

**The University of Iowa**  
**Economic Development Grow Iowa Values Fund Proposal**  
**FY11**

**OVERVIEW**

The University of Iowa is requesting \$1,459,200 to sustain our commitment to enhancing technology transfer, commercialization, job creation and economic development. The University of Iowa has carefully invested these funds in the past to build the infrastructure in people and facilities, needed to succeed in several key areas of economic development initiatives. Key elements of the impact of this funding includes the construction and occupancy of the new BioVentures, life science incubator, the creation of IOWA Centers for Enterprise, the creation of a cGMP facility, the expansion of the John Pappajohn entrepreneurial education outreach programs and seed grant programs to support new company formation that is derived from research at the University of Iowa.

**PROPOSED APPROACH IN 2011**

In FY11, The University of Iowa's focus will be to continue to invest and enhance faculty disclosures, technology transfer, commercialization, and especially new company formation by creating an integrated model involving the Office of the Vice President for Research, the University of Iowa Research Park, the Pappajohn Entrepreneurial Center and the University of Iowa Research Foundation. The ultimate goals are to facilitate university-private sector partnerships in entrepreneurship and continue to create new companies in Iowa based upon UI technology. Our primary focus in the upcoming years will be increasing energy and resources to identifying promising new companies and commercial opportunities.

The main elements of this approach are:

- The office of the Vice President for Research and Economic Development will continue this strong emphasis on the importance of economic development by continuing to invest in identifying faculty inventors and also increasing our focus on new business development, and linking Iowa based companies with various university assets.
- The University of Iowa Research Foundation (UIRF) will focus on two primary activities. First, continue with its contribution to the integrated model of new company formation. Second, educate faculty in key colleges and departments towards identifying viable technology that has potential to create intellectual property that can be protected and can lead to new companies and/or licensing opportunities.
- The Pappajohn Entrepreneurial Center key initiatives will include the development of online entrepreneurship and technology commercialization training modules and reference materials, enhancing support for faculty, areas of technology, high potential start-up concepts, and early stage companies through consultations and workshops, continued support for elevator pitch and business concept competitions for emerging ventures and ongoing support for select UI student team ventures housed at the Bedell Entrepreneurship Learning Laboratory.
- The University of Iowa Research Park will be available to provide unique facilities and incubate technology based companies as well as facilitate linkage with key university core resources.
- The expansion of Industrial Biotechnology Capability at CBB. CBB is mainly involved in production of biotherapeutic proteins. However, in the last year, CBB has seen a substantial increase in activities related to biofuels and chemicals from biomass. Via this expansion, CBB will be very well positioned to collaborate with Industrial Biotechnology companies and provide "a gateway" for such companies to establish operations in Iowa, including using corn and soybean biomass and/or residues as feedstocks.

## PROJECT DESCRIPTION

The University of Iowa proposes to allocate \$1,459,200 from the Grow Iowa Values Fund (GIVF) in continuing to refine our integrated model of economic development support. We propose to increase our focus on providing funding to promote increased faculty disclosures with the potential to identify promising transfer/start-up opportunities and assist in the formation and development of companies. Specific allocation of FY11 funds include:

**\$300,000 to support new company formation and faculty educational programs through the University of Iowa Research Foundation.** With this new component to faculty education, UIRF is now focused on all stages of new company formation, from conceptualization in a basic research laboratory through legal entity formation and early development to first equity investment. As these programs are implemented and sustained, we expect the pipeline of promising new ventures to become a robust source of on-going economic development in Iowa.

New company formation based on UI or Iowa-related intellectual property involves assessment and exploration, early planning and development, and pre-seed and seed investing. Among others, GIVF funds will be used to support these activities in forming new companies:

- University-private sector collaborations for “proof of concept” support for the commercialization of UI- or Iowa-related intellectual property.
- Gap funding for early-stage technologies and start-up companies based on UI- or Iowa- related intellectual property.
- Engagement of technology savvy-business development experts to identify new technology transfer opportunities from our most productive units.
- Engagement of Entrepreneurs-in-Residence to support UI spin-out companies.
- University-private sector formation and development of start-up companies in Iowa directly related to existing UI- or Iowa-related intellectual property.
- Collaboration with JPEC on student teams that will assist in assessment, exploration, early planning, and development.

The new faculty education program is designed to identify, and possibly increase, research that can be commercialized. Existing efforts have been focused on increasing awareness of intellectual property and the UIRF invention disclosure process. These existing efforts will continue, but it is important to supplement them with dedicated resources seeking promising commercial research in well-regarded laboratories. It is an activity “upstream” of new company formation and will increase the number of research projects that have the potential to become new ventures by sustained, focused discussion with faculty and staff.

**\$265,250 to support operational and personnel costs of key economic development areas.** These funds will support critical economic development support functions associated with the University of Iowa Research Park, BioVentures Center, Technology Innovation Center and IOWA Centers for Enterprise. In addition, funding will be provided for UIRP master plan and regional branding exercise.

**\$246,250 to fund expenses associated with operating costs of the new BioVentures Building.** The BioVentures Building was made possible by a collaborative partnership between Ryan Companies and the University of Iowa. The new building provides critical space and services for life science start-up companies at the University of Iowa Research Park. The BioVentures Center will use these funds to pay debt associated with the construction of the new BioVentures Building.

**\$150,000 to fund the expansion in Industrial Biotechnology (IB) capability at the Center for Biocatalysis and Bioprocessing.** CBB is continuing to collaborate with several start-up companies involved in producing biochemicals and fuels from biomass. 1) Surge in private and federal/state investments into industrial biotechnology is creating many opportunities; 2) the need for additional equipment and capability to meet all the needs of pilot scale process in industrial biotechnology and, 3) partnership opportunities for CBB with some of the start-up companies.

**\$331,700 to integrate and develop all economic development support functions.** These funds will be used by the Vice President for Research and Economic Development for program integration and development. A portion of these funds will be used to offset salary of key leaders with responsibilities in economic development. Additional funds will be used to supplement proof of concept funding to enable translation of promising basic research to clinical and commercial applications and other opportunities to foster medium to long range projects that will impact economic development.

**\$166,000 to fund expenses associated with training, consultation and outreach for Iowa entrepreneurs.** John Pappajohn Entrepreneurial Center will continue to expand outreach programs for Iowans.

- Online Technology Commercialization Modules - providing UI faculty, staff and graduate students education and information on technology commercialization, intellectual property, and business development is critical to the future expansion of technology commercialization and entrepreneurship at Iowa.
- Entrepreneurship Boot Camp – JPEC will sponsor two entrepreneurship boot camps. Each half-day program will focus on different aspects of technology commercialization and high growth ventures.
- Community Entrepreneurial Training - JPEC will continue to offer the entrepreneurial training FastTrac program in the region and deliver specialized seminars, speaker events, and workshops to meet the specialized needs of aspiring entrepreneurs.
- Regional and Distance-based Field Study Projects - JPEC faculty will direct undergraduate students (primarily) on field study projects for area and statewide entrepreneurial ventures. Student teams will be formed to engage in consulting assignments for Iowa-based companies.
- Initial Concept and New Venture Funding Competitions - JPEC will direct three new venture funding competitions in the 2010-11 year. The purpose of the elevator pitch competition is to identify new venture opportunities and provide initial seed awards to assist the aspiring entrepreneurs further develop and enhance their business concepts. As part of these competitions, JPEC will provide one-on-one assistance and group training to participants on pitching concepts and feasibility and business planning.
- Student Entrepreneurial Venture Fund - JPEC seeks to continue its student venture fund to enhance the development of student entrepreneurs, support student teams competing in state and national business plan competitions, and provide financial assistance to top teams as they launch their new companies.

The University of Iowa will leverage GIVF funds with a dollar-for-dollar match. Examples of funds that will be used to match GIVF include:

- Research funding focused on applied research with IP capability.
- Licensing revenues – directly used for support of above initiatives.
- Industry funding of fee for service contracts (e.g. CBB).
- BioVentures operating expenses and lab lease rental payments.

- Developer funding of BioVentures Center facility.
- In kind personnel support, business development and patent expenses.
- Revenue from land leases.
- Operating expenses from JPEC.
- TIF (Tax Increment Financing) funds from City of Coralville.
- Revenue from Oakdale Research Park facilities leases.

**OUTCOMES and Metrics:**

Iowa Department of Economic Development (IDED) administrative rules require certain information on the use of Grow Iowa Values Funds, which include:

- Number of research and development agreements executed with Iowa companies as part of GIVF projects funded.
- Company matched resources: Company sponsored funding provided by companies as part of GIVF projects funded.
- University matched resources: Involvement of university/college centers and institutes: description of laboratory equipment used and services provided measured by hours used, samples run or dollar amount of services provided.
- Number of licenses or option agreements executed with Iowa companies as part of GIVF projects funded.
- Number of new companies formed and jobs created as part of GIVF projects funded.
- Revenue to companies as a result of technology licenses executed as part of GIVF projects funded.

**Other metrics in addition to the IDED metrics:**

- Increase in activity in research that has potential to reach the public marketplace.
- Reported total earnings and earning impacts of Research Park and incubator company employees.
- Total number of companies, number of start-ups in University of Iowa Research Park and incubator.
- Collaborations and interactions with Iowa-based industry.
- New federal small business innovation research (SBIR) and small business technology transfer (STTR) applications and awards.
- Start-up companies formed and reaching critical milestones.

**University of Northern Iowa**  
**Grow Iowa Values Fund Proposal for FY 2011**  
**Total - \$729,600**

**Overview:** The University of Northern Iowa (UNI) respectfully submits this request for fifth year support from the Grow Iowa Values Fund (GIVF). UNI proposes a continued focus on the five critical economic development projects previously supported, in part, through the GIVF. Each project has leveraged private and federal support and achieved substantial outcomes. Specific details are included for the following projects:

- Technology Transfer and Business Incubation
- Rural Entrepreneurship
- Market Research
- Regional Development
- National Ag-Based Lubricants Center

**Project 1: Technology Transfer and Business Incubation ♦ \$254,600**

UNI continues to advance intellectual property evaluation and protection, commercialization of campus innovations through licensing/strategic partnerships, and new business development. A number of proposed services directly impact these efforts, including the Innovation Incubator and extension of the MyEntre.Net initiative. These efforts will result in stronger, broader based linkages between the University and the greater Iowa business community. Specific priorities for FY 11 are:

**Area 1 - Business Incubation:**

Expansion of the Innovation Incubator was completed in FY10, providing additional business development suites. All but one of the new suites are currently occupied and three new businesses recently graduated into the regional economy. Our goal for FY11 is to bring the incubator to full capacity and strengthen the mix of tenants, including more information technology companies. UNI's 4<sup>th</sup> Street Incubator, a partnership with the City of Waterloo and area development groups, graduated its 40<sup>th</sup> tenant into the regional economy in 2010 and will continue to play an important role in UNI's incubation and business development programs. The student business incubator has been full all of 2010 and another 30 student businesses are served as affiliates. As in past years, several student businesses recently graduated from the student business incubator and we anticipate quickly filling the vacancies.

**Area 2 - Intellectual Property Development:**

Intellectual property development at UNI continues to mature as a result of collaboration between Business and Community Services and the Office of Sponsored Programs. Due to the retirement of UNI's first full-time Intellectual Property Officer, intellectual property priorities for FY11 were reassessed. Specifically, more emphasis will be placed on the market feasibility of UNI's IP portfolio and commercialization efforts. Fewer IP disclosures have been received in the past year due to less available funding for faculty research projects. Our goal is to move five technologies to commercialization in FY11 through licensing, trade secrets or business development.

**Matching Funds:** Federal Funds from the SBA, UNI Research Foundation and program income

**Results/Metrics:** Occupancy at the expanded Innovation Incubator, 4<sup>th</sup> Street Incubator and Student Business Incubator will be at 100% occupancy by the end of the fiscal year. At least 10 intellectual property disclosures will be received, 5 patents filed and 5 technologies will be commercialized.

## **Project 2: Rural Entrepreneurship ♦ \$150,000**

MyEntre.Net is an entrepreneurship development system serving entrepreneurs and rural communities since 2003, bringing online services to entrepreneurs and in-community support to rural leadership toward creating entrepreneurial communities. In FY -10, MyEntre.Net was entirely rebuilt as *Iowa's Online Community for Small Business and Entrepreneurs*, and has now attracted more than 6,000 entrepreneurs online. In FY11, the online community will continue to be enhanced with on-demand and free research assistance for MyEntre.Net users, an ongoing *Dream Big, Grow Here* campaign and contest to attract growth-oriented small Iowa employer firms, and continued regional EntreBash! events statewide. New shared resources and technology tools for rural communities will be developed throughout the year. UNI will continue to lead a consortium of statewide service providers in the planning of EntreFest!, the statewide conference for small business and entrepreneurs, hosted this year in Dubuque, Iowa. This project will address the following critical areas of entrepreneurial development in the coming year:

### **Area 1 - Continued growth of MyEntre.Net, as *Iowa's Online Community for Small Business Owners and Entrepreneurs*:**

In May of 2009, MyEntre.Net was re-launched and expanded as *Iowa's Online Community for Small Business and Entrepreneurs*. In FY11, new online business analyst services will be created to provide on-demand, complementary access to business information and research to support MyEntre.Net members. Additionally, development of a peer-to-peer lending component on MyEntre.Net will continue and other new technologies will be introduced to enhance interaction among entrepreneurs online. A recently announced *Dream Big, Grow Here* campaign will target small employer firms in the state, providing a new portal for statewide service providers to showcase their new resources and services throughout the year.

### **Area 2 - Entrepreneurial Communities Project:**

In support of a planned expansion of outreach services within BCS, UNI will continue to deliver Entrepreneurship Economic Development Seminars statewide to communities requesting assistance in developing entrepreneurship support systems. These educational seminars will begin the process of building community capacity to serve entrepreneurs. In addition, participating communities will receive local EntreBash! events coordination, master calendar development and printing assistance, shared technology resources at MyEntre.Net and annual economic impact data collection through direct surveys of entrepreneurs in those regions.

**Area 3 - UNI will lead a consortium of 15-20 service provider and private partners in the delivery of the fourth annual EntreFest!, Iowa's conference for small business in the state:**

2011 will mark the fourth consecutive year of EntreFest!, Iowa's statewide conference for small business and entrepreneurs. The 2010 event saw a record number of attendees in West Des Moines; the conference will move in 2011 to the historic Hotel Julien in downtown Dubuque where more than 350 small Iowa firms are expected to attend.

**Matching Funds:** Regional Business Center client fees and Federal funds (SBA)

**Results/Metrics:** In FY 2010, MyEntre.Net's online community will grow by 50% to 9,000 Iowa small business owners engaged online. 500 small business owners will attend a regional EntreBash! event and 300 community leaders will begin the process of creating an entrepreneurship support system by participating in the Entrepreneurial Communities Project. Those served through this systems approach will generate 125 new or expanded businesses and create 300 new full-time jobs. 350 entrepreneurs representing 50 Iowa counties will attend the 4<sup>th</sup> annual EntreFest! statewide conference for small business on February 24<sup>th</sup> and 25<sup>th</sup> 2011.

**Project 3: Market Research ♦ \$75,000**

Investing GIVF funds in market research projects helps to expand and stimulate economic growth across Iowa by aiding business start-ups, business retention and business expansion opportunities. Whether starting or expanding a business, accurate information is needed to make sound decisions. Gathering and using "market intelligence" data to make decisions is what Strategic Marketing Services (SMS) offers. Poor decisions and failures are often the result of acting on incomplete, inaccurate or biased information. SMS will leverage Grow Iowa Values Fund support in five primary areas:

**Area 1: Market research projects for established Iowa companies**

This area of activity will receive priority for funding. Market research project costs will be split between the client and a GIVF investment, with maximum GIVF support of \$10,000 per project. The logic behind this approach:

- Funding to support market research projects is extremely limited and must be leveraged
- Established businesses should be willing to pay at least one-half of the project cost
- Priority will be given to businesses in the state's target industry clusters

**Area 2: Start-up business secondary market research and patent research services**

The concept of "Economic Gardening" started in Littleton, Colorado in 1989 and is being adopted across the U.S. by numerous economic development organizations. To support this effort in Iowa, Strategic Marketing Services will provide secondary market research services including patent research services to entrepreneurs and small businesses throughout the state. SMS will work in cooperation with existing economic development organizations and business service providers (i.e., Small Business Development Centers, John Pappajohn Entrepreneurial Centers, community economic development organizations, chambers of commerce, etc.) to conduct secondary research on behalf of those organizations' clients.

### **Area 3: Market research consultations, plans, and assessments**

SMS will consult with Iowa businesses, entrepreneurs, statewide associations and local governments to assess their market research needs. Where appropriate, market research plans will be developed. In some cases, the client may wish to undertake some or all of the research activities on their own, utilizing the market research plan as a guide.

### **Area 4: Assistance to UNI's technology transfer program**

Phase One research provides initial market screening for inventions and innovations to identify potential competitors. The UNI Research Foundation (UNIRF) will support 50% of Phase One research and GIVF will support 50%.

### **Area 5: Market research projects for Iowa associations and local governments**

Communities or organizations seeking to undertake market research projects to grow their economic base. Three examples include: 1) an association might seek information to grow its membership or provide services that would result in the strengthening of Iowa's economy; 2) a community may seek to become a regional center for specialized medical services by attracting medical specialties; 3) a community may seek to capitalize on its growing senior population to maintain or stimulate the local economy and support workforce development initiatives. GIVF support will be used to cover half the costs of these projects with the client paying the remaining half.

**Matching Funds:** Program income

### **Results/Metrics:**

SMS will complete 6-10 market research projects for Iowa businesses. The maximum allowed amount for any one project is limited to \$10,000. Measurement will be based on new/increased sales, new sales leads, new product introductions, product modifications, customer satisfaction measurements, new jobs created, physical plant expansions, new market penetration, market expansion, and job retention. In addition, the number of consultations, assessments, and market research plans, economic gardening projects or secondary research projects and technology transfer projects will be tracked.

### **Project 4: Regional Development ♦ \$100,000**

Building upon keen expertise and understanding of regional development, the Institute for Decision Making (IDM) will continue implementing economic development assistance programs that help to sustain Iowa's regional economies into the future. Specific priorities for FY 2011 are:

#### **Area 1: Sustainability of Regional Work and Strengthening the Collaborating Member Groups**

Many of Iowa's organized economic regional groups continue to benefit from technical and other assistance in sustaining themselves as active regions. Regional workforce continues to be a focus, and IDM will continue to collaborate with Iowa Workforce Development on workforce projects. IDM will continue to act as a quasi-staff member to

one region (Off-Shore Iowa), and to continue assisting other regions by providing technical assistance and/or strategic planning assistance.

**Area 2: Regional Metrics Project**

In FY 2009 IDM outlined metrics for regions in collaboration with IDED. These metrics will be updated in FY 2011. IDM will review and analyze 10 regional benchmark metrics in all 15 Iowa marketing regions. IDM will also assist regions in tracking 3-4 additional indicators based on individual regional plans. Testimonial letters will be gathered from the regions and used to outline progress on individual regional projects.

**Area 3: BEST of Iowa Partnership**

In partnership with the Iowa Department of Economic Development (IDED), Regents universities, community colleges, utilities, Professional Developers of Iowa (PDI) and the Iowa Department of Education, IDM will strengthen the Business Expansion & Strategic Trends (BEST) of Iowa program. BEST of Iowa supports local economic development organizations in implementing or increasing the effectiveness of their business retention and expansion efforts. BEST initiatives include enhancing statewide coordination of existing industry programs and implementation of the Synchronist Business Information System® at the regional level. Specifically, IDM will assist with improving data collection and input at the state and regional levels as well as developing a coordinated response to technology transfer issues on behalf of the Regents universities.

