected revenue and cost must be in line with the ability to perform technically and business-wise. The plan is shown below:

Revenue, in $000's	Unit/yr	FY2013	FY2014	FY2015	FY2016	FY2017	Sub-total	% total
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Indirect		$5,000	$7,000	$8,000	$10,000	$10,000	$40,000	33.4%
Sub-total		$16,500	$19,800	$24,800	$28,500	$30,300	$119,900	100.0%
Surplus/Loss		$2,000	$2,200	$3,200	$1,500	$1,700	$10,600	8.8%
Percent Surplus/Revenue		11%	10%	11%	5%	5%	8%	
(1) C-Ply is a patented bi-angle thin-ply non scrim fabric by Stanford University and Chomarat								
(2) Allowable Generation System is a proprietary digital testing system that can provide data in weeks, not years								
(3) Testing service to be offered to industrial clients for allowable generation using Item 2, for a mere $100k								
(4) Proprietary digital evalutation of warpage, voids, wrinkles and delamination, and their disposal								
(5) Proprietary software that spans FEA, FiberSim, and cure model to optmize design and manufacturing								
(6) Bonded and bolted joints: their design, manufacturing and inspection to achieve desired strength and life								

While we rely heavily on support from NIST in the first 3 years, our sustainability depends on the revenue from our products and services more so than from industry directly. We believe that this is more realistic and as time moves on requirements for maintaining our cutting edge technology will change. New products and services will be needed to maintain our sustainability. Looking at the last column of revenue, NIST share is 38%, industry 13% and the remaining 49 percent will come from our products and services to industry. On the cost side, we hope to have between 5 and 11% surplus to cover unexpected cost and to have ability to invest in high risk research.

12.c Other measures

There are other measures beyond the financial status. The number of patents, licensing, graduates placed with industry and their promotion for higher positions, and changing products and services generated by the institute are all important metrics for assess the success of the institute. Last but not the least is its impact on the national competitiveness of composites manufacturing in the US. The market size, job created, and new or expanded companies of small, medium and large ones.

13 What actions or conditions could improve how institute operations support domestic manufacturing facilities while maintaining consistency with our international obligations?

13.a Oversight

Most important action and condition is to minimize overall control and micro management. Professionals perform best with least control. University and small business which are the backbone of our team, function best when left alone. Examples of famous Stanford people who started in garages include Hewlett Packard, Sun Microsystems, Yahoo, and Google. Our team is so organized with multiple revenue centers that, it should be allowed to prosper technically and financially.

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X
	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

13.b Business model

While we rely heavily on support from NIST in the first 3 years, our sustainability depends on the revenue from our products and services more so than from industry directly. We believe that this is more realistic and as time moves on requirements for maintaining our cutting edge technology will change. New products and services will be needed to maintain our sustainability. Looking at the last column of revenue, NIST share is 38%, industry 13% and the remaining 49 percent will come from our products and services to industry. On the cost side, we hope to have between 5 and 11% surplus to cover unexpected cost and to have ability to invest in high risk research.

Revenue, in $000's	Unit/yr	FY2013	FY2014	FY2015	FY2016	FY2017	Sub-total	% total
NIST	$12,500	$12,500	$12,500	$12,500	$8,000	$4,000	$49,500	37.9%
Company support	$200	$1,000	$1,000	$3,000	$5,000	$7,000	$17,000	13.0%
State & local contracts	$250		$500	$500	$1,500	$2,000	$4,500	3.4%
Federal agency contracts	$500	$1,000	$2,000	$2,000	$3,000	$4,000	$12,000	9.2%
Product: C-Ply (1)			$500	$500	$1,000	$1,000	$3,000	2.3%
Product: Allowables syst (2)	$250	$500	$1,000	$1,500	$1,500	$2,000	$6,500	5.0%
Service: Testing (3)	$100	$500	$1,500	$2,000	$2,500	$3,000	$9,500	7.3%
Product: Digital NDE syst (4)	$250	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: Design-Lay-Cure (5)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: B & B joints (6)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Service: Consulting	$100	$1,000	$1,000	$2,000	$2,000	$2,000	$8,000	6.1%
Service: Training	$20	$500	$500	$1,000	$1,000	$1,000	$4,000	3.1%
Sub-total		$18,500	$22,000	$28,000	$30,000	$32,000	$130,500	100.0%
Cost, in $000's								
Salary & Fringe: Professors	$200	$4,000	$4,000	$6,000	$6,000	$6,000	$26,000	21.7%
Salary & Fringe: Students	$100	$2,000	$3,000	$4,000	$4,000	$4,000	$17,000	14.2%
Supporting staff		$1,500	$1,500	$1,500	$2,000	$2,500	$9,000	7.5%
Materials & Supplies		$1,000	$1,000	$1,500	$2,000	$2,500	$8,000	6.7%
Equipment		$2,000	$1,000	$1,500	$1,500	$2,000	$8,000	6.7%
Office/Lab rental		$500	$1,000	$1,000	$1,400	$1,500	$5,400	4.5%
Travel: Fare and Subsistance		$500	$1,000	$1,000	$1,200	$1,400	$5,100	4.3%
Legal and Patents			$300	$300	$400	$400	$1,400	1.2%
Indirect		$5,000	$7,000	$8,000	$10,000	$10,000	$40,000	33.4%
Sub-total		$16,500	$19,800	$24,800	$28,500	$30,300	$119,900	100.0%
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(5) Proprietary software that spans FEA, FiberSim, and cure model to optmize design and manufacturing
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14 How should institute engage other manufacturing related programs and networks?

14.a Method of engagement

We are not aware of any magic method of engaging other manufacturing related programs and networks. Certainly lessons learned from successful and less than successful entities can be of great value to ours. Our background, business plan and team functions are listed in the following sections. They define us. Similar information from other programs and networks will be helpful in guiding how we can improve our operations. We will designate individual members of our team to liaise with everyone of the other 15 Manufacturing Institues. By extension, each member will also liaise with any other related programs and networks.

14.b Our background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as the "silicon valley culture". Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Measured to assess performance will include all of the above in traditional academic achievements plus the collaborative projects with industry. In particular focus must be applied to revenue generation through products and services for industrial need today as well as for the future so our national competitiveness can be maintained.

The NIST RFP must make stringent requirement to ensure that its precious resources go to the most qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. A measure of success of institute will include short term items like revenue generation through products and services and exports, and long term items like graduates become the captains of industry.

14.c Our businesss plan

While we rely heavily on support from NIST in the first 3 years, our sustainability depends on the revenue from our products and services more so than from industry directly. We believe that this is more realistic and as time moves on requirements for maintaining our cutting edge technology will change. New products and services will be needed to maintain our sustainability. Looking at the last column of revenue, the NIST share is 38%, industry 13% and the remaining 49 percent will come from our products and services to industry. On the cost side, we hope to have between 5 and 11% surplus to cover unexpected cost and to have ability to invest in high risk research.

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Product: C-Ply (1)			$500	$500	$1,000	$1,000	$3,000	2.3%
Product: Allowables syst (2)	$250	$500	$1,000	$1,500	$1,500	$2,000	$6,500	5.0%
Service: Testing (3)	$100	$500	$1,500	$2,000	$2,500	$3,000	$9,500	7.3%
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Tool: Design-Lay-Cure (5)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: B & B joints (6)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Service: Consulting	$100	$1,000	$1,000	$2,000	$2,000	$2,000	$8,000	6.1%
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Cost, in $000's								
Salary & Fringe: Professors	$200	$4,000	$4,000	$6,000	$6,000	$6,000	$26,000	21.7%
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Materials & Supplies		$1,000	$1,000	$1,500	$2,000	$2,500	$8,000	6.7%
Equipment		$2,000	$1,000	$1,500	$1,500	$2,000	$8,000	6.7%
Office/Lab rental		$500	$1,000	$1,000	$1,400	$1,500	$5,400	4.5%
Travel: Fare and Subsistance		$500	$1,000	$1,000	$1,200	$1,400	$5,100	4.3%
Legal and Patents			$300	$300	$400	$400	$1,400	1.2%
Indirect		$5,000	$7,000	$8,000	$10,000	$10,000	$40,000	33.4%
Sub-total		$16,500	$19,800	$24,800	$28,500	$30,300	$119,900	100.0%
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14.d Our team functions

Our governance model is built on multiple revenue units. Some examples are shown in the chart below. Our team consists of Stanford, other leading universities in composites, and several small and mediums size companies as collaborators. Our team has been working together for several years and have started doing many of the products and services which we will develop. Key to our success is to allow talented individuals to grow with their students and postdocs. Setting the goals is important but leaving them alone is just as critical. Research requires time and its progress is not easily measured particularly in the early stages. Research is not production of some item. It should be understood by management.