**Area 4: Entrepreneurial Communities Project**

In support of entrepreneurial development across Iowa, IDM will partner with the UNI Regional Business Center and their MyEntre.Net program to implement the Entrepreneurial Communities Project (ECP). The goal of the ECP is to build the capacity of community stakeholders towards fostering entrepreneurial development within their respective communities. The approach centers on four areas: 1) research and assessment, 2) education of community stakeholders, 3) development of a community entrepreneurship strategic plan, and 4) implementation of the plan and follow-up. IDM staff will lend research and strategic planning expertise to this project, as well as providing customized technical assistance to meet community's needs.

**Matching Funds:** Program income, workforce development grants/contracts, federal funds from the Economic Development Administration (anticipated)

**Results/Metrics:** IDM will solicit and report testimonials related to all areas. In addition, progress will be tracked quantitatively across regional metrics and among communities engaged in entrepreneurial development. We anticipate four regional economies will directly benefit from the Entrepreneurial Communities project, engaging 300 entrepreneurs and 60 community leaders.

**Project 5: National Ag-Based Lubricants (NABL) Center ♦ \$150,000**

The University of Northern Iowa's National Ag-Based Lubricants (NABL) Center's brand-new 25,000 square foot facility, part of Cedar Valley TechWorks, houses one of the most

comprehensive biolubricant testing labs in the United States. The Center offers more than 100 specific product testing methodologies per ASTM, AOCS, or other standardized specifications, to testing clients and research partners. In addition, NABL offers biodiesel testing, analytical fingerprint analysis, and a full spectrum of customized research and development capabilities. The NABL Center has brought in more than \$5M in federal equipment funding to the University since its inception. NABL research in FY2011 focuses on expanding the successful use of biobased lubricants in applications currently restricted to petroleum or synthetic oils. Through research involving modified vegetable oils, derivative products with superior lubricity, cold temperature performance, and increased oxidative stability will be identified, and used to create formulations suitable for even the most demanding applications. In addition, NABL will continue to serve as a cornerstone for Iowa's developing biobased products industry.

#### **Area 1 – Support Iowa's Biobased Products Industry**

NABL will continue to participate in ASTM Laboratory Crosschecks, and other proficiency testing programs to ensure the laboratory's accuracy and contribute to improved test standardization for biobased products. Involvement and participation in industry organizations such as ASTM (American Society for Testing and Materials), NFPA (National Fluid Power Society), NLGI (National Lubricating Greases Institute), and AOCS (American Oil Chemists Society) is on-going and helps to make certain that biobased products are tested and evaluated on standards appropriate for vegetable oils. This will help to ensure that Iowa's biobased products meet the necessary performance certifications before entering the marketplace.

#### **Area 2 – Fundamental Research of Vegetable Oil Based Products:**

This research targets new methods of improving the inherent characteristics and fundamental properties of vegetable oils, such as esterification, estolides, genetic crop modifications, and the creative use of non-traditional additives.

#### **Area 3 – Study Vegetable Oil Derivatives for Improved Stability and Cold Temperature Properties**

This research activity specifically targets the investigation and testing of advanced vegetable oil derivatives and other oil modifications improving oxidative stability and cold temperature performance for use in advanced lubricant formulations, targeting high-performance applications currently limited to petroleum or synthetic products.

#### **Area 4 – Industrial Oil Crops**

NABL will investigate the opportunity to use non-food industrial crop oils in order to produce oils that illustrate strong cold temperature performance or other desirable characteristics.

**Matching Funds:** Federal funding from U.S. Department of Energy, and fees from NABL Center testing

**Results/Metrics:** NABL will provide fee-based testing services to at least 10 biofuels and/or biolubricant industry clients during FY11. NABL will complete at least three ASTM Crosscheck programs. NABL will participate in at least two scientific or industry organizations during 2011. NABL laboratories will complete test regimens on at least 10 unique vegetable oils of interest.

To: Board of Regents  
From: Sharron Quisenberry, Ph.D.  
Vice President for Research and Economic Development, Iowa State University  
RE: FY10 Grow Iowa Values Fund Appropriation  
Date: 14 July 2010

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This memo contains information on Iowa State University's request for the FY11 Grow Iowa Values Fund Appropriation. We propose to allocate the money consistent with the proposal presented to the Board of Regents in FY06. In response to the continued budget cuts, we have cut \$150,000 from the Infrastructure allocation (\$100,000 to IPRT and \$150,000 to the post-doctoral entrepreneurship program).

**FY10 Funding Summary (for each year):**

Infrastructure and Entrepreneurial Culture		\$ 500,000
ISU Research Park	\$200,000	
ISU PappaJohn Center	\$200,000	
Vice Provost for Research	\$100,000	
Commercialization Competitive Grants Program		<u>\$ 959,200</u>
<b>Annual Funding During This Period</b>		<b>\$1,459,200</b>

**System for Innovation**

The Iowa State University *System for Innovation* is focused on the transfer of university technologies into commercial applications in start up or existing companies. This System is coordinated by the Vice President for Research & Economic Development and has demonstrated significant success over the years. It recognizes that the fuel for a technology transfer/commercialization system is faculty and staff research.

**Infrastructure and Entrepreneurial Culture**

This funding will support the people and activity required to grow, improve and sustain the technology transfer/commercialization efforts at ISU. The staff and resources increase the capacity of the *System for Innovation* and fund resources and activities that improve performance. This progressive improvement is critical if the entrepreneurial culture at ISU and the *System for Innovation* is to achieve its full potential.

**Commercialization Program**

The purpose of this program is to build and sustain a larger pipeline of projects will require visibility and funding. There is also a need to identify and foster new projects that have potential to contribute significantly to Iowa's economy. The RFP process will be used to promote the campus-wide opportunity to obtain financial support for the development of innovations with commercial potential and to support the growth and expansion of existing companies. Funds not allocated in the RFP process are reserved for qualifying opportunities that arise during the year.

To date, 65 projects have been funded through the commercialization program, and nine additional projects are recommended for funding in FY11 (listed below). Fifty-one of these projects are complete and many showed excellent progress in improving the competitiveness and profitability of the Iowa companies involved.

**FY10 Projects Recommended for Funding**

We received 22 proposals this year; more excellent proposals than funding. We are working with other groups on campus and IDED to identify other sources of funding for projects that were not selected.

<b>Principal Investigator</b>	<b>Project Title</b>	<b>**Amount Requested</b>
Diane Janvrin	Market Research for Prioritizing Market Segments for Product Development	\$ 40,590
Hui Hu	Development of Advanced Flow Diagnostic Techniques to Characterize Next Generation Fuel Nozzles	\$ 78,305
Patrick Halbur	Development of a Novel Genetic Test for Inherited Bovine Diseases and Its Application to Embryos	\$ 83,000
Rick Sharp	Efficacy of a new Delivery System for B-Hydroxy-B-Methylbutyrate	\$ 99,883
Byron Brehm-Stecher	Advances in Food Safety: Fast Fragment Analysis for Differentiation and Tracking of Foodborne Pathogens	\$ 106,961
Sri Sritharan	Design Verification and Cost Evaluation of UHPC Towers for Enhancing Iowa's Wind Energy Production	\$ 109,000
Vasant Honavar	Data Mining Tools for Healthcare Informatics	\$ 109,243
Ayman Fayed	Battery Life Enhancement in Portable and Remotely Deployed Systems Using Spread-Spectrum Switching Power Regulators	\$ 117,944
Sanjeevi Sivansankar	Commercialization of an integrated, single molecule Atomic Force Microscope-Fluorescence Microscope for academic and industrial applications	\$ 120,075
Suraj Kothari	A Programmable Software Pattern Analyzer (PSPA); Critical Safety Improvement for Transportation Control Systems	\$ 77,388
<b>Total</b>		<b>\$ 942,389</b>

\*\* The unallocated projects funds will be allocated to a project at the Vice President for Research and Economic Developments discretion, consistent with the mission of these funds.

**Project Title:** *Efficacy of a New Delivery System for  $\beta$ -Hydroxy- $\beta$ -Methylbutyrate*

**PI:** Rick Sharp, Ph.D.  
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**Annual Sales:** Confidential  
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### **Executive Summary**

This project is designed to evaluate an improved delivery form of the dietary supplement  $\beta$ -hydroxy- $\beta$ -methylbutyrate (HMB) compared to the current commercially available Calcium HMB (CaHMB) product. We have developed a free acid gel system to deliver HMB more effectively to the tissues. Our preliminary studies show that this new form results in a faster delivery of HMB with a 25% increase in clearance and availability for tissue utilization attesting to the improved efficiency of this new form of delivery. The first specific aim will be evaluate the new form of delivery of HMB compared CaHMB following an acute bout exercise stress on diminishing acute muscle damage and in ameliorating the inflammatory responses. Secondly, we will also examine the effectiveness of this new form of delivery of HMB on muscle recovery and on muscle fatigue over a period of 4-days following the exercise protocol. We anticipate that the new HMB delivery form will be as efficacious if not more efficacious because of improved clearance and availability over the current commercially available CaHMB product.

This important new form of HMB will have widespread applications in nutritional and medical supplements affecting a large portion of the US population. Based on our current sales of CaHMB, we anticipate that the sales of HMB free acid gel in the exercise market will reach \$10,000,000 annually by the 5th year. Our projected sales in the larger nutritional supplement market could easily exceed this amount and could reach 20-30 million USD by the 5th year. MTI has been successful in transitioning HMB from an “exercise commodity” to a supplement that is used in medical nutritional products (such as Juven<sup>®</sup> and Abound<sup>®</sup> - Abbott Nutritional Laboratories). Funding from this grant will create and/or support two new jobs immediately in Iowa, and we anticipate the success of this project will result in the support of additional 10-20 full-time positions within the next 3-5 years.

**Project Description:** We have developed a new oral method of delivery of  $\beta$ -hydroxy- $\beta$ -methylbutyrate (HMB), the well known product that was introduced to the exercise market nearly 15 years ago. HMB is a metabolite of leucine and is currently marketed as a calcium salt (CaHMB). Previous studies in humans have shown that dietary supplementation with CaHMB led to significant improvements in both muscle mass and strength in various forms of exercise. Strenuous exercise, such as resistance training, can cause muscle damage and leads to slower recovery. Exercise induced muscle damage is accompanied by an increase in creatine phosphokinase (CPK) and lactate dehydrogenase (LDH) enzymes, as well as increases in pro-inflammatory cytokines (e.g. TNF $\alpha$ , IL-1, IL-6, etc.). Human studies have shown that muscle damage following intense exercise, measured by elevated plasma CPK is reduced with CaHMB supplementation.

We and others have shown that oral administration of the commercially available form, CaHMB, results in better recovery of muscle following acute exercise. The results indicate that complete absorption of CaHMB takes approximately 5-6 hours with maximal plasma levels attained within 120-150 min. Hence, achieving maximal effectiveness of this form of HMB requires its ingestion prior to the initiation of the exercise regimen. Our preliminary studies show that the ingestion of this new form of HMB free acid gel results in doubling of plasma HMB levels in about one-quarter of the time required for CaHMB salt. In addition, the use of the free acid gel form resulted in significant increase in the clearance and utilization of HMB (approximately 25%) attesting to its improved efficiency.

The proposed studies will test efficacy of HMB in free acid gel to decrease muscle damage and in ameliorating the inflammatory response following an acute exercise stress. In addition, we will also examine the effectiveness of this new form of delivery of HMB on muscle recovery and on muscle fatigue following the exercise protocol. We will administer HMB in a free acid gel as either a single dose before a bout of acute exercise or in multiple doses (one before and two doses after such that subjects receive a total of three daily doses). We hypothesize that HMB in free acid gel will result in less muscle damage, diminished inflammatory response, and improved muscle strength recovery compared to placebo treatment following a single bout of acute eccentric exercise and will be as effective as or greater than CaHMB.

For the proposed study, 30 (15 male and 15 female) subjects will be recruited from the Ames, IA area. Subjects recruited into the studies will be 18 to 40 years of age. Briefly, we will supplement subjects using a double-blind protocol with one of 5 treatments: 1) Placebo pre-exercise; 2) HMB calcium salt pre-exercise; 3) HMB free acid gel pre-exercise, 4) HMB calcium salt pre- and post-exercise; or 5) HMB free acid gel pre- and post-exercise. Pre-exercise will get 1 dosage of treatment and pre- and post-exercise groups will get the pre-exercise dosage as well as an additional 3 daily doses during the study period. Subjects will undergo a maximal eccentric flexion exercise of the elbow and CPK, LDH, and pro-inflammatory cytokines will be measured to assess muscle damage and inflammatory responses. Strength recovery and soreness will also be measured for the following 4 days. Our endpoints will include measurements of:

(1) markers for muscle damage (CPK and LDH); (2) muscle strength and soreness; (3) indicators of inflammation (CRP, TNF- $\alpha$ , IL-6, IL-1ra and IL-18). All endpoints will be used to assess the effectiveness of HMB in free acid gel.

We anticipate the following results from the study: (1) The Placebo group is expected to show a 700% increase in muscle damage, 28% decrease in muscle strength and a 1300% increase in muscle soreness based upon our earlier placebo-controlled study with HMB in exercising young adults. A 20-80% increase in inflammatory markers is expected based on previously published studies. (2) We expect the HMB (Calcium salt) groups to attenuate the increase in muscle damage, decrease in muscle strength and increase in muscle soreness. We expect CaHMB to blunt the increase in inflammatory markers. (3) We expect the HMB free acid gel groups to be as efficacious as or greater than the CaHMB group. Our preliminary data suggest that the free acid form of HMB (delivered in a gel) when compared to the currently available form, CaHMB, is more efficiently absorbed and rapidly distributes to the tissues.

In summary, improved efficiency and function of the new free acid gel formulation will greatly improve the current use of HMB for human performance optimization during exercise and training. We expect the results to show that the new HMB delivery form will be as effective if not more effective in minimizing CPK, LDH, pro-inflammatory cytokines, and soreness. We hypothesize that HMB free acid gel will be used by athletes to prevent and mitigate injury and decrease attrition, medical cost, minimize personal impact, and improve performance.

**Commercial Potential for the HMB Delivery System for Iowa:** Metabolic Technologies, Inc. (MTI) is a small research and development company located in the Iowa State University Research Park in Ames, Iowa, with current sales just under \$2 million annually. MTI was founded in 1990 with the vision of developing and marketing naturally derived products that enhance health, performance, and well-being. Central to this vision, MTI ensures that products are not marketed before quality manufacturing is guaranteed, safety is proven, and effectiveness is scientifically verified. MTI's vision results in highly effective products that have definably superior safety margins. In addition, the vitality of the company is assured by focusing on strong patent protection for the products developed.

**Developed Products:** The first commercial product developed was HMB<sup>®</sup> or  $\beta$ -hydroxy- $\beta$ -methylbutyrate. This naturally occurring leucine metabolite has become a standard bearer in the sports nutrition market by having superior efficacy and safety data available. HMB is now protected under several patents. HMB is currently sold as a calcium salt, CaHMB.

The second commercial product MTI developed was Juven<sup>®</sup>. Juven<sup>®</sup> is a combination of arginine, glutamine, and HMB. Clinical studies showed that this product enhanced maintenance and restoration of muscle mass in both AIDS and cancer patients. In 2003, the rights to market Juven<sup>®</sup> were acquired by Abbott Nutrition. Abbott Nutrition currently markets Juven<sup>®</sup> for AIDS, cancer-cachexia, and wound healing.

Although not commercially developed yet, a third product, Re-Vigor<sup>®</sup>, was researched and designed by MTI. Re-Vigor<sup>®</sup> is a combination of arginine, lysine, and HMB, and is intended to slow down muscle wasting in the elderly. In 2008, the rights to this product were acquired by Abbott Nutrition.

**Current Product:** We anticipate that the HMB free acid gel delivery system will replace the need for three daily doses of CaHMB, and thus will be a more efficient form of delivery and use in the exercise market. In addition, we anticipate that the ease of delivery of the free acid gel form will expand the current market potential for use of HMB as a nutritional supplement aimed at ameliorating tissue inflammation a condition that is prevalent in many diseases such as obesity, type 2 diabetes, rheumatoid arthritis, cardiovascular diseases and others. Data generated from this proposal will be used to apply for NIH Phase I and Phase II SBIR grants with potential funding of \$1,150,000. In addition, the results from the proposed studies will be used to support a provisional U.S. patent that was filed in December of 2009.

Based on our current sales of CaHMB, we anticipate that the sales of HMB free acid gel in the exercise market will reach \$10,000,000 annually by the 5<sup>th</sup> year. Our projected sales in the larger nutritional supplement market could easily exceed this amount and could reach 20-30 million USD by the 5<sup>th</sup> year. As previously stated, MTI has been successful in transitioning HMB from an “exercise commodity” to that used by medical nutritional products (Juven<sup>®</sup> and Abound<sup>®</sup>-- Abbott Nutritional Laboratories). We anticipate adding 10-20 new full-time positions within the next 3-5 years. These positions would be in the areas of research and development, quality control, sales, marketing, advertising and accounting.

**Competing Technologies and Advantages:** Currently, there are no nutritional products like HMB in the market that have been shown to be effective in minimizing muscle damage following exercise and improving muscle mass and function. While the CaHMB form of the HMB supplement will continue to be available, we anticipate that the introduction of the free acid gel form of HMB will result in a significant shift in market demand to the new delivery form. We anticipate this shift will reach both markets (exercise and general nutritional products), and that this form will offer significant advantages (in efficacy and delivery) of any other product that might become available over the ensuing 10-15 years.

### Budget

CATEGORY	AMOUNT REQUESTED	ISU COST-SHARE	MTI (cash)	MTI (in kind)	TOTAL
Salaries	\$31,768	\$34,515	\$15,391	0	\$81,674
Benefits	\$9,990	\$9,733	\$4,340	0	\$24,063
Grad student stipends	\$26,400	0	0	0	\$26,400
Benefits	\$3,485	0	0	0	\$3,485
Tuition	\$3,360	0	0	0	\$3,360
<b>Personnel Sub-Total</b>	<b>\$75,003</b>	<b>\$44,248</b>	<b>\$19,731</b>	<b>0</b>	<b>\$138,982</b>
Equipment	0	0	0	\$7,500	\$7,500
Lab Supplies	\$4,300	0	\$15,578	0	\$19,878
Other Supplies & Services	\$8,880	\$1,500	\$6,000	\$36,976	\$53,356
Miscellaneous	\$11,700	0	0	0	\$11,700
<b>TOTAL</b>	<b>\$99,883</b>	<b>\$45,748</b>	<b>\$ 41,309</b>	<b>\$44,476</b>	<b>\$231,416</b>

### Budget Justification

We estimate this project to require roughly 1 year to complete, with the majority of subject testing conducted during the academic year (2010-11). Consequently, PI salary during academic year will be covered by university funds while PI salary in summer session, 2011 is requested from MTI and GIVF. Research Associate and Graduate Assistant salaries are requested to cover the academic year when subject testing will be conducted. Because each subject will be tested daily for one week, this testing will require 30 weeks to complete (30 subjects x 1 wk each). To accelerate this schedule, we will test multiple subjects each week (up to four), requiring multiple personnel for conducting this testing. Blood sampling supplies, test reagents, and other testing supplies requests are based on number of total tests (30 subjects x 5 test sessions each) and recent costs incurred in similar projects. MTI will make an in-kind contribution in equipment (Bod Pod<sup>®</sup>) to ISU - Rick Sharp's lab. The equipment will be used during the study for body composition analysis. However, Rick Sharp's lab will retain the equipment following the study. The assays for serum cytokines and HMB and urinary cortisol, creatinine and 8-iso-prostane will be conducted in the laboratory of MTI and will be an in-kind contribution. MTI will also make a cash contribution of \$41,309.



Iowa State University Research Park  
2711 South Loop Drive, Suite 4400  
Ames, Iowa 50010

May 19, 2010

Office of the Vice President for Research and Economic Development  
Iowa State University  
2610 Beardshear Hall  
Ames, IA 50010

**RE: Grow Iowa Value Fund Proposal**

To Whom It May Concern:

Metabolic Technologies (MTI) believes this funding opportunity from the Grow Iowa Value Fund through Iowa State University will facilitate the advancement of a new product developed, researched and brought to market nationally from the state of Iowa.

In 2009, MTI invested in preliminary research and development on a new delivery method of a well established nutritional supplement, beta-hydroxy-beta-methylbutyrate (HMB). A free acid gel was developed to improve absorption and deliver HMB more effectively to the tissues. MTI has filed a provisional patent on this new technology and needs to expand the understanding of this improvement in relation to the efficacy of the modified delivery of this nutritional compound.

MTI believes this is an excellent Iowa based project, which will develop new technology as well as new jobs in the State of Iowa. Furthermore, this project will facilitate job creation in the following areas: research and development, quality control, sales, marketing, advertising and accounting.

MTI is committed to providing both the in-kind and cash support of this project to be completed under the supervision of Dr. Rick Sharp in the College of Human Sciences at Iowa State University.

Thank you in advance for your consideration of this funding for the proposed project.

Sincerely,

A handwritten signature in black ink, appearing to read "S. Baier", with a long horizontal flourish extending to the right.

Shawn Baier  
COO  
Metabolic Technologies Inc.

ph 515 296.9916  
fx 515 296.0908

**Proposal submitted to the “FY 2011 Grow Iowa Values Fund” Grant Program  
Data Mining Tools for Healthcare Informatics**

**Principal Investigator:**

**Vasant Honavar**, PhD, Professor of Computer Science; Director, Center for Computational Intelligence, Learning, and Discovery, 226 Atanasoff Hall, Iowa State University. 515.294.1098, [honavar@cs.iastate.edu](mailto:honavar@cs.iastate.edu)

**Collaborators:**

**Craig Fontenot**, PhD, Chief Executive Officer, Collaborative Health Solutions (CHS), LLC. 15300 Spillman Ranch Loop, Austin, TX 78738. 503.809.9665, [cfontenot@medizzle.com](mailto:cfontenot@medizzle.com)

**Peter F. Demitry**, MD, MPH, Chief Information Officer, CHS, LLC. 703.678.9888, [pdemitry@comcast.net](mailto:pdemitry@comcast.net)

**Wade Sikkink**, Chief Marketing Officer, CHS, LLC. 402.525.8538, [wsikkink@medizzle.com](mailto:wsikkink@medizzle.com)

**Jorge Abullarade**, Chief Operating Officer, CHS, LLC. 512.775.5723 [jabullarade@medizzle.com](mailto:jabullarade@medizzle.com)

**Executive Summary**

United States spends far more than any other nation on healthcare as a fraction of the per capita gross domestic product (GDP). As healthcare spending grows far more rapidly than wages or GDP it threatens to bankrupt Medicare and Medicaid. The increases in chronic illnesses among an aging population that are manageable or altogether preventable account for 75% of the medical costs and 70% of the deaths in the US. More than 30% of the healthcare spending and hundreds of thousands of deaths are due to avoidable medical errors, unnecessary or ineffective procedures or treatments. The US government mandated adoption of electronic medical records offers unprecedented opportunities for innovations in health informatics to improve the quality and to reduce the cost of healthcare. Against this background, **Dr. C. Layne Fontenot** and collaborators have developed an innovative health informatics platform ([www.medizzle.com](http://www.medizzle.com), patent pending) that brings together a large database of 15,000 symptoms, clinical presentations, and risk factors associated with over 750 illnesses with a doctor only medical content management system, a patient-side user interface and a community portal that supports flexible and secure information sharing among the participants). CHS was one of the 100 Startups (selected from among over 500 applicants) launched during Tech Crunch Disrupt ([disrupt.techcrunch.com/](http://disrupt.techcrunch.com/)) held in New York during May 24-26, 2010 where it was selected by investors as one of the 40 most promising startups. The goals of this GIVF project are to substantially enhance the functionality and the unique competitive advantages of our platform by developing and incorporating advanced machine learning algorithms and software tools for (1) Constructing predictive models for computer assisted evidence-based diagnosis and treatment of illnesses; (2) Interactive acquisition of data from patients in preparation for an appointment with physicians; (3) Clustering patients into communities and leveraging the community structure for sharing information anonymously among patients; and (4) Longitudinal studies of effectiveness of specific treatments and medical procedures. **This GIVF project will lay the groundwork an Iowa-based company Galen Analytics, LLC in Ames, Iowa to handle all predictive data mining R&D as well as advanced data analytics work for CHS, LLC.**

## PROJECT DESCRIPTION

### Technical Objectives

United States spends far more than any other nation on healthcare as a fraction of per capita GDP than any other country and yet ranks only 25<sup>th</sup> in terms of global life expectancy. Healthcare spending in US is growing more rapidly than employee wages and virtually every economic indicator including GDP. This trend, if left unchecked, is likely to bankrupt Medicare and Medicaid in the near future. Major increases in chronic illnesses among an aging population that with suitable measures, are manageable or altogether preventable account for 75% of the medical costs and 70% of the deaths in US [[finance.senate.gov/healthreform2009/](http://finance.senate.gov/healthreform2009/)]. According to the Kaiser family foundation, over 45 million Americans, or nearly 14% of the US population who are uninsured (not counting many more millions who are underinsured) are at high risk of foregoing necessary medical treatment. The recent passage of healthcare reform and the resulting push towards health insurance for all Americans presents an enormous challenge of improving the quality of clinical care while lowering the cost of healthcare. According to expert estimates, somewhere between one-third and one-half of total healthcare spending, not to mention, hundreds of thousands of hospital deaths each year are due to avoidable medical errors, unnecessary or ineffective procedures or treatments. The government mandated adoption of electronic medical records, and the anticipated federal investments in healthcare IT offer unprecedented opportunities for innovations in health informatics that help deliver higher quality care at lower cost by significantly reducing medical errors and unnecessary or ineffective procedures and treatments, and by adopting evidence-based approaches to clinical practice.

**Dr. Craig Fontenot** (an ISU alumnus) and active team members (**Dr. Honavar's primary collaborators on this project**) have already invested more than \$250,000 to develop an innovative health informatics platform (patent pending) that brings together a large database of 15,000 symptoms, clinical presentations, and risk factors associated with 700 illnesses, fully integrated with an doctor only medical content management system, a patient-side user interface and community, and a portal that supports flexible and secure information sharing among the participants. It's key features include a novel algorithms for the matching of patients based on symptoms-diagnosis-treatment protocols with potential conditions, prevention and treatment options, risk factors, as well as doctors, and other 'like' patients; and a novel secure social information sharing and web 2.0+ collaboration toolset that allows medical professionals to share new clinical and/or medical research findings, and treatment philosophies with each other and with patients. For the patient, this product suite revolutionizes the symptom, risk factor and illness information discovery process via a cutting edge differential diagnosis tool that connects the patient's electronic health record with and medical knowledgebase and social network. The knowledgebase contains medical knowledge extracted from textbooks, research papers, and contributions from doctors in the social network. Thus patients can quickly learn what illness(es) match their symptoms and risk factors, and access highly targeted medical information based on their specific circumstances. It also allows patients to anonymously connect and share experience and information with other medically similar individuals experiencing the same set of symptoms or illness. The proposed research and development efforts focus on the artificial intelligence and machine learning algorithms that are needed to demonstrate several key capabilities (intelligent and interactive patient data acquisition, social

network based information sharing among patients, among physicians, and between patients and physicians.

**Project deliverables** include: Algorithms and software for (1) constructing predictive models for computer assisted diagnosis and treatment of illnesses based on symptoms and risk factors (first results in 6 months to be refined over the next 6 months); (2) Clustering patients into communities and leveraging the community structure for sharing information anonymously among patients (6 months); (3) Intelligent and interactive acquisition of data from patients in preparation for an appointment with physicians (first results in 12 months, to be refined over the next 6 months); and (4) Longitudinal studies of effectiveness of specific treatments and medical procedures. **This project will enable the creation of an Iowa-based company Galen Analytics, LLC, in Ames** in partnership with **CHS, LLC**. Galen Analytics will handle, under Dr. Honavar's leadership, all predictive data mining and artificial intelligence research and associated software development for CHS.

### **Commercialization Plan**

**Market:** The first obvious revenue stream are highly targeted ads. CHS has already secured its first advertising customer and has a signed contract that pays, because of the highly targeted nature of our ads, ad rates well above that paid by the customer to WebMD. The business case for the project is also very compelling in light of the pressing need to contain the rising costs of healthcare in the US. Market analysis by CHS, LLC, leads us to strongly believe that our medical decision support software will be attractive to physicians, hospitals, out-patient practices and medical schools. CHS research has shown that most care providers welcome the ability to review patient information and prepare for the visit prior to the appointment so that they can be better prepared to deal with the case. Additionally, this will save the doctor's time during patient intake, which at an estimated at ~ 7 minutes per patient translates to a savings of \$120k/yr for each physician using the tool. It also enables the physician to deliver improved care by more effectively combining individual clinical expertise with the best available evidence (from the research literature, from the patient's social network, etc.) which in turn translates to further cost reductions and better patient outcomes in the long-term. The intelligent data acquisition tool which is part of the larger collaborative medical decision support platform that allows a patient to enter symptoms, symptom presentations, risk factors, and any lab test results or previous clinical history from the patient. This can be done at the patient's leisure via a secure Internet portal prior to a scheduled doctor's visit, or with a tablet PC when checking in at the doctor's office. The symptom and illness relationships will vary based on the illness and/or medical specialty and a list of possible illnesses will be displayed and ranked in real-time as the patient enters data. The early availability of patient intake data will allow doctors to review patient information prior to the clinical encounter and be better prepared for specific and difficult to answer questions that a patient might have. During the actual patient visit, the doctor will review the reported information, verify the accuracy of the reported symptoms, make any necessary changes, arrive at an informed diagnosis and prescribe appropriate treatment. The diagnosis and treatment will be entered into the database. The data is stored in a database to support its exchange in a format that is compliant with current data exchange standards (HL7, X12, SNOMED) to enable interoperability with leading Electronic Medical Record (EMR) and practice management software packages that comply with all industry standards. CHS has already established partnership with a major EMR system vendor in the

state of Virginia. This software application will provide an important source of revenue via licensing to healthcare providers, clinics, and hospitals. Several other more substantial revenue streams are under consideration.

**Competition:** Current competition in the medical data acquisition space is limited to unwieldy questionnaire-based tools. Current tools in the differential diagnosis space (WrongDiagnosis.com) are not equipped with data-driven machine learning capabilities. Current social networking tools are far more limited in their coverage of illnesses (15 in the case of PatientsLikeMe.com compared to over 750 in the case of Medizzle.com), lack sophisticated patient-to-patient matching capabilities, and privacy controls. Our tools represent a paradigm shift, and stand out from competing products because of: (1) the adaptive, interactive and intuitive GUI (patent-pending) of the tool, that using advanced algorithms, quickly 'guides' the user to the pertinent information they need to enter and (2) sophisticated patient-to-patient matching algorithms, (3) Fully HIPAA compliant informatics infrastructure, and (4) the machine learning algorithms to be developed by Dr. Honavar's group that will greatly enhance data acquisition and differential diagnosis .

**Financial Plan:** CHS is in negotiation with several VC Firms for funding in the range of approximately \$2.5 to \$5 million. CHS has in place sufficient funds to provide the CHS match for this GIVF proposal. **The focus of this Grow Iowa Funds Project is to carry out the research and establish an Iowa-based Company, Galen Analytics LLC under Dr. Honavar's leadership** to support the predictive data mining, informatics, semantic technologies and artificial intelligence research and development needs of CHS, LLC. Galen Analytics will be based in Ames, Iowa, to take advantage of the R&D strengths of ISU in Artificial Intelligence and related areas of Informatics. (A letter of Commitment from CHS, LLC is attached). To demonstrate its commitment, CHS has agreed to provide dollar for dollar match for the funds requested from GIVF. Galen Analytics can be expected to create in the short term, about 5 R&D jobs in informatics and advanced analytics, 5 to 10 jobs in software engineering, and 2 support personnel. Future growth prospects for Galen Analytics are tied in part to the success of the partnership with CHS. The partnership between ISU researchers, Galen Analytics, LLC and CHS, LLC opens up opportunities for commercializing the results of ISU research projects funded by NSF, NIH, and USDA grants in excess of several million dollars for informatics and data mining research under Dr. Honavar's leadership. Additional opportunities for growth of Galen Analytics are offered by applications of the intellectual property that is likely to result from this project (artificial intelligence and data mining algorithms) to a broad range of data-driven decision support scenarios (e.g., monitoring and containing the spread of disease outbreaks; monitoring and responding to threats arising emerging infectious diseases and/or biological weapons); virtual clinical trials (longitudinal studies of large cohorts of patients for effectiveness of specific treatments); and evidence-based optimization of healthcare delivery so as to maximize the benefits to patients while minimizing the cost of care. We will pursue grants from several additional sources, including SBIR grants from NSF and NIH, as well as NSF and NIH research grants for fundamental research. Other opportunities exist in the Federal Health Care systems which include the two largest medical systems in the world (Veterans and Dept of Defense). Dr. Demitry, who recently served as CIO for the Air Force, has many contacts that will facilitate these collaboration(s).

## Budget

Category	Amount Requested (GIVF)	Industry Cost-Share (Collaborative Health Solutions, LLC)	Total
Salaries	52722	52722	105444
Benefits	14298	14298	28596
Graduate student stipends	13950	13950	27900
Benefits	1842.00	1842	3684
Tuition	10431.00	10431	20862
Undergraduates			0.00
<b>Personnel Sub-total</b>	<b>93,243</b>	<b>93,243</b>	<b>186,486</b>
Equipment	5000	5000	10000
Lab Supplies	3000	3000	6000
Field Supplies			0
Other Supplies & Services	2000	2000	4000
Travel	3000	3000	6000
Publication	0	0	
Miscellaneous	3000	3000	6000
<b>TOTAL</b>	<b>\$109,243</b>	<b>\$109,243</b>	<b>\$218,486</b>

## Budget Justification

The PI Honavar requests 1 month of summer salary during the 18 months of the project to enable his full participation in planning, execution, and supervision of the project. The PI requests funds to support one postdoctoral research associate at a salary of \$5000 per month for 18 months, and a graduate student at \$1550 per month for 18 months at 20 hours per week. The postdoctoral research associate will be responsible for algorithm development and experimental evaluation and the graduate student will focus on the implementation and testing of algorithms. The current university fringe benefits rates are 28.2% for faculty and 20.2% for postdoctoral research associate, and 13.2% for graduate research assistants. Under equipment, a Mac OS quad core server is requested for computing and memory intensive data mining work at \$10,000. Under lab supplies, funds are requested for 2 MAC OS workstations at \$3,000 each for use by the postdoctoral fellow and the grad student. To cover the cost of travel to meet with research partners and to attend conferences, \$6000 is requested in travel funds. Under "other supplies and services," \$2000 is requested for the use of departmental network, and \$2000 for printing and copying and other miscellaneous office supplies. Under "miscellaneous", \$6000 is requested for the costs associated with establishing a company (Galen Analytics, Inc), intellectual property protection, etc.

**Matching funds from Collaborative Health Solutions, LLC is in the form of a dollar for dollar cash match for the funds requested through Grow Iowa Funds Grant Program. Thus, CHS will provide \$109,243, to match the \$109,243 being requested from Grow Iowa Values Fund Grant Program.**



C. Layne Fontenot, Ph.D.  
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<http://www.cohealthsolns.com/>

This letter is to accompany the Grant application for "Grow Iowa Funds, entitled *Data Mining Tools for Healthcare Informatics*.

I am an Alumnus of Iowa State University, having received a PhD in ChE, and a MS minor in MScE in 2001. While in Ames, I coached an Ames AAU basketball team for 5 years; to this day I remain in contact with several of the young men and their parents. I have strong ties to the Ames community and would love to help bring greater prestige, technical recognition to Iowa State University and more high quality jobs to the state of Iowa. Over the last 2 years Collaborative Health Solutions, LLC (CHS), of which I have majority ownership, has been working on medical data acquisition and decision support tools which assist both patients and doctors. Over two years ago, CHS contacted Mike Upah, to discuss how CHS could work with ISU to realize my vision for CHS. At that time, I also contacted Dr. Vasant Honavar to discuss the machine learning and informatics aspects of the project. He was enthusiastic about the project and agreed to collaborate with my group. However, before we could begin to develop predictive modeling tools, we needed to have in place, a software platform and a sufficiently rich illness knowledgebase to engage a large community of patients as well as clinical practitioners. Hence, CHS proceeded to develop a beta product. The product was launched during Tech Crunch Disrupt ([disrupt.techcrunch.com/](http://disrupt.techcrunch.com/)), held in New York during May 24-26, 2010 where it was among 40 startups selected by investors as having the greatest promise. An audio interview that I gave to John Washam of Startupnextdoor.com is available at <http://www.startupnextdoor.com/2010/05/startup-spotlight-interview-with-medizzle/>. CHS has also identified several investors to back the project.

The success my vision for CHS requires sophisticated data mining tools for analysis of, and predictive modeling using our illness knowledgebase and medical records database. Hence, CHS intends to open Galen Informatics LLC, in Ames, Iowa under Dr. Honavar's leadership to handle the advanced data analytics and informatics R&D for CHS. This would allow CHS to leverage the significant expertise of Dr. Honavar in artificial intelligence, data mining and informatics. It will also give me, an ISU alumnus, an opportunity to help bring recognition to ISU and jobs to Iowa. CHS will match dollar for dollar, the funds requested from GIVF to make this plan a reality. The precise timing of establishing Galen Analytics in Ames will depend on the growth of CHS, but an estimate is within 1-2 years. Please do not hesitate to contact me if you have questions or would like to meet with me before making a decision on this proposal. I look forward working with ISU in as we bring new health informatics tools to the world.

Sincerely,

C. Layne Fontenot, PhD

May 29, 2011

## Proposal submitted to “Grow Iowa Values Fund” Program

**Project Title:** Development of Advanced Flow Diagnostic Techniques to Characterize Next Generation Fuel Nozzles

**Principal Investigator:** Dr. Hui Hu  
Department of Aerospace Engineering, Iowa State University  
2271 Howe Hall, Room 1200, Ames, Iowa 50011-2271  
Phone: 294-0094; Email: [huhui@iastate.edu](mailto:huhui@iastate.edu)

**Company Partner:** Mr. Kevin Gordon, Vice-President of Tech., QA, and Bus. Excellence  
Goodrich Engine Components Division  
811 4<sup>th</sup> Street, West Des Moines, Iowa 50265-0100  
Phone: (515)271-7289; Email: [kevin.gordon@goodrich.com](mailto:kevin.gordon@goodrich.com)

### EXECUTIVE SUMMARY

Legislation in the US, Europe and Asia requires reductions in pollutant emissions in aviation, marine and power generation gas turbine engines. In an effort to meet the needs of maximum energy efficiency, maintain operability requirements and minimize pollutant emissions, gas turbine combustion systems must be capable of achieving specific traits of local air/fuel ratios, mixing rates, and residence times. This requires particular attention be paid to the fuel nozzle, as it is the key component initiating many of these traits. Goodrich Engine Components Division (GECD) in West Des Moines, Iowa, has specialized in the design and manufacture of fuel distribution products since 1937. GECD products include vaporizers, air-blast fuel injectors, pressure atomizers, and combinations thereof as well as various valves, manifolds, spray bars, dome swirlers, and oil nozzles.