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X
	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

15 How should institutes interact with state and local economic development authorities?

15.a Method of engagement

We are not aware of any magic method of engaging state and local economic authorities. The State of California has limited dealings with private universities since it has more direct relations with its university and state colleges. With local authorities like the city of Palo Alto, there have been many interactions with development. In our institute we need to explore how we can interact for mutual benefits. The best method of interaction is through the California Council on Science and Technology (CCST). The CCST is a non-profit organization established in 1988 at the request of the California state government and sponsored by the major public and private postsecondary institutions of California and affiliate federal laboratories, in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and recommending public policies and initiatives that
will maintain California's technological leadership and a vigorous economy.
Our background, business plan and team functions are shown in the next three sections. It may serve as a way to start interaction with our state and local authorities.

15.b Our background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Yahoo, and Google were all started by hardworking, friendly environment and timing. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Measured to assess performance will include all of the above in traditional academic achievements plus the collaborative projects with industry. In particular focus must be applied to revenue generation through products and services for industrial need today as well as for the future so our national competitiveness can be maintained.

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Equipment		$2,000	$1,000	$1,500	$1,500	$2,000	$8,000	6.7%
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Travel: Fare and Subsistance		$500	$1,000	$1,000	$1,200	$1,400	$5,100	4.3%
Legal and Patents			$300	$300	$400	$400	$1,400	1.2%
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	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
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Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

16 What measures could assess institute contributions to long term national security and competitiveness?

16.a National security and competitiveness

Better understanding of composites and how they can be produced more efficiently and with higher reliability always carry significant implications in national security and competitiveness. Discovery for this composites manufacturing program can improve military systems and create manufacturing opportunities for both domestic and international markets. Exports of products and technology will aid our balance of trade. Thus both security and competitiveness can improve if the proposed program succeeds. Our program is planned to make a national difference if you consider our team (one of the best in the country), generous budget, and highly relevant products and services to be offered to industry. These are shown in the next three sections.

16.b Our background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as the "silicon valley culture". Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Measured to assess performance will include all of the above in traditional academic achievements plus the collaborative projects with industry. In particular focus must be applied to revenue generation through products and services for industrial need today as well as for the future so our national competitiveness can be maintained.

The NIST RFP must make stringent requirement to ensure that its precious resources go to the most qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. A measure of success of institute will include short term items like revenue generation through products and services and exports, and long term items like graduates become the captains of industry.

16.c Our business plan

While we rely heavily on support from NIST in the first 3 years, our sustainability depends on the revenue from our products and services more so than from industry directly. We believe that this is more realistic and as time moves on requirements for maintaining our cutting edge technology will change. New products and services will be needed to maintain our sustainability. Looking at the last column of revenue, NIST share is 38%, industry 13% and the remaining 49 percent will come from our products and services to industry. On the cost side, we hope to have between 5 and 11% surplus to cover unexpected cost and to have ability to invest in high-risk, high-impact research.