In response to legislative directives and market trends, GECD is pursuing capability to develop next generation fuel nozzles which can further optimize fuel preparation characteristics. This optimization will require advanced flow diagnostics to provide a detailed description of the dynamic and thermodynamic behaviors of liquid sprays. **The objective of this proposed research is to develop advanced diagnostics to quantify spray characteristics and to elucidate important processes in spray flows, such as the breakup of liquid jets and sheets, atomization and evaporation of fuel droplets, and air/fuel mixing in order to assist GECD in developing next generation fuel nozzles for maximized energy efficiency while minimizing pollutant emissions, and maintaining the operability requirements.** The techniques to be developed include a PIV/PLIF combined technique for the velocity field measurements of both air streams and fuel streams in spray flows; and a molecular tagging technique for the simultaneous droplet size, velocity and temperature measurements to characterize dynamic and thermodynamic behaviors of fuel droplets. The feasibility and implementation of the proposed techniques will be demonstrated by conducting detailed measurements to characterize the spray flows injected from GECD liquid fuel nozzles. **Successful completion of the proposed research will provide GECD with valuable tools to develop next generation fuel nozzles and to maintain long-term dominance in the fuel nozzle market for aerospace, marine and power generation applications.**

## INTRODUCTION

Legislation in the US, Europe and Asia require reductions in pollutant emissions in aviation, marine and power generation gas turbine engines, while transportation and energy demands globally continue to rely heavily upon the use of fossil fuels. In an effort to meet the needs of maximum energy efficiency, maintain operability requirements and minimize pollutant emissions, gas turbine combustion systems must be capable of achieving specific traits of local air/fuel ratios, mixing rates, and residence times. For gas turbine engines, this requires particular attention be paid to the fuel nozzle, as it is the key component initiating many of these traits.

Goodrich Engine Components Division (GECD) in West Des Moines, Iowa, has specialized in the design development and manufacture of fuel distribution products since 1937. With over 2000 team members located in the United States, England and Mexico, GECD has become renowned for innovative technology and exceptional reliability. As a premier supplier to the aerospace, marine, and power generation industries, GECD works directly with customers to understand the unique needs, budgets and specific requirements of each individual project. GECD products include vaporizers, air-blast fuel injectors, pressure atomizers, and combinations thereof as well as various valves, manifolds, spray bars, dome swirlers, and oil nozzles.

In response to legislative directives and market trends, GECD is pursuing capability to develop next generation fuel nozzles which can further optimize fuel preparation characteristics. This optimization will require advanced flow diagnostics which can provide a detailed description of the dynamic and thermodynamic behaviors of liquid sprays. It is well known that the process of breaking up or atomization of liquid fuel into droplets in the form of a fine spray plays a pivotal role in improving energy efficiency and suppressing pollutant formation, while meeting the operability requirements of the particular application. Significant product improvement can be achieved by having the ability to control the spray characteristics through the optimal design of fuel nozzles. Doing so requires a keen understanding of the physical mechanisms of breakup of liquid jets and sheets, atomization and evaporation of fuel droplets and air/fuel mixing in spray flow fields.

## RESEARCH OBJECTIVE AND RESEARCH PLAN

The objective of the proposed research is to develop advanced flow diagnostics to quantify spray characteristics and to elucidate important processes in spray flows, such as the breakup of liquid jets and sheets, atomization and evaporation of fuel droplets, and air/fuel mixing in order to assist GECD in developing next generation fuel nozzles which maximize energy efficiency while minimizing pollutant emissions, and maintaining the operability requirements of the particular application. The proposed research will consist of two tasks, each providing GECD with valuable tools to develop the next generation fuel nozzles and to maintain world-class level innovation for the aerospace, industrial and power generation spray markets.

### **Task #1: Development of a PIV/PLIF combined technique for the velocity field measurements of both air streams and fuel streams in spray flows.**

By combining the advantages of Particle Image Velocimetry (PIV) and Planar Laser Induced Fluorescence (PLIF) techniques, a novel PIV/PLIF combined technique will be developed to achieve the velocity field measurements of both air streams and fuel streams in spray flows. Conventional point wise measurement techniques, such as the Phase Doppler Particle Analyzer (PDPA) system and optical patterning systems available at GECD, are only capable of measuring mean velocity of droplets at limited points. The proposed techniques are time-resolved, whole-field measurements which can provide significant advantages in characterizing the global features of the spray flows and providing spatial correlations of the unsteady flow structures in both air streams and fuel streams. A better understanding of the spray characteristics is critical in guiding the direction of optimization of liquid fuel nozzle designs.

The feasibility and implementation of the proposed PIV/PLIF technique will be demonstrated by conducting detailed flow field measurements to characterize both the air streams and the fuel streams in the combined spray flows prepared from two kinds of GECD fuel nozzles: a pure air-blast style and a simplex air-blast style. The measurements of the proposed PIV/PLIF combined system will be compared quantitatively with those obtained by using the conventional measurement techniques such as PDPA or optical patterning for quantitative validation and measurement uncertainty estimation of the proposed PIV/PLIF combined system. The PI of this proposed project, Dr. Hu, has extensive experiences in developing and applying PIV and PLIF techniques to study various complex thermal flows. The knowledge, experience and skills gained from those previous studies have built a solid base to secure the success of the present proposed research.

**Task #2: Development of a molecular tagging technique to characterize dynamic and thermodynamic behaviors of fuel droplets in spray flows.**

As described above, a detailed definition of the dynamic and thermodynamic behavior of the fuel droplets in a spray flow is required for the optimization of a liquid fuel nozzle in order to maximize energy efficiency, minimize pollutant emissions, and meet the operability requirements of a particular application. Among different parameters of interest in characterizing a spray flow, droplet temperature is one of the least investigated due to the lack of proper measurement techniques. Droplet temperature is an important index associated closely with the atomization and evaporation processes of the fuel droplets. The processes play significant roles by controlling the distribution of the fuel droplets and thus the local fuel/air ratio in combustion chamber. This ratio can be directly related to the global efficiency of combustion and to the formation of pollutants.

Guided by our recent work to develop a molecular tagging velocimetry and thermometry technique to achieve simultaneous measurements of velocity and temperature distributions in single-phase fluid flows, we propose to invent a novel molecular tagging technique for the simultaneous droplet size, velocity and temperature measurements to characterize the dynamic and thermodynamic behavior of the fuel droplets in multiphase spray flows for the development of next generation GECD fuel nozzles. With the quantitative information of the droplet size, velocity and temperature measured by using the molecular tagging technique, the atomization and evaporation processes of the fuel droplets in the spray flows injected from GECD liquid fuel nozzles will be elucidated in great detail. A better understanding of the important physical processes can therefore help to optimize the fuel nozzles for improved energy efficiency and reduced pollutant formation.

**Project Timeline**

The proposed research will be carried out in 18 months (01/01/2011~06/30/2012).

Months 1-6	Design and construct experimental rig to build the framework of the proposed techniques. Characterize a GECD fuel nozzle using conventional techniques.
Months 7-12	Set up a PIV/PLIF combined system to conduct velocity field measurements of both air and fuel streams to characterize spray flows injected from GECD fuel nozzles.
Months 13-18	Set up a molecular tagging system to characterize dynamic and thermodynamic behaviors of fuel droplets in spray flows injected from GECD liquid fuel nozzles.

**PROJECT BENEFIT AND COMMERCIAL IMPACT**

GECD's ability to secure new contracts and product lines is heavily reliant upon the ability to provide cost effective, innovative solutions in marketable time scales. To be able to provide these solutions, and to continue to improve current product offerings, it is vital to invest in equipment and technologies that can be used to increase the understanding of complex physics that surround fuel spray technologies. Typically the time to market for aerospace is quite long, due to the complexity, and required reliability of the designs. There is a strong interdependence between the combustion

module and the compressor, turbine and engine control systems, resulting in numerous design iterations and expensive engine and rig testing. By enabling optimized solutions in fewer iterations, GECD would be at a very advantageous position relative to its competitors through faster development cycles. A detailed understanding of the spray flows will allow for better decisions and hypotheses for offering tailored solutions to customer's requirements. **The development of the proposed advanced diagnostic techniques to better characterize the fuel nozzles will provide GECD a valuable technical advantage to its customers resulting in contract wins, strategic partnering agreements and ultimately the retention of more technology driven jobs in Iowa.**

For example, GECD recently signed a research agreement with *Rolls-Royce* to develop next generation fuel nozzles for "lean burn" combustion systems, which would be used on future environmentally responsible gas turbine engines for reduced emissions and increased efficiency. GECD's lean burn program focuses on optimized fuel nozzle designs to meet increasingly stringent requirements for reduced emissions on next generation aircraft. The opportunity with *Rolls-Royce* to develop breakthrough technology and provide products for their next generation engines further strengthen market position of GECD. In addition, GECD has been selected to supply *Rolls-Royce* with the fuel nozzles for the new *Rolls-Royce* Trent XWB engines for the *Airbus A350* commercial aircraft. GECD has also been selected to supply an integrated fuel injection system, consisting of fuel nozzles and flexible manifolds for the Hamilton Sundstrand Power System's APS5000 auxiliary power unit, which will be offered on the *Boeing 787*.

As part of a continued effort to explore renewable energy to decrease dependency upon fossil fuels, biofuels are gaining momentum in the aerospace industry. One published goal is to have 15% of all commercial aviation fuel derived from algae by 2030. The Air Force is certifying 50:50 blend of conventional jet fuel and plant-derived biofuel, sometimes called hydrotreated renewable jet fuel, across its fleet. The hydrotreated renewable jet fuel is expected to be approved for use in commercial aircraft this year. However, research into algae-derived fuels is still very limited. **With the proposed advanced flow diagnostic techniques described above, GECD will be able to accurately assess the impacts of varying fuels with regard to the fuel nozzle characteristics.**

The availability of the proposed advanced flow diagnostic techniques to GECD would also generate more opportunities for collaborative efforts with other products. These products include fuel cell reformers, spray dryers, industrial applications, home heating, even medicinal and pharmaceuticals. Product lines such as these would ensure that GECD be exposed to a broad range of markets, thus maximizing potential opportunities. **Other divisions of GECD would certainly also benefit from the proposed advanced diagnostic techniques**, either from utilization of equipment available in West Des Moines, or through licensing of the technology through Iowa State University. Other divisions associated with GECD include use of nozzles for surface treatments (such as thermal barrier coating on turbine blades), home heating (using liquid fuel nozzles), steel mill processes, and even faux tan applications.

**The proposed project would also bring great benefits to ISU.** First, the development of the advanced diagnostic techniques to characterize spray flows for the design optimization of liquid fuel nozzles **will result in patentable intellectual property for ISU** that can be licensed to industries such as GECD. Moreover, by developing the proposed technology and demonstrating the expertise in this field, the PI **will be able to attract external funding from federal and other industrial sources** for related researches, especially since this project will result in highly visible technology with very wide applications. As a matter of fact, the PI and GECD engineers are in the conversation of development joint research proposals to be submitted to federal agencies such as NSF, DOE and AFOSR. **If this proposed project is supported, some results derived from the proposed research will serve as preliminary results of the joint proposals to be submitted to NSF, DOE and AFOSR, which will make the proposals much more solid and competitive.**

## BUDGET

CATAGORY	AMOUNT REQUESTED	ISU COST-SHARE	GOODRICH COST-SHARE	TOTAL
Salaries	\$10,786	\$32,358(in-kind)		\$43,145
Benefits	\$ 3,042	\$9,125(in-kind)		\$12,167
Graduate student stipends	\$21,600		<b>\$10,800 (cash)</b>	\$32,400
Benefits	\$2,851		<b>\$1,426 (cash)</b>	\$4,277
Tuition	\$15,026			\$15,026
<b>Personnel Sub-total</b>	<b>\$53,305</b>	<b>\$41,484(in-kind)</b>	<b>\$12,226(cash)</b>	<b>\$107,014</b>
Equipment	\$15,000			\$15,000
Lab Supplies	\$0	<b>\$2,000 (cash)</b>		\$2,000
Field Supplies	\$0			\$0
Other Supplies and Services	\$5,000		\$30,000(in-kind)	\$35,000
Travel	\$5,000			\$5,000
Publication				\$0
Miscellaneous				\$0
<b>TOTAL</b>	<b>\$78,305</b>	<b>\$43,484</b>	<b>\$42,226</b>	<b>\$164,014</b>

## BUDGET JUSTIFICATION

### Salaries, Benefits and Tuition

- 1). Faculty – The PI will spend about 4 months to work on the project. Only one month salary (\$10,786/month) and benefit support is requested. The salary and benefits for other three months will be provided by ISU as an in-kind cost share. ISU faculty benefit rate is 28.2%.
- 2). Graduate Student – 12 months support (salary \$1800/month) for a Ph.D. student is requested. The other 6 month support for the graduate student will be provided by Goodrich as the cash share (total \$12,226). ISU graduate student benefit rate is 13.2%. Graduate student tuition is also requested at the rate of \$14,764.

### Equipment, Lab Supplies, Travel and Publication

\$15,000 is requested for the design, manufacture and labor costs to establish a test rig for the project. \$2,000 is budgeted to purchase lab supplies such as optical mirrors, lens, tracer particles and molecular tracers for the flow diagnostics. \$5,000 is requested for the PI and the graduate student to travel to meet with GECD personnel over the course of the project as well as to attend a conference to present the results and findings derived from the proposed project.

### Other Supplies and Services

\$5,000 is requested for the maintenance and service of the lasers and imaging systems. \$30,000 will be provided by Goodrich as the in-kind match for atomization nozzles, air-box, appropriate liquid, and bracketing and for the time of GECD engineers in designing and machining the parts.

### Summary of Cost-Sharing by ISU and GECD

#### ISU Cost-sharing

- a) **\$2,000 cash match is provided from the PI's research incentive account.**
- b) \$41,484 of faculty salary and benefits will be provided by ISU as an in-kind cost share.

#### GECD Cost-sharing

- a). **\$12,226 cash will be provided by GECD to cover graduate student salary and benefits.**
- b). \$30,000 of parts, engineer and technician time, and machining costs as an in-kind cost share.



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**Engine Components Division**

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**Kevin A. Gordon**

V.P Technology, QA, and  
Business Excellence

May 26, 2010

Dr. Hui Hu

Department of Aerospace Engineering, Iowa State University  
2271 Howe Hall, Room 1200, Ames, Iowa 50011-2271  
Phone: 294-0094; Email: [huhui@iastate.edu](mailto:huhui@iastate.edu)

**GIVF Proposal: Development of Advanced Flow Diagnostic Techniques to Characterize  
Next Generation Fuel Nozzles**

Dear Dr. Hu,

Goodrich Corporation is a leading global supplier of systems and services to the aerospace and defense industry. As part of our key strategic initiatives, Goodrich is committed to developing innovative products and systems for next generation gas turbine engines. We currently have several programs directed at enhancing our ability to deliver the latest fuel delivery and combustion technologies to engine manufacturers and end users.

Goodrich Engine Components (EC) currently funds advanced research to develop low NO<sub>x</sub> gas turbine combustion technologies. Gas turbine designers continue to raise pressures and temperatures in the engines in order to improve efficiency and CO<sub>2</sub> emissions. However, stoichiometric combustion at these higher temperatures generates exponentially higher Nitrous Oxides (NO<sub>x</sub>). Development of fuel delivery and combustion systems capable of controlling NO<sub>x</sub> in these conditions is critical to the future success of these gas turbine systems. Therefore, Goodrich and its customers view an in depth understanding of the fuel break up, atomization, vaporization, and mixing process within the combustion system, prior to and during combustion, as critical to this success. Our involvement in your program will allow us to continue the development and demonstration of breakthrough technologies in gas turbine combustion, while sharing the knowledge gained from our current programs.

It is also important to note that Goodrich EC has a rich history of technological advancement and job growth/creation in Iowa. EC began as Delavan Inc. in 1937 building aircraft engine magnetos. Soon after its inception, a line of oil heating nozzles was acquired launching the company into fuel spray technology. In the late 40's and early 50's, Pratt and Whitney contracted Delavan to develop a new dual orifice nozzle based on the oil heating technology. This nozzle was for the J57 engine, used to power the B-52 and KC-135 airframes which are still in service today. Since that time, the company has been an integral part of the gas turbine fuel injection business and has grown its customer base, technology, and engineering workforce in West Des Moines. EC now serves all major aerospace and industrial gas turbine manufacturers with approximately 550 Iowa employees. Leveraging our internal research funding with GIVF funds will help us continue to protect and potentially grow our high tech Iowa workforce by advancing technology and knowhow beyond our competition. Additionally, it will help us continue increasing our value to our customers by more deeply understanding how our products interact inside the gas turbine throughout its operating envelope.



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V.P Technology, QA, and  
Business Excellence

Should your program be selected for Grow Iowa Values Fund (GIVF) funding, Goodrich EC will provide \$12,000 for graduate student funding, and \$30,000 in-kind support of hardware and engineering man-hours to your effort during the project. This support may include providing standard components, such as fuel injectors, help in fabrication, review of designs, participation in test analysis, and providing guidance to ensure realistic and practical solutions are developed.

In addition, support of this project may include the delivery and technical support of the technologies currently under development as part of our programs. Goodrich EC will participate in the team's review meetings, and provide critical feedback regarding the success and needs of the diagnostic systems, analytical techniques, and procedures.

Should you have any questions or concerns please contact me at (515) 271-7289.

Sincerely,

A handwritten signature in black ink, appearing to read "K. A. Gordon", written in a cursive style.

Kevin A. Gordon  
Vice President, Technology, Quality Assurance, and Business Excellence  
Goodrich Engine Components



Rolls-Royce

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Direct fax +441332245654  
Date 27<sup>th</sup> May 2010  
Our Ref NPE/COMB/ERW/5899

To Whom It May Concern:

A fuel spray nozzle is a critical part of the gas turbine combustion process and with an eye to the future will continue to be a key driver in our ability to meet emission standards set by the International Civil Aviation Organization (ICAO) Committee of Aviation Environmental Protection (CAEP). The preparation, dispersion and mixing of fuel and air within the combustion chamber of a gas turbine is paramount in being able to meet these standards, as well as achieving suitably high combustion efficiency.

As part of adherence to these standards, Rolls-Royce has invested, and will continue to invest in achieving and verifying technology specifications for components which are integrated into our combustion systems. With an eye to the future, Rolls-Royce is developing a long-term solution to help ensure that our technology is capable of meeting these standards, and part of our strategy is through the validation of a lean burn combustion system for aviation. This is a significant departure from traditional aviation combustion technology, and as such, traditional characterization techniques also need to evolve.

A significant amount of technology development and capital investment is required to mature components to Technology Readiness Level (TRL) 3. The availability of non-intrusive high fidelity flow diagnostic techniques to characterize fuel spray nozzles prior to TRL3 testing would provide much needed information on the fundamental physical processes that affect the performance of the fuel spray nozzle. This information is extremely valuable in providing insight that can lead to the development of predictive models and eventual development of fewer iterations of engineering investment towards a marketable solution.

As a world class fuel spray nozzle developer and manufacturer, Goodrich Engine Components (GECD) must be able to quantify the characteristics of the fuel spray nozzle to increase the level of knowledge prior to investment in TRL3 testing. As the Chief of Combustion Technology Acquisition within Rolls-Royce, I am very familiar with GECD and their current ability to qualify their development prototypes for TRL3 testing. The merit of this technology is greatly emphasized in aiding the industries ability to meet and exceed the emissions standards of ICAO. A greater ability to understand and characterize will ensure that GECD will be the world leading manufacturer of fuel spray nozzles, and as such, Rolls-Royce strongly encourages public or private assistance to innovative companies like GECD and its partners.

Best Regards,

A handwritten signature in blue ink, appearing to read 'K J Young'.

P.P.

Dr K J Young  
Chief of Combustion Technology Acquisition

**Honeywell Aerospace**

111 S 34<sup>th</sup> Street  
P.O. Box 85181  
Phoenix, AZ 85034

Kevin Gordon,  
Vice-President of Tech., QA, and Bus. Excellence  
Goodrich Engine Components Division

June 1, 2010

**Subject:** Lettre of support for BF Goodrich **proposal to “Grow Iowa Values Fund” Program  
Development of Advanced Flow Diagnostic Techniques to Characterize Next Generation Fuel Nozzles**

Dear Kevin,

Fuel injectors are a critical component of the gas turbine combustion system. The preparation, dispersion and mixing of fuel and air within the combustion chamber of a gas turbine is key to meet high combustion efficiency and emissions.

Honeywell continues to invest in fuel injector technologies through suppliers, providing specifications for fuel injector components which are subsequently integrated into our combustion systems. Honeywell is developing long-term solution to ensure that subject technology is capable of meeting performance requirements and emission standards set by the International Civil Aviation Organization (ICAO) Committee of Aviation Environmental Protection (CAEP).

A significant amount of technology development and capital investment is required to mature components to Technology Readiness Level (TRL3). The availability of non-intrusive high fidelity flow diagnostic techniques to characterize fuel spray nozzles prior to TRL3 testing would provide needed information on the fundamental fuel break-up processes that affect the performance of the fuel injectors. **These measurements are valuable in providing insight into the fuel break-up process that can lead to the development of predictive models and eventual development with fewer iterations and lower engineering investment towards a marketable solution.**

Honeywell values Goodrich Engine Components (GECD) as a world class fuel injector supplier capable to quantify the characteristics of the fuel spray, seeking to increase the predictive capabilities prior to TRL3 testing. As the Chief of Combustion Technology within Honeywell, I am familiar with GECD and their current ability to qualify their development prototypes. **The merit of this technology enables this industry to meet and exceed performance and the emissions standards of ICAO in a shorter development cycle. A greater ability to understand the underlying physics will ensure that GECD will retain the world leading manufacturer of fuel injector position, supporting Honeywell’s products, for which we strongly endorse public or private assistance to innovative suppliers like GECD and its partners.**

Regards



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John G. Meier  
Director, Advanced Programs  
Honeywell Aerospace

## Continuation Proposal for "Grow Iowa" Values Fund Grant Program

### *Development of a Novel Genetic Test for Inherited Bovine Diseases and its Application to Embryos*

**PI:** Patrick G. Halbur DVM, MS, PhD  
ISU CVM, Veterinary Diagnostic and Production Animal Medicine (VDPAM)  
2203 Lloyd Vet Med, (515) 294-6970, [pghalbur@iastate.edu](mailto:pghalbur@iastate.edu)

#### **Co-Investigators:**

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#### **Company Partner:**

Ames Center for Genetic Technologies  
2711 South Loop Drive; Suite 4400  
Ames, Iowa 50010  
Contact Person: Dr. Melissa Madsen, Phone: 515-230-3947, [mlmadsen@iastate.edu](mailto:mlmadsen@iastate.edu)

Number of Employees: 3  
Years in Business: 2.5  
Approximate Annual Sales: < \$10,000

**Executive Summary:** The increasing awareness of the role of genetics in eliminating disease and improving efficiency has resulted in a marked increase in demand for genetic testing of livestock. Traditionally genetic testing is conducted on samples from live animals (hair, blood, etc.) and performed for single genes. This strategy is expensive because it requires the cost of pregnancy (testing done on offspring) and the cost of running multiple tests. Current tests have limited capacity for multiplexing. Recent advances in molecular techniques allow for development of next generation genetic testing modalities that reduce the sample size (i.e. embryo biopsies) necessary for analysis and allow for a multiplexed genetic testing platform that is easily customizable at a fraction of the cost. This proposal is for funding for the second year of a collaborative effort between the Ames Center for Genetic Technologies, the ISU College of Veterinary Medicine Embryo Transfer Unit and the ISU Veterinary Diagnostic Laboratory to develop, validate and apply this novel testing platform for animal host genetics and infectious diseases. Our primary goal in year #1 was to validate the genetic testing platform on clinically derived tissues. We have achieved this for 2 of the most important bovine genetic diseases (BLAD, CVM), for gender determination, and for bovine species confirmation. We have confirmed by serial dilution that we can detect below 10 genome equivalents. Further validation using cultured cell lines and demonstration that biopsies from embryos have sufficient DNA for use in the testing platform is in progress. In year #2 we will expand the test panel for genetic diseases by 3 (AM, NH, Fawn Calf), add a test for coat color and a virus detection panel (IBRV, BVDV, BTV, BLV), fully adapt this testing for use on biopsies from bovine embryos and scale-up and commercialize sale of the test panels through the ISU VDL.

### **Technical Objectives and Research Plan**

Ames Center for Genetic Technologies, Inc. (ACGT), the ISU CVM Embryo Transfer (ISU ET) unit, and the ISU Veterinary Diagnostic Laboratory (ISU VDL) have partnered to validate and apply this novel testing platform for animal genetics. ACGT is a start-up company resulting from the ISU Entrepreneurial Program, focusing on genetic testing methods and their commercialization. They have **a unique testing platform that allows for rapid, cost-effective, and flexible panels for genetic tests** that can be applied to both genetic diseases and animal production efficiency genes. **It requires very small amounts of DNA making testing of embryo biopsies a realistic possibility.** The ISU ET unit provides comprehensive embryo transfer services that currently include embryo sexing technology done with the use of polymerase chain reaction. **This unit was responsible for 58% of all the transfers of biopsied embryos reported nationwide** in the most recent survey published by the American Embryo Transfer Association. While the majority of these transfers were on fresh (un-frozen) embryos **the ISU ET unit now has results suggesting that freezing biopsied embryos can provide pregnancy rates of 50% which is acceptable for commercialization of the technology.** The ISU VDL will be the distributor of the testing services. The ISU VDL currently provides broad scope diagnostic services on approximately 45,000 case submissions per year from Iowa and 14 other states, Canada, Mexico and Australia. The ISU VDL is the only laboratory in Iowa that is fully accredited by the American Association of Veterinary Laboratory Diagnosticians and it is also one of 12 core laboratories in the National Animal Health Laboratory Network.

**Development of a genetic testing platform:** By employing proven new chemistries and analyses, the ACGT is able to profile genetic samples more rapidly at a reduced cost, enhancing competitiveness and market share. Current industry methods for genetic identification use gel-based separation techniques that require extensive maintenance and are limited in sample size and speed of analysis. The solid phase platform employs novel intellectual property, some of which has been licensed from Integrated DNA Technologies (IDT) of Coralville, Iowa to enhance accuracy, reduce maintenance costs, increase speed of analysis and provide an overall enhancement in detection limits. The later is particularly important with samples of limited quantity or with degraded samples. Unlike current technologies that depend on relative measurements, this technology uses a unique “binary” or “on/off” signal that discriminates genetic profiles in extremely small quantities of DNA, a significant advancement in the field. ACGT has chosen to partner with us on this project to develop a testing platform for food animals.

In year #1 significant progress has been made in development of the platform and test kit. We have completed microarray validation for **Bovine Leukocyte Adhesion Deficiency (BLAD)** and **Complex Vertebral Malformation (CVM)**. We have also completed microarray validation of **three independent sexing primer pairs and oligonucleotide probes** and two have been selected for inclusion in the kit and the third reserved for **bovine specific typing**. These five markers (2 for bovine diseases, 2 for gender determination, 1 for bovine species confirmation) are well into transition to the Luminex xMAP Technology. Primer pairs and oligonucleotide probes have been designed and are undergoing PCR optimization and validation for **Arthrogryposis Multiplex (AM)** and **Neuropathic Hydrocephalus (NH)**. Designs are also in progress for **coat color**. Once designed, these three additional tests will be confirmed by microarray and shifted to the Luminex xMAP Technology. In addition, we will develop and add

a test for a newly emerged disease now known as **Fawn Calf Syndrome**. Sensitivity levels for detection of genetic disease are under validation using serial dilutions of known genomic DNA concentrations. We have confirmed that we can detect below ten genome equivalents by serial dilutions on the microarray platform. To further validate sensitivity and preserve embryo samples for downstream validations, we have grown a tissue culture cell line and picked single, two, four and six cells from tissue cultures for sensitivity determination of the cell quantity. Once this level has been determined, we are ready to begin testing biopsied embryo samples.

The second major objective for year #2 is to develop a virus screening panel for bovine embryos to protect against introduction of new diseases and to open up export markets. Viruses to be included in the panel include Bovine Virus Diarrhea Virus (BVDV), Infectious Bovine Rhinotracheitis Virus (IBRV), Blue Tongue Virus (BTV), and Bovine Leukosis virus (BLV). Viruses will be grown in cell culture and titrated by established protocols. PCR tests for these pathogens are already in place in the ISU VDL. The PCR assays will be shifted to the Luminex xMAP Technology. The sensitivity and specificity will be determined by testing titrated cell culture propagated virus. Cultured embryos will also be exposed to virus, biopsied, and tested.

**Genetic testing of embryos and subsequent freezing, thawing and implanting:** The embryo biopsy technique will be further adapted and validated to achieve acceptable pregnancy rates following post-biopsy genetic testing and freezing. To achieve client acceptance, calves must be born from biopsied, frozen and transplanted embryos and confirmed to demonstrate the traits or lack of traits as predicted by the test results. Several embryos have been collected, biopsied to provide genetic materials for testing, and frozen. In year #2 these embryos will be transferred after the corresponding biopsy has been tested for the traits. Recipients for embryo transfer have been identified and transfers are being performed.

In year #2, approximately 40 more donor cows will undergo embryo recovery until 120 grade 1 and 2 embryos are obtained displaying the traits sought by the specific tests. A biopsy will be taken from the embryos using a micromanipulation technique and all embryos will be frozen. The biopsies will be tested by ACGT to validate the test platform. All embryos will be transferred to recipients. Indications to date are that we can achieve pregnancy rates greater than 50% for biopsied embryos. Confirmation that genetic testing of the embryonic tissue matches the genetic tests of the live born calves will be done as calves are born.

### **Commercialization**

**Market Size:** Available data suggest that significant commercial markets exist for genetic testing of both live animals and embryos. Live animal numbers in Iowa alone are currently estimated at 216,000 dairy cows on 2000 dairy farms and 1,070,000 beef cows housed on 25,000 farms. Furthermore, given that the novel testing platform proposed will significantly reduce the cost of testing by as much as 5-10-fold compared to other commercially available tests, we anticipate a large amount of additional testing attracted from out-of-state. This would result in increased cash flow into the Iowa economy. Equally exciting are the potential markets on the embryo testing side. Currently embryo testing is not commercially available and given the high cost of the embryo transfer procedure and the marketing advantage associated with knowing the genotype of embryos, it is expected that a significant portion of the industry would be interested in genetic testing of embryos. Data collected in 2007 and presented by the American Embryo Transfer Association indicated that in the North Central region of the United States there were

19,361 cows undergoing ET in that single year with collection of 117,634 transferable quality embryos (TQEs). Nationally the data indicated that 54,080 cows, both beef and dairy, underwent the procedure in 2007 with a total of 332,496 TQEs.

**Industry Impact:** The Iowa dairy industry provides more than 26,000 jobs and annually contributes in an excess of \$1.5 billion to Iowa's economy. Iowa has 12,866 jobs directly related to the beef cattle industry with cash receipts from cattle and calves in 2005 accounting for \$2.425 billion. These genetic tests will significantly benefit all Iowa cattle producers by decreasing costs associated with maintaining the pregnancies of genetically diseased animals and allowing for selection of genetically superior seed stock.

**Expected consumers and benefit:** The ultimate goal of this project is to demonstrate acceptable genetic testing on embryos resulting in significant cost savings for cattle producers. Consumers utilize ET technology to increase their marketing options for offspring of highly desirable cattle. This is achieved by directly selling the frozen embryos or by using ET to increase the potential number of live offspring that can be marketed. As the number of genetic diseases increases rapidly (5 new diseases characterized in the last 2 years) many of these valuable cattle may be identified as "carriers" for one or more of these diseases. This results in the situation where offspring are at high risk of being either carriers or affected in which case their value is significantly diminished (carriers) or completely lost (affected) as breeding stock. The ability to genotype embryos removes potential risk to a buyer purchasing frozen embryos and leads to significant savings to the seedstock producer who no longer needs to invest time and money into implanting diseased embryos into cattle only to discover the condition nine months later after birth. The ability to concurrently test for viruses could be a major added advantage to our services that may make it possible to export biopsied embryos identified as free of the virus(es).

**Expected Market Growth:** Growth in the overall genetic testing market is approximately 15-20% annually. The animal testing market is newly emerging so initially growth should be much higher. Current competitors are small, focused laboratories. The work described in this proposal would greatly enhance our marketing strategy since it would demonstrate a "one of a kind" service not available using other testing platforms that require larger DNA samples. Basic genetic testing in the food animal market currently cost \$40-\$150 for single markers. Our platform will be for multiple markers and we expect to test 5 to 10 markers per sample. We expect our testing charges to be approximately \$5 per marker depending on the volume and the number of markers analyzed. With these highly competitive prices both the ISU VDL and ACGT should quickly gain a substantial amount of the market share. The genetic testing services would likely become a separate section within the VDL and employ 6-12 upper level technicians and research associates. To supply the ISU VDL with the necessary kits to meet demand, ACGT would likely need to employ 6-12 people in scientific development and production. Within the state of Iowa and the Midwest region, the ISU VDL has potential to be a leader in the genetic diagnostic testing market because of well established, long term relationships with livestock producers and the veterinarians who serve them. The ISU VDL receives an average of 7,500 case submissions per year from 14,500 cattle producers for diagnosis and surveillance of diseases and toxicoses. Approximately 75% of the bovine submissions are associated with beef cow-calf breeding herds or dairy operations. Of these, the majority of the dairy operations and approximately 50% of the beef operations utilize advanced reproductive techniques such as ET and thus are likely customers. Additional labs in the genetic testing business include Pfizer Animal Health and Merck-Meriel Animal Health Labs, Agrigenomics, DDC Animal DNA Services and SGS Brookings.

## Budget

CATEGORY	AMT REQUESTED	ISU COST-SHARE	ACGT COST-SHARE	TOTAL
Salaries		30,000	30,000	60,000
Benefits		8,700		8,700
Graduate student stipends				
Benefits				
Tuition				
Undergraduates				
<b>Personnel Sub-total</b>				
Equipment				
Lab Supplies	5,000			5,000
Donor and recipient cow boarding	40,000	30,000		70,000
Payment to ACGT for platform assay development	30,000			30,000
Travel	3,000	3,000		6,000
Publication				
Marketing	5,000			5,000
Miscellaneous				
Armbrust Endowment		10,000		10,000
<b>TOTAL</b>	<b>83,000</b>	<b>81,700</b>	<b>30,000</b>	<b>\$194,700</b>

### Budget Justification:

#### ISU and ACGT Cost Share

- ISU salary and benefit cost share is \$38,700 for Dr. West, Marianna Jahnke and a portion of an ISU VDL technician who will be running the assays for customers during the start up phase
- ACGT salary and benefit cost share is \$30,000 for Dr. Madsen.
- Approximately 50% of the proceeds from the Armbrust Professorship Endowment for 2010 (\$10,000) will be applied to this project for recipient cow care.
- Up to \$30,000 from ISU ET unit service account will be applied towards costs of boarding of donor and recipient cows.
- \$3000 for travel to recover and transfer embryos

#### Requested from Grow Iowa Values Fund

- \$40,000 for donor cow care and boarding and other expenses associated with embryo flushing and biopsy
- \$30,000 for payment to ACGT for assay and multiplex kit development
- \$5,000 for lab supplies for embryo recoveries, biopsy, freezing and transfer
- \$3000 for travel to recover and transfer embryos
- \$5000 for marketing of the new services through the ISU VDL

**AMES CENTER FOR GENETIC  
TECHNOLOGIES, INC.**

2711 South Loop Drive  
Suite 4400  
Ames, Iowa 50010

T 515-230-3947

June 1, 2010

Dr. Patrick Halbur  
Professor and Chair, Department of Veterinary Diagnostic and Production Animal Medicine  
Executive Director, ISU Veterinary Diagnostic Laboratory  
Iowa State University College of Veterinary Medicine  
1600 S. 16th Street  
Ames, Iowa 50011

*RE: Development of a Novel Genetic Test for Inherited Bovine Diseases and its application to tissues and embryos (Year 2)*

Dr. Halbur:

I am writing to express my continued support for the research program that the Iowa State University Veterinary Diagnostic Laboratory and Embryo Transfer Group is submitting to the "Grow Iowa" Values Fund Grant Program for support.

Ames Center for Genetic Technologies, Inc., has a continuing interest in the successful implementation of a novel, cost effective genetic testing platform for the cattle industry that will be marketed through the Iowa State University Veterinary Diagnostic Laboratory. Additionally, our genetic testing platform will complement the embryo transfer technology being developed and validated through this project. Expanding cost-effective genetic testing options to prescreen embryos prior to transfer represents an important step forward in the difficult business of increasing margins in a tight production animal market.

We would like to offer you an in-kind support of scientist salary (Dr. Madsen) of \$30,000 over the course of the grant period.

I look forward to hearing that you have been successful in obtaining support.

Sincerely,



Melissa L. Madsen

President

Ames Center for Genetic Technologies, Inc.  
2711 South Loop Drive  
Suite 4400  
Ames, Iowa 50010

**Proposal for “Grow Iowa” Values Fund Grant Program**  
**Battery Life Enhancement in Portable and Remotely-Deployed Systems using Spread-Spectrum Switching Power Regulators**

**Principal Investigator:** Dr. Ayman Fayed, Dept. of Electrical and Computer Engineering, Iowa State University, 2117 Coover Hall, Ames, IA 50011, (515)-294-6112, [aafayed@iastate.edu](mailto:aafayed@iastate.edu)

**Company Partners:** Rockwell Collins, Inc., more than 75 years in business with 20,300 employees and average annual sales of \$4.47B.

**Contacts at Rockwell:**

- 1) Mr. Haluk Sasmazer, Principal Engineering Manager, Government Systems, External Technology Pursuits. 855 35<sup>th</sup> Street NE, MS 137-137, Cedar Rapids, IA 52498, Phone: (319) 295-2597, Email: [hsasmaze@rockwellcollins.com](mailto:hsasmaze@rockwellcollins.com)
- 2) Dr. Matt Yao, Principal Engineering Manager, Advanced Technology Center, Miniaturized Power Technology. 400 Collins Road NE, MS 108-102, Cedar Rapids, IA 52498, Phone: (319) 295-0147, Email: [myao@rockwellcollins.com](mailto:myao@rockwellcollins.com)

**Executive Summary:**

Power efficiency is a very important design consideration in battery-operated remotely-deployed systems such as portable communication/navigation devices used by military personnel. As those systems require multiple isolated power supplies, the very energy-efficient switching regulators are the most attractive power conversion method that can be used for providing these power supplies out of an unregulated battery pack. However, due to the heavy Analog/RF circuit content in these communication devices, it is crucial for these circuits to have well regulated and very low-noise power supplies in order to meet their stringent performance specifications. While switching regulators are very energy-efficient, their switching behavior results in “periodic” switching noise at their output, i.e. spurs. These spurs pose a great challenge to the performance of the highly-sensitive Analog/RF circuits. Moreover, with the integration of multiple RF cores in a single communication device, this challenge is even greater as every RF core has its own sensitivities and noise requirements, making it very difficult to meet these requirements using switching regulators. Thus, linear regulators, despite their very poor energy efficiency, are widely used in the industry as an alternative power conversion method for these devices due to the absence of switching noise at their output. While this approach produces adequate Analog/RF performance, it comes on the expense of lower power efficiency, and consequently shorter battery life. This mandates carrying a large number of batteries by military personnel to sustain the device for its intended mission period.

This proposal targets the development of spur-free switching regulators using innovative random-control schemes that will spread spurious energy over a wide frequency range, i.e. whiten its spectrum. These new switching regulators can then be used to directly power sensitive Analog/RF modules, and thus eliminating linear regulators. Since the Analog/RF parts typically consume more than 90% of the total system power, replacing linear regulators with switching regulators will *double the battery life, or alternatively, reduce the number of batteries carried by military personnel to half*. Research collaboration, support, and IP commercialization has been arranged with Rockwell Collins, a major Iowa-based company involved in the design of electronic systems for military and commercial applications. Since power efficiency is a differentiating factor in their products, this project offers them a competitive advantage in the market place.