Revenue, in $000's	Unit/yr	FY2013	FY2014	FY2015	FY2016	FY2017	Sub-total	% total
NIST	$12,500	$12,500	$12,500	$12,500	$8,000	$4,000	$49,500	37.9%
Company support	$200	$1,000	$1,000	$3,000	$5,000	$7,000	$17,000	13.0%
State & local contracts	$250		$500	$500	$1,500	$2,000	$4,500	3.4%
Federal agency contracts	$500	$1,000	$2,000	$2,000	$3,000	$4,000	$12,000	9.2%
Product: C-Ply (1)			$500	$500	$1,000	$1,000	$3,000	2.3%
Product: Allowables syst (2)	$250	$500	$1,000	$1,500	$1,500	$2,000	$6,500	5.0%
Service: Testing (3)	$100	$500	$1,500	$2,000	$2,500	$3,000	$9,500	7.3%
Product: Digital NDE syst (4)	$250	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: Design-Lay-Cure (5)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Tool: B & B joints (6)	$50	$500	$500	$1,000	$1,500	$2,000	$5,500	4.2%
Service: Consulting	$100	$1,000	$1,000	$2,000	$2,000	$2,000	$8,000	6.1%
Service: Training	$20	$500	$500	$1,000	$1,000	$1,000	$4,000	3.1%
Sub-total		$18,500	$22,000	$28,000	$30,000	$32,000	$130,500	100.0%
Cost, in $000's								
Salary & Fringe: Professors	$200	$4,000	$4,000	$6,000	$6,000	$6,000	$26,000	21.7%
Salary & Fringe: Students	$100	$2,000	$3,000	$4,000	$4,000	$4,000	$17,000	14.2%
Supporting staff		$1,500	$1,500	$1,500	$2,000	$2,500	$9,000	7.5%
Materials & Supplies		$1,000	$1,000	$1,500	$2,000	$2,500	$8,000	6.7%
Equipment		$2,000	$1,000	$1,500	$1,500	$2,000	$8,000	6.7%
Office/Lab rental		$500	$1,000	$1,000	$1,400	$1,500	$5,400	4.5%
Travel: Fare and Subsistance		$500	$1,000	$1,000	$1,200	$1,400	$5,100	4.3%
Legal and Patents			$300	$300	$400	$400	$1,400	1.2%
Indirect		$5,000	$7,000	$8,000	$10,000	$10,000	$40,000	33.4%
Sub-total		$16,500	$19,800	$24,800	$28,500	$30,300	$119,900	100.0%
Surplus/Loss		$2,000	$2,200	$3,200	$1,500	$1,700	$10,600	8.8%
Percent Surplus/Revenue		11%	10%	11%	5%	5%	8%	
(1) C-Ply is a patented bi-angle thin-ply non scrim fabric by Stanford University and Chomarat								
(2) Allowable Generation System is a proprietary digital testing system that can provide data in weeks, not years								
(3) Testing service to be offered to industrial clients for allowable generation using Item 2, for a mere $100k								
(4) Proprietary digital evalutation of warpage, voids, wrinkles and delamination, and their disposal								
(5) Proprietary software that spans FEA, FiberSim, and cure model to optmize design and manufacturing								
(6) Bonded and bolted joints: their design, manufacturing and inspection to achieve desired strength and life								

16.d Our team functions

Our governance model is built on multiple revenue units. Some examples are shown in the chart below. Our team consists of Stanford, other leading universities in composites, and several small and mediums size companies as collaborators. Our team has been working together for several years and have started doing many of the products and services which we will develop. Key to our success is to allow talented individual to grow with their students and postdocs. Setting the goals is important but leaving them alone is just as critical. Research requires time and its progress is not easily measured particularly in the early stages. Research is not production of some item. It should be understood by management.

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X
	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

17 How can institute support advanced manufacturing workforce development at all education levels?

17.a Academic background

There are many elements that would make a good training and educational program. Quality of the teaching staff and supporting facilities will be of the top requirements. Having been ranked nationally the top department in aeronautics & astronautics in the past 3 years in succession is a good start. The top three professors at Stanford in Tsai, Springer and Christensen are among the best in composites in their research, publications of original papers and books, chairmanship in professional committees, organizers of international conferences, chief editorship in scientific journals, national and international awards, and membership of the National Academy of Engineers. Pedro Marcal is a noted innovator who has contributed to finite element analysis (inventor of Marc), robotics, and wide ranging topics in modeling and simulation. Other professional members in universities and industrial collaborators of our team have similar qualifications in their achievements and recognitions. Together they are the foundation of our research as well as training and education.

17.b Recruiting graduate students and postdocs

In the upcoming NIST program, we will have an unusual opportunity to make training and education with impact on our national competitiveness. With strong financial support for students and postdocs, and our leading position in the academic ladder, we can recruit the best there is. We intend to reach out for the best from all corners of the world. We will offer not only generous fellowship but with important industrial content in their training and education. Most if not all students and postdocs will spend time **as interns in our industrial collaborators and clients**. Their training will be well rounded, and their prospect of being hired by companies will increase.   They will in turn make companies more competitive. A win-win situation. We will also work with companies to offer work permit for international students and postdocs. Over a period of 3 years, we can establish our Composites Design Group as the best there is in the world. We expect to graduate 40 students and postdocs each year. Some of our graduates will go to universities to carry our method of teaching, research, and interaction with industry to their students. This is the best way to maintain our national competitiveness in composites manufacturing for years to come. With such accomplishment, we will be able to secure and sustain funding through endowed chairs and fellowships, direct contributions and research contracts.