## Project Description:

With the ever increasing demand for integrating multiple functionalities within a single portable electronic device, system designers are forced into dividing the system into different parts, with each part requiring its own well-regulated, independently-defined power supply. Since the power source available to these systems is a shared unregulated battery pack, power conversion modules are needed to generate all the independent power supplies required by the system. The most commonly used modules for that purpose are linear and switching regulators shown in Fig. 1. A linear regulator produces a constant lower-voltage power supply at its output from a variable higher-voltage input power source by controlling the resistance of a power transistor between its input and output using a negative feedback loop. Thus, any extra energy beyond what the load needs is wasted across the power transistor. The maximum theoretical efficiency of a linear regulator can be shown to be the ratio between the output and input levels. Thus, producing a 1.8V supply (typically used for Analog/RF loads) out of a 5.5V Lithium Ion battery will result in merely 33% efficiency. Nevertheless, the output of a linear regulator has the advantage of being low-noise and spur-free, a desirable feature for the sensitive Analog/RF components of any system.

On the other hand, a switching regulator produces the same power supply but by controlling the period of time at which the power transistor is turned “on” during a fixed clock period. The bursts of energy resulting from this switching process are stored into energy storing elements, i.e. capacitors and inductors, which are then used to provide energy to the load when the power transistor is turned “off”. By controlling the “on” period of the power transistor using a negative feedback loop, an average DC voltage at the desired level can be produced at the output. In this manner, power is delivered at the exact levels needed by the load without wasting the excess energy across the power transistor. The efficiency can theoretically reach 100%, but is typically less due to nonidealities associated with the power transistors and the energy storing elements. Nevertheless, efficiencies in the range of 85% to 95% are commonly achieved. The major disadvantage of switching regulators is that their output, due to switching, contains voltage ripples with a frequency spectrum that contains concentrated energy at the switching frequency and its harmonics, i.e. spurs. These spurs interfere with the Analog/RF circuitry and significantly degrade their performance, which is driving the industry to using linear regulators instead, and accepting the loss of precious battery life due to their inefficiency.

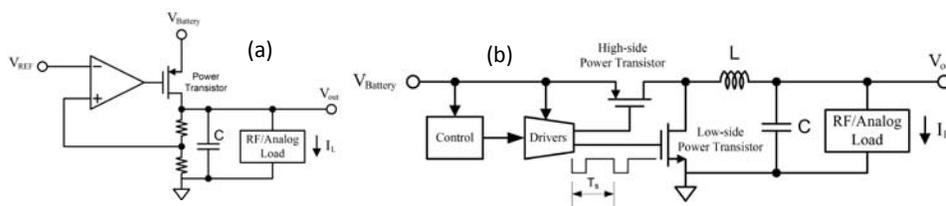
**Technical Objective and Probability of Success:** This proposal focuses on developing innovative control techniques that manipulate the switching behavior of switching regulators in order to redistribute the energy of their output voltage ripples across a very wide, and most importantly, a continuous frequency range, i.e. whiten the ripple spectrum. Since noise with a “white” spectrum has much less impact on the performance of sensitive Analog/RF circuitry than “spurious” switching noise, whitening the ripple spectrum will allow the use of switching regulators instead of linear regulators to directly power these sensitive parts of the system. With the Analog/RF parts consuming most of the system power, the efficiency improvement achieved is expected to **reduce the total power consumption by half, or doubling the battery life.** Alternatively, the efficiency improvement can be used to **cut the number of batteries in the system by half, i.e. cutting device weight.** The proposed control schemes are based on spread-spectrum and random clocking techniques, which had been proven successful in the areas of wireless communications and data conversion, but rarely explored beyond these two areas. Employing these techniques in the field of switching regulators is very promising. To the best of the author’s knowledge, using these techniques in switching regulators would be a first in the industry.

**ISU Research & Funding Opportunities:** Battery life is one of the most critical parameters in determining the viability of any battery-operated system, whether it is a cellular phone for personal communications, or an implantable device for medical applications, or a navigation device for a soldier in the field. For a long time, the room for reducing the power consumption of portable systems was very wide, and therefore, the focus of the industry in the past ten years has always been to tackle the battery life question by simply reducing the power consumption of the system. Thus, using more efficient power conversion techniques and studying their impact on the system performance had taken a back seat role with very little research done. Investing in reducing the power consumption of the system, both in industry and academia, has certainly paid off in terms of the development of new low-power circuit/system design techniques, along with a drastic scaling of silicon fabrication technology that allowed extremely low-power implementations. However, with the maturity of low-power electronics, the path of reducing power consumption is yielding diminishing returns, and reinvestigating the currently used power conversion schemes is becoming inevitable for further improvement in battery life. However, with this shift in focus, the industry is facing a difficult compatibility challenge: *The performance of existing systems significantly degrades when using more efficient power conversion techniques such as switching regulators* for the reasons previously outlined, and with the lack of enough research in the topic, the industry is forced to continue using the same energy inefficient schemes, namely linear regulators, in order to maintain system performance. Nevertheless, the demand is mounting in the market place (consumer, military, and biomedical) for resolving this compatibility challenge as it is a key hurdle in the path of lower power consumption and longer battery life. Thus, conducting the proposed research presents ISU with a unique opportunity to establish itself as a pioneer in the field of efficient power conversion for Analog/RF systems; a field that is in a heavy industrial demand but has not yet been adequately addressed in research institutions. This will certainly attract future funding from commercial/government entities. In fact, collaboration with Rockwell Collins, has just resulted in the submission of a joint proposal in response to a recent BAA from the Dept. of the Navy (N0017810Q1911) targeting multiple aspects of this field.

**Research Plan and Commercialization/Collaboration with Rockwell Collins, Inc. (RCI):**

RCI is a major Iowa-based corporation heavily involved in the design and manufacturing of electronic systems for both commercial and government customers. While RCI is not a power management IC company, *power management ICs are in the heart of all their products*. A common approach for system integrators such as RCI is to subcontract IC manufacturing houses to fabricate ICs that are customized for their products. Since the new IP generated by this research provides RCI with a key technological advantage over its competitors, collaboration during the course of the project has been agreed upon to ensure the integrate-ability of the new IP with RF/wireless end products. *Commercialization of the IP developed by ISU will be through licensing and subcontracting of IC manufacturing vendors for fabricating the resulting IP*. The project will require two Ph.D. students for 2 full years. In the first year we will focus on the system design including analyzing randomization techniques, modeling, and system simulation. In the second year, circuit design, simulation, fabrication, and testing will be conducted.

Fig. 1.  
(a) A Linear Regulator  
(b) A switching Regulator



### **Commercialization Plan:**

The factors that determine the commercial success of any idea are essentially need, cost, and market size. Power conversion efficiency is very critical in all electronic systems even if they are not battery-operated, because of the direct relation between efficiency and the total power consumption. On the other hand, in battery-operated applications, where an extra half an hour of battery life, or a slight decrease in battery count, greatly differentiate one manufacturer from another, battery life is ultimately determined by power conversion efficiency. Moreover, in remotely-deployed systems, where access to traditional power sources to charge the battery is very limited, battery life is not merely a differentiation factor between manufacturers, but rather a deciding factor on the feasibility of the application itself. The previous arguments clearly establish the “need” for better power conversion efficiency, yet satisfying that “need” is not only technologically challenging, but also economically challenging. An extra \$20 in the device cost for longer battery life might be acceptable, but unlikely to be economically worthwhile if it is \$200. Thus, higher efficiency combined with cost-effectiveness is the key to commercial success. The proposed IP simultaneously addresses both aspects by enabling the use of more energy-efficient power conversion circuits with *no cost overhead*. This is accomplished by relying on digital control techniques that constitute a minimal incremental cost, instead of adding extra expensive components to the system. Thus, the success of the IP in the market place will be highly probable.

RCI has established itself as a major player in the market of large non-portable electronic systems used mainly in commercial/military communications, navigation, and avionics. Since these large systems contain very power-demanding Analog/RF components, this project will enable significant reduction in the power consumption of these systems without compromising performance or increasing cost, which will be a great advantage for RCI over competitors such as Lockheed Martin and Raytheon. Moreover, RCI's share in the rapidly growing handheld and wearable electronics for dismounted soldiers and first responder market is crucial to the company's growth. This includes applications such as self-sustaining battle field devices, Helmut Mounted Displays, Night Vision Goggles, and Dynamic Image Gun-sight Optical systems. With battery life in the center of these applications, the IP developed by ISU during this project will put RCI steps ahead of the competition, leading to a potentially significant increase in its share in this market. In collaboration with university partners and various government agencies, RCI has demonstrated its commitment to research and its willingness to support and adopt new advancements in the electronics industry, which has fueled significant growth in its sales and market share. In fact, sales grew from under \$2B in 2001 to \$4.47B in 2010 with at least 5000-6000 new employment opportunities within the State of Iowa. While it is difficult to quantify the exact market share increase and the number of new employment that this particular IP will produce, it is the PI's and RCI's belief that any impact in this market niche will translate to a significant contribution to revenue and potential new jobs in Cedar Rapids and many other State of Iowa communities.

While the short term commercialization is through RCI, it is important to highlight that this new IP would be of a great interest to many power management IC companies such as Texas Instruments and Linear Technology, as well as system integrators in the portable consumer electronics market, such as Nokia and Apple, since battery life is crucial in these products. The initial commercialization by RCI will establish a high level of credibility to the IPs developed by ISU and provide a unique opportunity to expose our research to the market place. As of 2008, the market size of portable electronics exceeded \$5B, and projected to grow to \$7B by 2012. With such a large market, *the long term prospects of the commercialization of this IP could be very significant.*

**Budget (Total for two Academic Years):**

Category	Amount Requested	ISU Cost-Share	Rockwell Cost-Share	Total
Salary	\$64,209.82	\$52,535.30		\$116,745.12
Fringe Benefits	\$13,411.60	\$10,973.13		\$24,384.72
Tuition	\$17,823.30	\$14,582.70		\$32,406.00
<b>Personnel Sub-total</b>	<b>\$95,444.71</b>	<b>\$78,091.13</b>		<b>\$173,535.84</b>
Equipment	\$13,000.00			\$13,000.00
Materials & Supplies	\$4,000.00			\$4,000.00
Travel	\$5,500.00			\$5,500.00
Rockwell Collins Cash Support			\$20,000.00	\$20,000.00
Rockwell Collins In-kind Support: Consultation, Technical Support, Design Reviews, and Commercialization			\$20,000.00	\$20,000.00
<b>Total</b>	<b>\$117,944.71</b>	<b>\$78,091.13</b>	<b>\$40,000.00</b>	<b>\$236,035.84</b>

**Budget Justification (Total for two Academic Years):**

Salaries: One half-time and one quarter-time PhD graduate research assistants will assist in conducting this research, 12 months each year for 2 years. Ayman Fayed, PI, 0.75 academic months and 0.75 summer months each year for 2 years for research time, grant coordination, and management. Half of all cost will be contributed by ISU and Rockwell Collins cost-share. A 4% salary increase is accounted for in the second year.

Fringe Benefit: Fringe benefits at 13.2% for graduate research assistants and 28.2% for faculty.

Tuition: Tuition has been included to cover the in-state tuition benefits at Iowa State University. ISU policy requires a 100% tuition scholarship for all qualifying PhD seeking students and 50% tuition scholarship for all qualifying MS seeking students. For this proposal, tuition for 12 months for 2 years has been applied for the PhD students who will be assigned to this project.

Equipment: This includes testchips fabrication and packaging, in addition to printed-circuit-board design and fabrication for lab testing of the resulting circuits.

Materials & Supplies: This includes the purchase of PCs, Linux machines, and software licenses necessary for the graduate research assistants to conduct this research.

Travel: Travel expenses are requested each year for the investigators to attend design review meetings with the industrial sponsor, travel expenses and registration fees for attending conferences, and presenting publications (both foreign and domestic).

Rockwell Collins Cash Support: \$20K cash support provided by Rockwell Collins towards supporting the different phases of the proposed research.

Rockwell Collins In-kind Support: Consultation, Technical Support, Design Reviews, and Commercialization: \$20K in-kind support provided by Rockwell Collins that include the assignment of one Principal Engineer for a total of 1 month distributed over 2 years period to assist with the design, layout, reviews, verification, and lab measurements. He will also assist with the commercialization of the newly generated IP through licensing and subcontracting IC manufacturing vendors for chip fabrication towards the integration of the IP in end products.



**Haluk Sasmazer**  
Principal Engineering  
Manager

Government Systems  
855 35th. Street NE  
Cedar Rapids, IA 52498  
319.295. 2597 Fax 319.295.5742  
hsasmaze@rockwellcollins.com

May 24, 2010

Attention: Office of the Vice President for Research and Economic Development.

Iowa State University  
2117 Coover Hall  
Ames, Iowa 50011

Subject: Letter of Support for Grow Iowa Values Fund (GIVF) Grant program

Dear Madame/Sir:

On behalf of Rockwell Collins, Inc. I am pleased to submit this letter of support for the research efforts being proposed by Dr. Ayman A. Fayed and his staff from the ISU Electrical and Computer Engineering Department. Rockwell Collins, Inc., headquartered in Cedar Rapids, Iowa, is a \$4.47 billion company (FY09 sales) with a 75-year history of excellence in providing avionics and communications products and systems solutions to the global marketplace.

When successfully implemented, the proposed research effort will play a major role in improving the performance and marketability of many portable and handheld electronic products and systems developed by Rockwell Collins, Inc., both for commercial and government customers. In order to improve battery life and reduce power consumption in our products, a very important challenge is implementing more efficient power conversion techniques without impacting other performance parameters in our systems. During a recent visit by Rockwell Collins engineering managers to ISU, Dr. Ayman A. Fayed presented us with a project concept, outlined in this proposal, which addresses this need using very elegant and novel techniques.

Since this research topic is of a special importance to our business, Rockwell Collins has agreed to provide approximately \$40,000 of support (\$20,000 cash and logistical and consultation assistance valued at \$20,000) towards the successful execution of this project. Logistical and consultation support will be provided via the assignment of one of our Principal Engineers for a total of one month, or 160 hours, distributed over a two-year period, beginning August 15, 2010 and continuing through July 11, 2012. Consultant support is intended to provide Dr. Fayed and his research group with the technical assistance related to the design itself, as well as all the special considerations and requirements necessary for achieving our ultimate goal of a viable implementation in a high-volume industrial/commercial environment. Upon completion of this period, Rockwell Collins will supply Iowa State University with a letter confirming realized participation of the Rockwell Collins engineer.

The involvement of our principal engineer, combined with the strong industrial background of Dr. Fayed, will be crucial to the success of this project and will greatly facilitate the future integration of the proposed concept in many of our products. We believe that this effort will serve as a foundation for further research collaboration between Rockwell Collins, Inc. and ISU, as well as resulting in better design methods that will help differentiating our products from the competition leading to potentially larger market shares, improved profitability, and employment expansion within the state of Iowa.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Haluk Sasmazer". The signature is fluid and cursive, with a long, sweeping underline.

Mr. Haluk Sasmazer  
Principal Engineering Manager  
External Technology Pursuits



**Rhonda Edwards**  
Sr. Contract Manager  
Government Systems



400 Collins Road NE  
Cedar Rapids, IA 52498  
319.295.9224 Fax 319.295.4784  
rbedward@rockwellcollins.com

25 May 2010

In reply refer to RBE2010\_0507

Iowa State University  
Department for Electrical and Computer Engineering  
2117 Coover Hall  
Ames, Iowa 50011

Attn: Professor Ayman Fayed, PhD

Dear Dr. Fayed:

Rockwell Collins is pleased to provide this letter indicating our support of your research in the area of improved battery life and reduced power consumption.

We are most interested in this research and the potential commercialization of the resultant technology.

We look forward to providing cash and logistical and consultation assistance as defined in the document and we look forward to your success.

Best regards,

Rhonda Edwards  
Sr. Contracts Manager  
Rockwell Collins Government Systems

Enclosure

## **Commercialization of an integrated, single molecule Atomic Force Microscope-Fluorescence Microscope for academic and industrial applications.**

**PI:** Dr. Sanjeevi Sivasankar, Assistant Professor, Department of Physics and Astronomy, Iowa State University, Ames, IA. (515) 294-1220, sivasank@iastate.edu

**Company Partner:** Novascan Technologies Inc.; 10-15 employees; 11 years in Business; Sales figures confidential. *Contact Person:* Dr. Raj Lartius, 131 Main St., Ames, IA. (515) 233-5400, rlartius@novascan.com

### **Executive Summary**

The objective of this proposal is to build a highly integrated and modular single molecule Atomic Force Microscope-Fluorescence Microscope (smAFM-FM) for academic and industrial applications. The study of single molecules and their interaction with receptors, toxins, and pharmaceuticals has become a powerful tool in biomedical research, drug discovery, cancer diagnostics and ultra sensitive bio-sensing applications. Two of the most commonly used techniques to study single molecules are Atomic Force Microscopy (AFM) and Fluorescence Microscopy (FM). However, these techniques have serious limitations that can only be overcome using a simultaneous single molecule AFM-Fluorescence Microscope (smAFM-FM) approach.

Recently, in collaboration with Dr. Steven Chu (Nobel Laureate and current Secretary of Energy), the PI built an integrated smAFM-FM to simultaneously manipulate and detect single biological molecules<sup>1</sup>. Over the past year, the PI's laboratory has significantly refined this instrument by increasing its measurement capabilities, efficiency, bandwidth, and ease of use. However the equipment is still in the breadboard state, occupying some 50 square feet of valuable laboratory space, which does not lend itself to commercial viability. The objectives of this proposal are twofold, (i) perform proof of concept experiments that demonstrate the capabilities of the smAFM-FM technique and (ii) collaborate with Novascan Technologies, an Ames based company, to develop smAFM-FM into a compact turnkey device utilizing Novascan's VERTIGO single molecule AFM platform that is being released this summer.

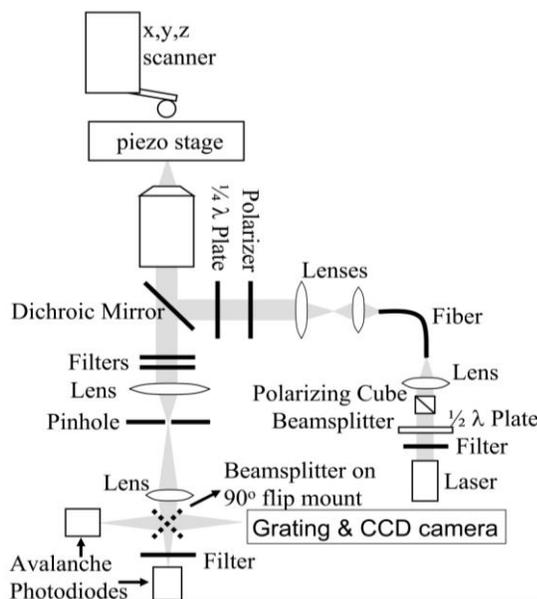
Market research from Novascan suggests that there is currently an untapped market for integrated Optical-AFM force measurement systems. Based on market share and revenues of publicly traded companies, the total AFM market is estimated to be in the range of \$100 million per year and the optical imaging/spectroscopy market is estimated to be \$10 billion a year. Any new technology that is successful in penetrating this market must be novel, compact, easy to use and easily manufactured, allowing for competitive pricing at an acceptable margin. Our proposed smAFM-FM will be state of the art, user friendly and will have a reduced manufacturing cost. Furthermore, we project that the instrument will have price points that are in line with current technologies in the research grade scanning probe and optical microscope markets.

To develop smAFM-FM in a commercially viable fashion, we will meet specific milestones. In the first six months of funding, we will do proof of principle experiments that validate our approach. The next year will be devoted to building a prototype instrument around the VERTIGO platform. We will publish our research in peer reviewed journals to demonstrate the instrument capabilities to the scientific community, which will be essential for successfully marketing the instrument in the future. In addition, we will seek funding through the SBIR program for development of future instrument modules.