17.c Online Composites Design Workshop

We have offered 11 online Composites Design Workshops since 2007. Over 1000 registrants have taken this training. First, each workshop offered more than 15 instructors from universities, industry and government agencies. It is an intensive training that covers over 30 hours of lectures, homework, software demonstration and practice. Thus theories are backed up by computational tools so generation of numerical results is part of the learning. Equally important for formulas for design are test methods, failure under impact, delamination, fatigue, and engineering reliability.   Offered free as part of the workshop are three authoritative e-books, design tools, data, and all presentations recorded for viewing by registrants at their leisure, official credit from Stanford's registrar at a nominal processing cost, free iPad and free iMicMac app. Thus not only do we have a top-flight teaching staff but also include many features that conventional training courses do not have. Thus our workshop has achieved a unique status. A similar approach with expanded scope will be included as part of our NIST proposal. In particular, we will explore the benefits of offering scholarships to the Teaching Faculty in Community Colleges in order to seed composites training in those Institutions. In tables below we show the listing of the past 10 on-line offerings that started in 2007, and the topics and schedule of the last workshop help in August 2012.

Composites Design Workshop VII is not a sequence of Composites Design Workshops I to VI or Composites Design Tutorials 1 to 4. Composites Design Workshop VII is enhanced with new materials and offered as an intensive workshop format.

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Offered in 2007, from Sept.04 to Nov.20

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Offered in 2008, from Apr.08 to Jun.24

Composites Design Tutorial 3
Offered in 2008, from Sept.02 to Nov.18

Composites Design Tutorial 4
Offered in 2009, from Mar.31 to Jun.16

Composites Design Workshop I
Offered in 2009, from Sept. 21 to Oct. 02

Composites Design Workshop II
Offered in 2010, from Jan. 07 to Jan. 21

Composites Design Workshop III
Offered in 2010, from Jul. 21 to Aug. 04

Composites Design Workshop IV
Offered in 2011, from Jan. 12 to Jan. 26

Composites Design Workshop V
Offered in 2011, from Jul. 21 to Aug. 02

Composites Design Workshop VI
Offered in 2012, from Jan. 17 to Jan. 26

Day/Date	Time	Lecturer	Topic
Tue, Aug 14	Noon-1:10 PM	John Linck	Challenges and Opportunities
	1:30-2:40 PM	Steve Tsai	Laminated Plate Theory
	3:00-4:00 PM	Steve Tsai	Mic-Mac's*
Wed, Aug 15	Noon-1:10 PM	Antonio Miravete	Materials & Processing*
	1:30-2:40 PM	Steve Tsai	Failure Criteria
	3:00-4:00 PM	Melih Papila	Failure Envelopes*
Thu, Aug 16	Noon-1:10 PM	Sangwook Sihn	MicMac-FEA*
	1:15-3:00 PM	Daniel Melo	Angly-ply Laminates*
	3:05-4:00 PM	Steve Tsai	Failure Criteria II
Fri, Aug 17	Noon-1:10 PM	Steve Tsai	Design Rules
	1:30-2:40 PM	Daniel Melo	Master Curves; Biaxial Testing
	3:00-4:00 PM	Sung Ha	Lekhnitskii's MicMac-Hole*
Mon, Aug 20	Noon-1:10 PM	Kim Parnell	Delamination; Cohesive Elem.; Composite Optimization
	1:15-2:55 PM	Steve Tsai	Anisotropic Plates; Failure Criteria III
	3:00-4:00 PM	Woo Il Lee	Cure Modeling and Monitoring
Tue, Aug 21	Noon-1:10 PM	Jeffrey Fong	Uncertainty Estimation**
	1:30-2:40 PM	Jeffrey Fong	Reliability Theory**
	3:00-4:00 PM	TE Tay & Ridha	Progressive Damage
Wed, Aug 22	Noon-1:10 PM	Tim Schmidt	Full-field Deformation
	1:30-2:40 PM	Sung Ha	3D Beam: Features**
	3:00-4:00 PM	Sung Ha	3D Beam: Applications
Thu, Aug 23	Noon-2:00 PM	Alan Nettles	Test Methods; Damage Tolerance Design
	2:05-3:00 PM	Steve Maier	Real World Problems
	3:05-4:00 PM	Daniel Melo	Homework Solutions & Closing
* Homework due Aug 20; ** Homework due Aug 23			

17.d Additional training opportunities

We have Stanford Center for Professional Development as our advisor (in Bryan Chin) to expand our reach and content of our workshop offering. This internet training can be coordinated with our university partners so the best person for the topic will be arranged to speak for our team. The same for our industrial collaborators to bring theory to practice. We can also expand our degree program for practicing engineers that SCPD has done successfully for years. With NIST support and impetus, we will look for new approaches to training and teaching to seek more effective methods, sources of motivation, and contents to make our manufacturing more competitive.

We also have Abaris, a famous training academy for engineers and technicians (headed by Mike Hoke, and headquartered in Reno) to coordinate and expand their offering in composites in general and repair in particular.

Cerritos Community College (headed by Terry Price) is known for his training course of technician for composites. We will coordinate the courses there with that at Abaris and our entire team to make sure that our training in all levels are complementary, up-to-date, and recognized as the best anywhere in the US and around the world. Training can be another source of income. On the high end, we wish to match the fee charged by Stanford and other business schools. In the middle, we hope to reach hundreds from students, postdocs and practicing engineers. In the novice level we hope to learn from Mike Hoke and Terry Price to see how best to train technicians so they become employable and contribute to the national competitiveness.

7.e Teaching staff

All our professionals will be involved in training. The teaching staff will be not only professors but also key innovators from industry and government. In the chart below, the teaching staff and their affiliations are listed. In the last column their role in teaching and training is also shown.

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train	
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X	
	George Springer		X			X		X						X	X	
MAG	Dick Christensen		X				X							X	X	
	Sung Ha*	X	X		X	X			X	X				X	X	I
	Tong Earn Tay*		X		X			X						X	X	/
	Woo Il Lee*					X		X						X	X	(
	Daniel Melo*		X				X			X			X	X	X	I
	Pedro Marcal*		X			X								X	X	\
	Alan Nettles*	X	X	X	X									X	X	/
	Ryan Chin														X	/
Univ Delaware	Tsu-Wei Chou						X							X	X	
Univ Houston	Su Wang		X							X			X	X	X	
Montana St Univ	Doug Cairns		X	X					X	X				X	X	/
Michigan St Univ	Larry Drzal						X				X			X	X	/
	Al Loos					X		X						X	X	/
Georgia Tech	Ben Wang						X							X	X	I
N Carolina A&T	Ajit Kelkar	X				X								X	X	I
Hexcel	Bruno Boursier	X			X	X		X	X					X	X	S
Cerritos College	Terry Price														X	(
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X	I
Trilion	Tim Schmidt		X	X	X			X						X	X	(
ICE	Steve Maire	X		X				X					X	X	X	(
VX Aerospace	Bob Skillen	X		X					X					X	X	(
MAG	Jim Hecht	X				X			X					X	X	T
Siemens/Vistagy	Olivier Guillermin					X			X					X	X	T
American Artisan	John Eggers	X										X		X	X	(
TPI	Steve Nolet							X		X	X		X	X	X	i
Abaris	Mike Hoke										X				X	(
	* Visiting Scholar															

18 How could institutes ensure that advanced manufacturing workforce development activities address industry needs?

18.a Industrial needs

It is a critical requirement to provide training and education that can strike the right balance between intellectual content and practicality. For students and postdocs, both must be satisfied. For technicians, the emphasis is on how-to. But in real life, we need both understanding and how-to. Industrial needs are not defined in a neat package. Often times, industry knows short range problems much better than their long term needs. Neither do university professors. So it is a collaborative effort how the contents and teaching methods must be exercised. In our Stanford team we not only have some of the best known teachers in the country but has also other university professors and many key players from industry to jointly develop our training and educational programs. In the next three sections, we will list some of the people, our current online workshop topics, and the people who will be teaching under the NIST sponsorship.

18.b Our background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of Hewlett Packard, Sun Microsystems, Intel, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as the "silicon valley culture".   Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Measured to assess performance will include all of the above in traditional academic achievements plus the collaborative projects with industry. In particular focus must be applied to revenue generation through products and services for industrial need today as well as for the future so our national competitiveness can be maintained.

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MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

19 How could institutes and the NNMI leverage and complement other education and workforce development programs

19.a Leverage

Education and workforce development can be made complementary through sharing equipment and facilities much more easily than the teaching staff. But such collaborative effort should be explored.

Our experience in online workshop can easily be offered to others because its flexibility and savings in travel time and expenses. With recordings, participants can view the review the lectures at their leisure.

In the next section, the history and example of the program are shown.