The PI has extensive experience in developing single molecule technologies<sup>1,2,3,4,5,6,7</sup> and has inventions that have been patented by Stanford University<sup>7</sup> and by the University of California at Berkeley<sup>4</sup>. The PI has a track-record of successful partnership with industry having previously consulted for Molecular Imaging and for Cisco Systems. Novascan Technologies has 11 years of experience and a proven track record in development and commercialization of cutting-edge AFM and optical microscopes, and has successfully landed significant SBIR funding.

### Technical Objectives

**Background:** The focus of this project is to develop an integrated single molecule Atomic Force Microscope-Fluorescence Microscope (smAFM-FM) for biomedical research, drug discovery, disease diagnosis, and ultra sensitive bio-sensing applications. Single molecule fluorescence, particularly Fluorescence Resonance Energy Transfer (FRET), and single molecule force measurements with the Atomic Force Microscope (AFM) are two powerful techniques that are widely used to study single molecules and their interaction with receptors, toxins, and pharmaceuticals. Single molecule FRET can report on the structure and dynamics of biomolecules while AFM can be used to manipulate molecules and measure their interactions. However each of these techniques suffers from limitations that can be overcome using a combined smAFM-FM approach. For example, with a stand-alone AFM it is difficult to determine the structural changes in biological molecules as they interact. These can however be identified by attaching fluorescent probes to the molecules and monitoring their structure and dynamics using FRET.



**Figure 1.** Schematic of smAFM-FM

In collaboration with Dr. Steven Chu, the PI recently built the first smAFM-FM instrument to apply forces on individual biological molecules and simultaneously monitor their structure and dynamics<sup>1</sup>. Within the past year, my group has significantly enhanced this microscope by increasing its capabilities, efficiency, bandwidth, and ease of use. However, we still need proof of concept experiments that demonstrate the capabilities of the smAFM-FM approach. Furthermore, the instrument is still in the breadboard state occupying 50 square feet of laboratory space and needs to be re-engineered in more user friendly fashion to make it commercially viable.

The objectives of this proposal are twofold: (i) perform proof of principle experiments that will demonstrate the capabilities of smAFM-FM and (ii) collaborate with Novascan Technologies of Ames, Iowa to develop this instrument into a compact turnkey device utilizing Novascan's existing AFM platform and their design, device integration and commercialization knowledge. We will perform proof of concept experiments in the initial 6 months of funding and file an invention disclosure with the Technology Transfer Office at ISU. Novascan will plan to negotiate licenses with ISU on patentable technologies relevant to a commercial instrument design. In the subsequent 12 months, we will re-engineer this microscope around Novascan's VERTIGO single molecule AFM platform, as a user-friendly turnkey instrument. Novascan Technologies has 11 years of experience in the design, integration and commercialization of cutting-edge AFM instrumentation. The PI has extensive experience in developing single molecule technologies<sup>1,2,3,4,5,6,7</sup> and has multiple patents<sup>4,7</sup>.

A schematic of our smAFM-FM is shown in Figure 1. A tip scanning AFM is mounted on a sample scanning confocal microscope. Macromolecules (for e.g. biological receptors) labeled with a donor fluorophore are bound to a substrate while their binding partners (i.e. ligand) labeled with acceptor dyes are immobilized on an AFM-tip. The substrate is raster scanned to image individual donor labeled receptors and locate them under the AFM tip. The tip and substrate are brought into contact so that receptor and ligand bind; and then withdrawn to rupture the receptor-ligand complex and measure its bond strength with 1pN resolution. Simultaneously, donor and acceptor fluorescence is measured with single photon counting avalanche photodiodes

to determine FRET in real time. The FRET time traces indicate changes in the structure of the bound biomolecules with 1nm resolution and the dynamics of unbinding with 1ms time resolution.

**Proposed proof of principle experiment:** To validate the smAFM-FM technique, we will measure the force induced shearing of dye-labeled, double stranded DNA. The DNA will be sheared into its complementary single strands and mechanical transitions corresponding to DNA rupture will be correlated with changes in FRET. This experiment will showcase smAFM-FM's capabilities to simultaneously measure the interaction of single biomolecules with pN force resolution, their structure with nm distance resolution, and dynamics with ms time resolution. Similar experiments will be used in generating future sales and marketing material.

**Proposed instrument design:** While the proposed instrument will have a similar optical scheme as Figure 1, we plan to incorporate very significant refinements. The proposed instrument will be integrated with Novascan's Vertigo AFM platform and will be more user friendly with a smaller footprint. A pulsed laser will be used to measure single molecule fluorescence and FRET lifetimes and perform antibunching measurements. Additionally, the fluorescence will be dispersed using a grating onto a CCD camera to obtain single molecule fluorescence spectra. These changes in the optical setup will enable multiple plug-and-play single molecule modules to be incorporated into the instrument including (i) AFM-FRET intensity and lifetime measurements, (ii) AFM-fluorescence intensity and spectral measurements, (iii) AFM-photon antibunching experiments, (iv) AFM-Raman measurements, (v) Near Field Scanning Optical microscopy (NSOM) and (vi) stand-alone AFM, Fluorescence, FRET and Raman spectroscopy.

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6. Zhang, Y., Sivasankar, S., Nelson, W.J., Chu, S., (2009), **Proc. Natl. Acad. Sci.**, 106, 109.
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#### Commercialization Plan

There are no comparable single-molecule technologies currently available in the market. AFM-Optical microscopes from companies such as Agilent, Veeco, and Asylum have limited sensitivity and resolution and utilize partially-integrated approaches to combining AFM with fluorescence capabilities. Namely, optical microscopes are purchased from companies such as Nikon/Olympus/Zeiss and an AFM is mechanically attached to the optical microscope sample stage. Other than that, the instruments remain largely separated in terms of scanning mechanisms, electronics and computer control interfaces, etc.

Novascan has identified that a more integrated approach is key to improving performance and reducing the extremely high cost of production. Novascan sees a great opportunity for growth by pursuing this untapped AFM market in the areas of optical imaging and spectroscopy using highly integrated AFM-Fluorescence systems. Currently the total AFM market is estimated to be in the range of \$100 million per year. (This figure is based on the market share and revenue of publicly traded companies such as Veeco Instruments, 2007). The optical imaging/spectroscopy market has been identified as a \$10 billion opportunity with the need for higher resolution techniques that could be filled by the smAFM-FM method described in this proposal.

Successful penetration into this market will rely strongly on aggressive price points as well as perceived instrumentation "ease of use". Current instruments are far too expensive and require

extensive training for use and data interpretation. For example, typical costs for common combined AFM optical instruments are

AFM Fluorescence system	~\$150-250K
AFM Raman system	~\$250-350K
AFM Spectral Confocal system	~\$400-700K

These high prices have largely limited sales to university wide facilities as opposed to individual laboratories. Novascan believes that the integrated approach, described in this proposal, is key to reducing cost while maintaining margin. Reduced cost could also lead to increased instrument production volume and more optimized mass production techniques. To be widely adopted, new technologies for the microscopy industry must also be easy to use and require less training. For example, industrial users evaluate instruments based not only on price, but also on performance, time and reliability since these factors are critical to profitability. Biological users can only embrace the technology if it is less complicated particularly in fluids. Instrument users, in general, tend to use systems more sporadically than in the past, depending on their project needs. These users require a very intuitive user-interface to minimize frequent re-training. Our proposed smAFM-FM will be state of the art, compact, user friendly and will have a reduced manufacturing cost. Furthermore, we project that the instrument will have price points that are in line with current technologies in the research grade scanning probe and optical microscope markets.

Another critical factor is the availability of government funding to make purchases. Fortunately, improvements in federal funding via the American Recover and Reinvestment Act (ARRA) make this a good time to introduce new technologies. For example, ARRA provides the National Science Foundation (NSF) with an additional \$300M specifically earmarked for research instrumentation. Other industrialized countries have also introduced similar spending programs.

**Time line for Commercialization:** The success of this project will require meeting specific milestones in order to produce products in a commercially viable and timely fashion. In the first six months of funding, we will do proof of principle experiments that validate the smAFM-FM approach. The PI will file an invention disclosure with the Office of Intellectual Property and Technology Transfer at ISU. Novascan will negotiate licenses with ISU on patentable technologies relevant to a commercial instrument design. The next year will be devoted to building a user-friendly integrated instrument with a reduced footprint around Novascan's VERTIGO AFM platform. We will publish our research in peer reviewed journals to demonstrate the instrument capabilities to the scientific community. This will be essential for successfully marketing the instrument in the future. In addition, we will seek funding through the SBIR program for subsequent work that will focus on the development of future instrument modules including Raman spectroscopy, FRET life-time measurements, fluorescence spectroscopy, photon anti-bunching, NSOM etc. During Year 2 we will begin marketing and selling the instrument through Novascan's established channels, adding optional modules as they come on line.

Timetable			
Tasks	Phase I (6 months)	Phase II (6 months)	Phase III (6 months)
Validation of smAFM-FM approach			
Building integrated single molecule instrument around Novascan's VERTIGO AFM platform			
Application for SBIR funding to incorporate additional instrument modules			

**Budget**

<b>Category</b>	<b>Amt requested</b>	<b>ISU Cost-Share</b>	<b>Novascan Cost-Share</b>	<b>Total</b>
<b>Salaries (budgeted for 18 months)</b>				
PI (15% commitment for 15 months)		\$17,000		\$86,167
PI Summer (salary for 3 months)	\$22,667			
Postdoc (33% commitment for 18 months)		\$19,800		
1 Graduate Student	\$26,700			
<b>Benefits</b>				
PI (15 months) @ 27.20%		\$4,624		\$18,867
PI Summer @ 27.20%	\$6,165			
Postdoc (18 months) @ 23%		\$4,554		
1 Graduate Student @ 13.20%	\$3,524			
<b>Tuition (budgeted for 18 months)</b>	\$14,699			\$14,699
<b>Personnel Subtotal</b>	<b>\$73,755</b>	<b>\$45,978</b>		<b>\$119,733</b>
<b>Equipment</b>	<b>\$38,000</b>	<b>\$100,000</b>	<b>\$105,000</b>	<b>\$243,000</b>
<b>Other Supplies and Services</b>	<b>\$8,320</b>	<b>\$7,680</b>	<b>\$25,000</b>	<b>\$41,000</b>
<b>Total</b>	<b>\$120,075</b>	<b>\$153,658</b>	<b>\$130,000</b>	<b>\$403,733</b>

**Equipment requested from GIVF:** Back-illuminated ultra-low-noise EMCCD camera: \$38,000

**Equipment from ISU Cost-Share:** Leasing of optical equipment for 1000 hours at \$100 per hour. Equipment includes High-Speed closed loop piezo stage and controller, Inverted microscope, Two Silicon Avalanche Photodiode based Single Photon Counting Modules, Two electronic fast shutters and controllers, Green (532nm) laser, Red (650nm) laser, Optical Table, Relay Optics and Optomechanics, Various excitation and emission fluorescence filters, Oil immersion 60x (1.4NA) objective lens, Ratemeter, Spectrum analyzer, Digital Optical Power Meter, Spectrum analyzer, Miscellaneous electronics.

**Novascan Cost-Share:** Leasing Atomic Force Microscope for 700 hours at \$150 per hour.

**Other Supplies and Services requested from GIVF:** 104 hours of Machining and Mechanical Design services from Machine shop at \$80 per hour: \$8,320

**Other Supplies and Services from ISU Cost-Share:** 96 hours of Machining and Mechanical Design services from Machine shop at \$80 per hour: \$7,680

**Supplies and Services from Novascan Cost-Share:** Engineering & Programming support for 200 hours at \$125 per hour.



Novascan Technologies, Inc.  
Novascan Research Building  
131 Main Street  
Ames, Iowa USA 50010  
Telephone: 515-233-5400  
Fax: 515-233-5151

May 28, 2010

Sanjeevi Sivasankar  
Assistant Professor  
Department of Physics & Astronomy  
Iowa State University, Ames, IA 50011

Dear Dr. Sivasankar:

Novascan is very pleased to collaborate with you in the development of a novel, commercially viable AFM optical based instrument for high resolution single molecule applications. We are confident that this state of the art technology will be particularly attractive to cutting edge academic and corporate groups who are involved in important applications such as new drug discovery, cancer research, toxin screening, etc..

In addition this technology is an excellent compliment to Novascan's new VERTIGO single molecule series of instrumentation that will be introduced later this summer. In support of the project, Novascan can offer in-kind support including a 2 year no cost lease of single molecule AFM instrumentation, as well as hardware, software, and probe chemistry expertise.

Sincerely,

A handwritten signature in blue ink that reads "Raj".

Dr. Raj Lartius

RKL/gr

## Market Research for Prioritizing Market Segments for Product Development and Marketing

**PI:** Diane Janvrin, Accounting., 515-294-9450, [djanvrin@iastate.edu](mailto:djanvrin@iastate.edu)

**Co-PI:** Mike Upah, ISU Pappajohn Center, 515.294.7828, [mjupah@iastate.edu](mailto:mjupah@iastate.edu)

**Company:** WebFilings, Marty Vanderploeg, COO, [marty@mvanderploeg.com](mailto:marty@mvanderploeg.com),

### EXECUTIVE SUMMARY

**Business:** Cloud-based software for compiling complicated reports

**Problem:** SEC (Security & Exchange Commission) reports are difficult to compile because **i)** they are compiled by multiple-individuals who do not have appropriate tools for version control or auditing for changes; **ii)** the report uses the same data in multiple places within the report but with no automated method for coordinating or updating; **iii)** they involve integrating spreadsheet tables into word processors which is a notoriously difficult scenario in which to manage formatting; and **iv)** timelines must include artificial internal deadlines due to “end-game crunch” issues caused by issues such as final review, data tagging, and 3<sup>rd</sup> party publishing.

**Solution:** WebFilings, an Iowa based startup, has developed and begun selling a cloud-based software application that solves all of the previously stated problems. In addition, the cloud-based, subscription model is ideal for providing service to report contributors that are geographically dispersed and eliminates enterprise installation complexities.

The need for the WebFilings application arose from a WebFilings founder’s recognition of the inadequacy of the status quo while serving as CFO of a public company. Significant due diligence (interviews with other public companies) revealed that no adequate solution existed and that no competitor offered near the breadth of function or a cloud-based distribution model that was envisioned by the founders. As a result, WebFilings was founded by an experienced management team that previously started and grew a software startup into a public company (Engineering Animation, Inc.).

There are two key market trends of importance for WebFilings:

1. Reporting, and especially financial reporting, is becoming more complex and onerous
2. Cloud-computer is a maturing technology which enterprise-scale customers recognize as secure, reliable and advantageous to traditional software distribution models.

The SEC reporting market segment for the WebFilings application is large and is estimated at over \$1B in the top five global markets.

WebFilings is beginning to gain substantial traction in the SEC reporting market segment, but a significant challenge for the company is prioritizing additional market segments for product development and sales. This issue is particularly challenging due to the breadth of potential applications for the WebFilings software.

This proposal is for a project which will utilize ISU faculty, staff and students to provide a market research project that will be performed in four phases: **1)** a broad look for market segments which should be of interest to WebFilings; **2)** a narrowing of the fields through additional research; **3)** in-depth research on a particular market segment of interest; and **4)** validation of the market segment via sales activities at trade event(s).

## The Project

**Scope of Work:** The market research project will provide WebFilings management with a broad understanding of the “reporting” market on a global basis, and an in-depth understanding of a single market segment. The total project will be delivered in four objectives (phases).

### Objective #1: Broadly Identify Market Segments

Identify as many as twelve industry segments where significant and perpetual reporting requirements exist for regulators, customer, or stakeholders. Two SEC categories - public company and mutual fund reporting – are well understood and will not be included; however, any other SEC categories such as hedge fund reporting should be included.

Prevalent characteristics of attractive segments include:

- Reports are large and complex
- Collaboration is required across departments (e.g., legal and finance) and geography.
- Version control is useful or necessary due to simultaneous evolution of the document by multiple parties. Ability to audit reports for accountability is useful or necessary.

**Resources:** Two business graduate students

**Methodology:** Secondary and primary market research.

**Timeline:** 3 weeks

**Outcome:** Presentation of industry segments with cursory data indicating attractiveness of market segment.

### Objective #2: Perform Research to Prioritize a Single Market Segment

Present findings of Objective #1 to WebFilings managers to identify up to four segments for additional study. Determine a framework for market research needed to choose a single market segment for in-depth study (Objective #3).

**Resources:** Two business graduate students with assistance of 3 undergraduate students

**Methodology:** Secondary and primary market research

**Timeline:** 4 weeks

**Outcome:** Selection of a single market segment for in-depth study (Objective #3).

### Objective #3: In-depth Study of a Single Market Segment

Thorough analysis of a single market segment chosen by WebFilings management based on the data collected in Objectives #1 and #2.

**Resources:** Two business graduate students with assistance of 6 undergraduate students

**Methodology:** Primary market research

**Timeline:** 6 weeks

**Outcome:** Final report including: Market Size with listing of participants as available; Interviews with industry to determine common best practices currently in use including common third-party consultants (by name if possible when a third party such as Grant Thornton is commonly used) and key contacts at

such consultants if available; Software commonly used in report generation such as Excel, Word, other or proprietary methods; Submission methods (electronic, paper, web, etc.), estimated ratio of in-house preparation vs. the use of 3<sup>rd</sup> party consultants; key contacts at leading prospective customers as available; regulator(s) that reports are submitted to including report timing and report requirements.

**Objective #4: Validation / Sales**

WebFilings professional staff will attend industry events identified in Objective #3 for the purpose of validation of the market and the creation of sales.

**Resources:** WebFilings staff for pre-event planning, pre-event sales activities, event demonstration and follow-up. Student resources utilized in Objectives #1 through #3 will potentially be involved in these activities.

**Methodology:** Public relations, marketing, and direct sales

**Timeline:** 6 weeks

**Outcome:** Lead generation and sales.

**Project Analysis:**

This project is substantially different than traditional GIVF funded projects which focus on technical aspects of product development. The proposed project will allow ISU to aid companies further along the development timeline and allow access to significant ISU expertise and resources at a time when typical company resources (as is the case for WebFilings) are focused on scaling and supporting customers in the original vertical market and where little resource is left-over for prioritizing the remaining market segments. In this regard ISU's involvement has the potential to minimize internal subjective opinions of market priorities by providing objective and professional market evaluation. We believe that this type of project could provide significant benefit to many ISU related startups, help those startups build relationships with college of business faculty and students, and could be considered a pilot for future projects of this nature.

**Assessment of Technical and Commercial Risks:**

The commercial viability of the WebFilings application has already been demonstrated by the successful sale to more than a dozen public companies and also through formal evaluation by more than 100 additional public companies. This project is intended to accelerate the speed by which WebFilings can evaluate and enter additional market segments. Much evidence has been garnered by WebFilings staff members regarding additional potential markets – therefore a high degree of confidence exists that additional attractive markets exist.

**Economic Impact:**

In a relatively short time WebFilings has grown to greater than 50 employees and it is believed that the SEC market segment has the potential to create employment of over 200. It is believed that additional market segments will sustain existing development jobs and create new job creation of between 25 and 100 individuals per segment depending on size.

### **Future Funding:**

WebFilings future funding is likely to be provided by venture capital sources. These groups are very interested in a product development plan. ISU's ability to help WebFilings create and validate such a plan will be useful in convincing potential investors that the WebFilings product development strategy is well conceived.

### **ISU Perspective and Benefit:**

This project will have several important benefits to ISU.

- WebFilings was begun in 2008 and by 2010 already employs more than 50 individuals and has in a few short months of sales and marketing activity acquired more than a dozen high quality customers. The ability for the company to more quickly evaluate additional market segments will help keep the company out in front of potential competitors and diversify the company's customer base.
- WebFilings is an ISU Research Park company.
- ISU faculty will gain from interaction with industry. ISU students will gain from experiential learning and form relationships with industry for possible formal internships or eventual employment.
- ISU will benefit from a relationship with a company in the cutting-edge field of cloud-computing.