19.b Online Composites Design Workshop

We have offered 11 online Composites Design Workshops since 2007. Over 1000 registrants have taken this training. First, each workshop offered more than 15 instructors from universities, industry and government agencies. It is an intensive training that covers over 30 hours of lectures, homework, software demonstration and practice. Thus theories are backed up by computational tools so generation of numerical results is part of the learning. Equally important for formulas for design are test methods, failure under impact, delamination, fatigue, and engineering reliability. Offered free as part of the workshop are three authoritative e-books, design tools, data, and all presentations recorded for viewing by registrants at their leisure, official credit from Stanford's registrar at a nominal processing cost, free iPad and free iMicMac app. Thus not only we have a top-flight teaching staff but also many features that conventional training courses do not have. Thus our workshop has achieved a unique status. A similar approach with expanded scope will be included as part of our NIST proposal. In tables below we show the listing of the past 10 on-line offerings that started in 2007, and the topics and schedule of the last workshop help in August 2012.

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Offered in 2011, from Jan. 12 to Jan. 26

Composites Design Workshop V
Offered in 2011, from Jul. 21 to Aug. 02

Composites Design Workshop VI
Offered in 2012, from Jan. 17 to Jan. 26

Day/Date	Time	Lecturer	Topic
Tue, Aug 14	Noon-1:10 PM	John Linck	Challenges and Opportunities
	1:30-2:40 PM	Steve Tsai	Laminated Plate Theory
	3:00-4:00 PM	Steve Tsai	Mic-Mac's*
Wed, Aug 15	Noon-1:10 PM	Antonio Miravete	Materials & Processing*
	1:30-2:40 PM	Steve Tsai	Failure Criteria
	3:00-4:00 PM	Melih Papila	Failure Envelopes*
Thu, Aug 16	Noon-1:10 PM	Sangwook Sihn	MicMac-FEA*
	1:15-3:00 PM	Daniel Melo	Angly-ply Laminates*
	3:05-4:00 PM	Steve Tsai	Failure Criteria II
Fri, Aug 17	Noon-1:10 PM	Steve Tsai	Design Rules
	1:30-2:40 PM	Daniel Melo	Master Curves; Biaxial Testing
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	1:30-2:40 PM	Sung Ha	3D Beam: Features**
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	2:05-3:00 PM	Steve Maier	Real World Problems
	3:05-4:00 PM	Daniel Melo	Homework Solutions & Closing
* Homework due Aug 20; ** Homework due Aug 23			

19.c Teaching staff

All our professionals will be involved in training. The teaching staff will be not only professors but also key innovators from industry and government. In the chart below, the teaching staff and their affiliations are listed. In the last column their role in teaching and training is also shown.

Organization	Professional	C-Ply	Allow	Testing	NDE	D-L-C	Nano	Joints	Aero	Wind	Transp	Sport	Off-shr	Consul	Train
Stanford Univ	Steve Tsai	X	X		X	X			X				X	X	X
	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

20 What measures could assess institute performance and impact on education and workforce development?

20.a Institute performance and impact

The performance and impact of education will need a long time to evaluate. Student reaction alone is not sufficient. For a national program of this significance, we must strive to have the best time, not one that is minimally qualified. Thus experience on a national or international scale is absolutely required. In that regard, we will show the background of our professors from Stanford, and other affiliated professors from universities, and innovators from some key industry members on our team. These will be covered in the next two sections.

One measure of the impact of the education would be the quality of the graduates and how they perform in industry and government. Do they rapidly progress to captains of their chosen professional activities. Again, this is a long term process and can only go back to many years of record. In this respect our team members have done well and is the best measure that can be applied immediately.

20.b Our background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of

Hewlett Packard, Sun Microsystems, Jntel, Yahoo, and Google were all started by hardworking, friendly environment and timing, often referred to as the "silicon valley culture". Stanford University being the main provider of Technological and Managerial talent in the valley, together with its very active alumni network, can justifiably claim credit for initiating this torrent of innovation. In the field of composites, the Stanford group has gathered the very top performers in this technology. They are the who's who in this business. Measured to assess performance will include all of the above in traditional academic achievements plus the collaborative projects with industry. In particular focus must be applied to revenue generation through products and services for industrial need today as well as for the future so our national competitiveness can be maintained.

The NIST RFP must make stringent requirement to ensure that its precious resources go to the most qualified. Our department at Stanford has been ranked No. 1 by the US News and World Report for the last three years in succession. NIST centers should be led by universities with expertise with impact not only to perform research but also to recruit top students and postdocs. In composites, our Stanford team is ready to justify our reputation. We will develop products and services that industry must have to be competitive. Examples include a Stanford/Chomarat invented C-Ply fabric for simultaneous weight and cost reduction, expanded use of automation in manufacturing, rapid design allowables generation, quantitative NDE to determine effects of defects, in-situ properties of composites as manufactured, integrated design-layup-cure software, confidence in bonded joints, and training of workers from technicians to postdocs. These innovations will generate revenue to fund our team for years to come. A measure of success of institute will include short term items like revenue generation through products and services and exports, and long term items like graduates become the captains of industry.

20.c Team members

All our professionals will be involved in training. The teaching staff will be not only professors but also key innovators from industry and government. In the chart below, the teaching staff and their affiliations are listed. In the last column their role in teaching and training is also shown.

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	George Springer		X			X		X						X	X
MAG	Dick Christensen		X				X							X	X
	Art Owen		X		X			X						X	X
	Sung Ha*	X	X		X	X			X	X				X	X
	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
	Pedro Marcal*		X			X								X	X
	Alan Nettles*	X	X	X	X									X	X
	Ryan Chin														X
Univ Delaware	Tsu-Wei Chou						X							X	X
Univ Houston	Su Wang		X							X			X	X	X
Montana St Univ	Doug Cairns		X	X					X	X				X	X
Michigan St Univ	Larry Drzal						X				X			X	X
	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Iowa St Univ	TBD				X					X				X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

21 How might institutes integrate R&D activities and education to best prepare the current and future workforce?

21.a Integration of R&D and education

The best universities in this world are the research universities. Both research and education are fully integrated. To master the art of learning, both the teachers and students must be qualified and fully motivated. The new element in manufacturing to improve national competitiveness must be integrated in the established operation of research universities. At Stanford and its affiliated university assembled for the NIST program, we have the track record of working with industry to improve education and training so what we offer as a research topic is geared explicitly for the current or future needs of industry. In the next three sections, we will show first the background of our people, followed by our ongoing online design workshop that is taught by famous people from academia, industry and government, and finally a list of our team members and their affiliations who will be teaching our graduate students and postdocs.

21.b Our background

Demand to achieve technical excellence goes far beyond having equipment and floor space. One key for innovation comes from superior training, discipline and motivation of the people. NIST's RFP must demand the best talents that this nation can offer. Talents are measured by degrees, work experience, publications, patents, awards, and training in students and postdocs. Examples of business success of

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	Tong Earn Tay*		X		X			X						X	X
	Woo Il Lee*					X		X						X	X
	Daniel Melo*		X				X			X			X	X	X
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	Al Loos					X		X						X	X
Georgia Tech	Ben Wang						X							X	X
N Carolina A&T	Ajit Kelkar	X				X								X	X
Hexcel	Bruno Boursier	X			X	X		X	X					X	X
Cerritos College	Terry Price														X
Chomarat	Brian Laufenberg	X							X	X	X	X		X	X
Trilion	Tim Schmidt		X	X	X			X						X	X
ICE	Steve Maire	X		X				X					X	X	X
VX Aerospace	Bob Skillen	X		X					X					X	X
MAG	Jim Hecht	X				X			X					X	X
Siemens/Vistagy	Olivier Guillermin					X			X					X	X
American Artisan	John Eggers	X										X		X	X
TPI	Steve Nolet							X		X	X		X	X	X
Abaris	Mike Hoke										X				X
	* Visiting Scholar														

Respectfully submitted,

Prof. Stephen W. Tsai, George S. Springer, Richard M. Christensen, Ryan Chin
Visiting scholars: Prof. Pedro Marchal, Sung K. Ha, Woo Il Lee, Tong-Earn Tay, Daniel Melo, and Dr. Alan N. Nettles
Department of Aeronautics & Astronautics, Stanford University

Prof. Tsu-Wei Chou, University of Delaware

Prof. Su Su Wang and Dr. King Him Lo, University of Houston

Prof. Douglas Cairns, Montana State University

Prof. Lawrance Drzal, Alfred C. Loos, Michigan State University

Prof. Ben Wang, Georgia Institute of Technology

Prof. Ajit Kelkar, North Carolina A&T

Brian Laufenberg and Philippe Sanial, Chomarat, Anderson, SC

Tim Schmidt, Trilion, LINY

Steven Maire, Innovative Composite Engineering, Bingen, WA

Bob Skillen, VX Aerospace, Morganton, NC

James Hecht, MAG IAS, LLC, Hebron, KY

Olivier Guillermin, Siemens, Waltham, MA

Stephen Nolet, TPI, Warren, RI

Dr. John Eggers, American Artisans, Sonoma, CA

Bruno Boursier o, Hexcel, Dublin, CA

Michael Hoke, Abaris, Reno, NV

Terry Price, Cerritos Community College, Cerritos, CA