## Budget

	AMOUNT	ISU	INDUSTRY	
CATEGORY	REQUESTED	SHARE	COST SHARE	TOTAL
Salaries	10,000		26,640	36,640
Benefits	3,450			3,450
Graduate Student Stipends	8,320			8,320
Benefits	4,548			4,548
Tuition	-			-
Undergraduates	6,912			6,912
<b>Personnel Sub-Total</b>	<b>33,230</b>			<b>59,870</b>
Equipment	2,000			2,000
Rent	1,800		10,000	11,800
Phone / Internet	1,560			1,560
Lab Supplies				-
Field Supplies				-
Other Spplies & Service			1,000	1,000
Travel			3,000	3,000
Marketing			8,000	8,000
Miscellaneous	2,000			2,000
<b>Total</b>	<b>40,590</b>		<b>48,640</b>	<b>89,230</b>

**Industry Cost-Share:** The ultimate goal of this project is accelerated sales in a new vertical market. To achieve this WebFilings's cost share is based on significant sales effort which will logically be centered around a significant industry conference or trade show event. It is assumed that the existing team of five sales people will spend a minimum of a week's worth of effort making contact and recruiting sales demonstrations at the event, along with significant PR and marketing work. The effort involved along with attendance expenses are based on WebFilings experience in attending similar events.

Industry Cost Share		
PR	20	hours
Sales Effort	200	hours
At event	24	hours
Post Event	200	hours
	444	total hours
	\$ 60.00	Hourly rate
	26,640	
Booth	10,000	
Travel	3,000	
Shipping	1,000	
Advertising / Sponsorships	8,000	
	48,640	



June 2, 2010

Dr. Diane Janvrin  
Accounting Department, College of Business  
3365 Gerdin Business Building  
Iowa State University  
Ames, IA 50011-1350

Dear Dr. Janvrin:

WebFilings' supports your grant application under the GIVF for the *Market Research for Prioritizing Market Segments for Product Development and Marketing* project.

The data resulting from this project will provide WebFilings with a substantial understanding of the key target market segments for product development. This knowledge will help us to prioritize our product development and marketing efforts.

Currently, WebFilings has not allocated any resources to deploy a market research project and welcomes the opportunity for Iowa State University to complete this project. WebFilings' resources are being utilized for scalability and sales efforts for its primary product which was released to the market in March 2010.

I look forward to your project being completed.

Sincerely,

A handwritten signature in cursive script that reads "Martin Vanderploeg".

Martin J. Vanderploeg  
Managing Director

## Proposal for “Grow Iowa Values Fund” Grants Competition, Spring 2010

**Project Title:** “*AdvanCEs* in Food Safety: Fast Fragment Analysis for Differentiation and Tracking of Foodborne Pathogens”

**Project Period:** August 1<sup>st</sup>, 2010 – February 1<sup>st</sup>, 2012 (1.5 years)

**PI:** Byron Brehm-Stecher, Food Science & Human Nutrition, 2312 Food Sciences Building, [byron@iastate.edu](mailto:byron@iastate.edu)

**Company Partners:** Advanced Analytical, Inc., 2901 S. Loop Drive, Ames, IA 50010; Hy-Line International, 2583 240<sup>th</sup> Street, Dallas Center, IA 50063.

**EXECUTIVE SUMMARY:** Today’s food production and distribution networks are extremely efficient. We are able to move food from the field to the table rapidly and effectively - on a global scale - under conditions that maximize quality, visual appeal and nutritional content. Unfortunately, toxigenic or infectious microbes may also join along for the ride at any number of points along this farm-to-fork journey. As we have seen with recent incidents in the United States with *Salmonella* alone, contaminated ingredients provided to large food companies by relatively small niche players can wreak havoc throughout the food chain. Examples include the nut paste and other peanut products sold by the Peanut Corporation of America (2009), the crushed black pepper added to over 1 million pounds of processed meat (2010) or the hydrolyzed vegetable protein produced by one small Nevada firm (2010), all of which were recalled due to contamination with *Salmonella*. Because these materials were used as base ingredients in foods produced by many other firms, their contamination with *Salmonella* echoed disproportionately throughout the food chain, leading to *thousands* of product recalls, hundreds of illnesses and in some cases, death. Using patented technology licensed from Iowa State University (ISURF01604; Yeung et al., US 5,324,401; Yeung et al., US 5,498,324), Advanced Analytical has developed the *AdvanCE* FS96 system - an instrument capable of rapid, sensitive and highly reproducible resolution of complex pools of DNA fragments and equipped with sophisticated and integrated pattern recognition capabilities. This home-grown Iowan technology could have a transformative impact on agriculturally-important DNA analysis markets, allowing end users to not only quickly detect target pathogens, but also to characterize isolates and provide epidemiologically useful strain tracking or “fingerprinting” capabilities. This work could have far-reaching implications for farmers, food processors and veterinarians, as well as those involved in bio- or food defense. This project will facilitate collaborative work between Iowa State University, Advanced Analytical and major Iowan agri-processing companies such as Hy-Line International, and will yield key data demonstrating the utility and flexibility of the *AdvanCE* FS96 system for DNA fragment-based analyses critical for protecting Iowa’s core economic assets, such as the layer hen and egg production industries.

**Project Description:** Today's food production and distribution networks are extremely efficient. We are able to move food from the field to the table rapidly and effectively - on a global scale - under conditions that maximize quality, visual appeal and nutritional content. Unfortunately, toxigenic or infectious microbes may also join along for the ride at any number of points along this farm-to-fork journey. Recent major outbreaks or recalls due to *Salmonella* alone in foods include peanut butter (2007 and 2009), Jalapeño and Serrano peppers (2008), alfalfa sprouts (2009), black pepper (2010) and hydrolyzed vegetable protein (2010). Together, these incidents have led to several deaths, hundreds of illnesses and thousands of recalled products. Improved, more rapid methods for detecting *Salmonella* and other bacterial pathogens in complex foods, in bulk food ingredients or in environmental samples from food processing or animal handling facilities are needed *now* to ensure the safety of our food supply.

Capillary electrophoresis (CE) has long been a workhorse technology in analytical chemistry labs. CE provides rapid and efficient separations of biologically relevant molecules or compounds, can be used to analyze small sample volumes and typically requires minimal sample preparation. A key advantage of CE is its superior ability to separate complex pools of nucleic acid fragments that present distinct challenges to the gel-based electrophoresis systems that are most commonly used for DNA analysis. Recently, CE-based analyses have been used for genetic detection and/or characterization of pathogenic bacteria or other microorganisms. These approaches are many and include detection of "signature" single strand conformational polymorphisms (SSCPs) generated via PCR from bacterial 16S or 16S-23S spacer region rRNA, use of a combined PCR-ligase detection reaction-CE approach targeting bacterial 16S rRNA genes and multiplex mRNA transcript analysis of microbial cultures using CE-detectable oligonucleotide probe pools. Although CE has found wide application in analysis of nucleic acids, the approaches described in the literature typically involve specialized, task-dedicated instrumentation that lacks the flexibility needed to multiple assay types. A drawback of many molecular tests, including some of the CE-based methods described in the literature is that they are relatively complex and may involve repetitive steps, which can lead to operator fatigue and error. Fortunately, many of these assay types are amenable to automation. Benefits of assay automation include reduced labor, increased throughput, better reproducibility and faster time-to-results.

The *AdvanCE FS96* system from Advanced Analytical leverages ISU-based intellectual property to enable rapid, sensitive and highly reproducible analyses of DNA fragments, with sophisticated pattern recognition capabilities integrated via software. Unique characteristics of the FS96 include its ability to resolve dsDNA fragments as small as 3 base pairs, vastly improved sensitivity and reproducibility over traditional gel-based separations and an advanced software interface providing integrated pattern recognition and fragment analysis capabilities. **The FS96 is an open-ended system whose critical advantages may be applied to almost any assay requiring sensitive, high-resolution analysis of dsDNA fragments. Therefore, the proposed work has the potential for substantial and broad impact on DNA analysis markets.** We will work closely with our colleagues at Advanced Analytical and Hy-Line International to develop and validate DNA fragment-based methods for pathogen characterization, fingerprinting and tracking, ultimately applying these to the practical problems of pathogen ecology in layer hen production facilities. **The proposed research addresses the "Grow Iowa Values Fund" objectives to expand the commercialization of ISU technology, to help ISU technology reach the marketplace, to help the growth of existing Iowa companies, to develop collaborative research with companies having an Iowa presence, and to increase sales and/or profitability of Iowa companies through provision of new market opportunities.** Letters of support for this work, provided by Advanced Analytical, Hy-Line International and The Iowa Farm Bureau are attached.

## Summary of Technical Tasks

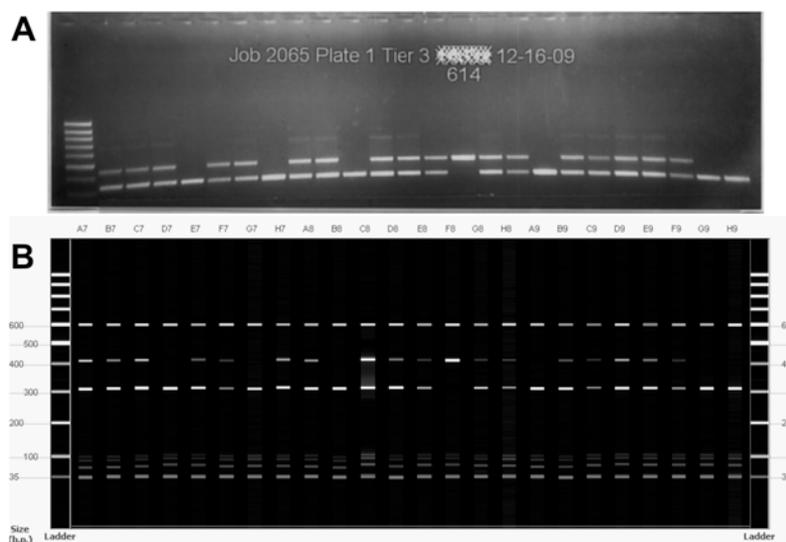
1. Compare existing methods for DNA fragment-based pathogen analysis using traditional gel or advanced CE methods. Comparisons will be made using a number of parameters, including detection sensitivity, number of detectable/resolvable fragments, method throughput, and method reproducibility and impact of automation. The predictive ability of pattern recognition software in determining identities of unknown samples will also be examined.
2. Apply the technology developed here to practical problems of pathogen ecology in facilities operated by a major Iowan producer of layer hens. Specific goals include definitive identification of environmental *Salmonella* isolates and testing of isolates from different locations within the producer's facilities for clonal relatedness.
3. Publish results in high-visibility peer-reviewed meeting abstracts and journal(s).

## Schedule (Technical Tasks)

Task	Year 1				Year 2	
	Q1	Q2	Q3	Q4	Q1	Q2
Task 1						
Task 2						
Task 3						

**Competitive Environment:** Over the past 15 years, a variety of DNA fragment-based methods for pathogen characterization, fingerprinting and tracking have been developed. These include Random Amplification of Polymorphic DNA (RAPD), Enterobacterial Repetitive Intergenic Consensus PCR (ERIC-PCR), Repetitive Extragenic Palindromic sequence PCR (rep-PCR) and others. One notable fragment-based method is Pulsed Field Gel Electrophoresis (PFGE), which is the “gold standard” used by state laboratories and the Centers for Disease Control and Prevention (CDC) for typing of bacterial pathogens involved in foodborne outbreaks. Regardless of exactly how complex populations of DNA fragments are generated from microbial DNA, the power of these typing or fingerprinting approaches cannot be fully realized without a reliable, reproducible and sensitive means for separating, detecting and analyzing the resultant fragment pools. Traditional gel-based

analysis, although commonly relied upon, has severe limitations and drawbacks. Advanced Analytical's *AdvanCE FS96* system, based on patented ISU technology, combines a series of reagent, hardware and software solutions for the rapid and highly reproducible separation of double-stranded DNA fragments. The FS96 is an open-ended system that may be applied to almost any assay that depends on advanced resolution and sensitive detection of dsDNA fragments. Figure 1 (right) provides a side-by-side comparison of traditional gel electrophoresis results (Panel A) with those obtained from the same sample using the FS96 platform (Panel B). It is clear from this example that traditional gel electrophoresis lacks the sensitivity to detect all bands present. Physical deformation of the gel (“smiling”) also caused apparent differences in fragment migration (Panel A). In contrast, the FS96 output enabled sensitive detection of multiple fragments, with reliable, repeatable and simultaneous characterization of



fragment size and DNA concentration (Panel B). There are 3 other CE-based systems that may also be used for dsDNA analysis. These include the Qiaxcel system from Qiagen, the Bioanalyzer from Agilent and the GXII by Caliper. The FS96 has distinct and sustainable competitive advantages over these systems in terms of fragment resolution, speed, ease of use, dynamic range, sample throughput, automation and/or sensitivity of detection.

**Anticipated Market:** The US market for DNA-based infectious disease testing is worth an estimated **\$1.1 billion** (<http://www.researchandmarkets.com>). Because the *AdvanCE* FS96 is an open-ended system whose critical advantages may be applied to almost any assay requiring sensitive, high-resolution analysis of dsDNA fragments, this platform has the potential for substantial penetration into and impact on DNA analysis markets in general. Expected markets include, but are not limited to: pathogen testing and tracking, analyses in support of plant and animal health or breeding, standards of identity testing for prevention of “food fraud” (e.g. lumpfish roe sold as beluga caviar, etc.), criminal forensics and paternity testing.

**Summary of Commercial Tasks**

1. Identify commercially viable fragment-based approaches for microbial characterization, fingerprinting and tracking from the scientific literature, specifically those reported for analysis of *Salmonella* spp. Considerations for what constitutes “commercial viability” include potential market size of test and lack of background IP that might impede free use of the test on the FS96 system. Become proficient in use of these methods for generation of complex DNA fragment pools.
2. Generate key data illustrating the efficacy of the *AdvanCE* FS96 system for analysis of complex pools of DNA fragments. Carry out direct comparison of FS96 performance to that of traditional gel-based or competitive CE-based methods. These data can be used to support instrument sales through direct presentation to potential customers or through publication via internet and print advertising channels.
3. Work with agri-business partner and potential future customer (Hy-Line International) to apply the technology developed here to practical problems of pathogen ecology in layer hen facilities (overlap with technical tasks described above).
4. Raise awareness of this technology and its potential through high-profile presentation and publication of research results at national conferences and in leading peer-reviewed journals.

**Schedule (Commercial Tasks)**

Task	Year 1				Year 2	
	Q1	Q2	Q3	Q4	Q1	Q2
Task 1						
Task 2						
Task 3						
Task 4						

**Why Grow Iowa Values Fund Support is Critical:** We believe that this proposal is an excellent fit for the GIVF program and addresses or satisfies several key criteria unique to this funding program. Specifically, the proposed research addresses the “Grow Iowa Values Fund” objectives to expand the commercialization of ISU technology, to help ISU technology reach the marketplace, to help the growth of existing Iowa companies, to develop collaborative research with companies having an Iowa presence, and to increase sales and/or profitability of Iowa companies through provision of new market opportunities. As detailed in the letter of support provided by Dr. Steve Lasky of AATI, we have cultivated a productive and mutually rewarding collaborative relationship with AATI, facilitated in large part by past GIVF support to my lab. Through the work proposed here, we seek

to replicate our past and ongoing successes with AATT's DNA PROFiler instrument for the *AdvanCE* FS96 platform. Funding of this proposal will be **invaluable** in helping to apply for and obtain competitive external funding (such as the NSF SBIR applied for under our current GIVF project with AATI) and to sustain the forward, market-focused momentum we have built for advancing AATT's CE-based analysis systems into key positions of visibility and profitability.

**Budget**

Category			Requested Amount	ISU Cost Share	Company Cost Share	TOTAL
<i>Faculty</i>			\$18,382			\$18,382
<i>Faculty Benefits (27.2%)</i>			\$5,000			\$5,000
<i>Postdoc</i>			\$37,149			\$37,149
<i>Postdoc Benefits (23%)</i>			\$8,544			\$8,544
<i>Grad Student</i>			\$24,368			\$24,368
<i>Grad Student Benefits (13.2%)</i>			\$3,216			\$3,216
<i>Tuition</i>			\$8,302			\$8,302
Salaries & Wages Subtotal			\$79,899			\$79,899
Fringe Benefits & Tuition Subtotal			\$25,062			\$25,062
Equipment					\$70,000	\$70,000
Lab Supplies (cash support)				\$9,900	\$10,000	\$19,900
Lab Supplies (in-kind support)					\$20,000	\$20,000
Travel			\$1,000			\$1,000
Publication			\$1,000			\$1,000
<b>Total Cost</b>			<b>\$106,961</b>	<b>\$9,900</b>	<b>\$100,000</b>	\$216,861

**Budget Justification (Request):** **Salary:** Support (\$37,149) for a postdoc (Hyun Jung Kim, PhD) is requested. Dr. Kim is currently appointed until January 2011 at an annual salary of \$37,000. The amount requested would provide 1 year of additional support for Dr. Kim, with a 1.5% increase from his current salary. Support for an MS-level graduate student is requested for 1.25 years of this project. The current graduate student stipend in FSHN is \$19,494, therefore **\$24,368** is requested. Two months of summer salary (**\$18,382**) is requested for Dr. Brehm-Stecher over the duration of the 1.5-year project. Dr. Brehm-Stecher is on a 9-month appointment at a projected annual rate of \$82,719 (current rate of \$81,497 + 1.5% increase). **Benefits:** Benefits are 23% for postdocs, therefore, **\$8,544** is requested. Benefits for graduate students are 13.2%, therefore, **\$3,216** is requested. Benefits are 27.2% for faculty, therefore, **\$5,000** is requested. **Tuition:** **\$8,302** is requested (Fall 2010 - Spring 2012). **Travel:** Funds are requested for travel to one national meeting (**\$1,000**). **Publication:** **\$1,000** is requested for publishing the results of our studies. **Explanation of Cost Share:** Advanced Analytical will supply **\$10,000 in cash support** to this project and an additional **\$20,000 in in-kind** supply of the CE-related materials and reagents (capillaries, gels, buffers, consumable plasticware, replacement parts, etc.) needed to carry out this work. **Dr. Brehm-Stecher's lab will also receive an *AdvanCE* FS96 system from a private donor through the Iowa State University Foundation to support this work. This instrument is valued at \$70,000. This donation will be made after July 1<sup>st</sup>, 2010, enabling its use here as cost share.** Further, Dr. Brehm-Stecher will also commit **\$9,900** in cash remaining from an existing capillary electrophoresis-based grant from the Midwest Dairy Association (MDA). Dr. Lloyd Metzger, director of the Midwest Dairy Center, has authorized use of these funds for this purpose. Together, this represents a cost share commitment of **\$109,900**.



Steven J. Lasky, PhD  
President and CEO  
Advanced Analytical, Inc.  
2901 S. Loop Drive  
Ames, IA 50010  
May 28, 2010

Office of the Vice Provost for Research  
& Economic Development  
Iowa State University  
Ames, IA 50011  
Attn: Grow Iowa Values Fund Grants Competition

To Whom It May Concern:

I am writing this letter in support of Dr. Byron Brehm-Stecher's application for funding from the Grow Iowa Values Fund. The work proposed by Dr. Brehm-Stecher, "**AdvanCEs in Food Safety: Fast Fragment Analysis for Differentiation and Tracking of Foodborne Pathogens**", will develop critical pathogen tracking applications for our newly developed *AdvanCE* FS96 DNA fragment analysis platform. I expect that the outcome from this work will be of general value to Iowan agri-industry, including animal producers, plant breeders or the egg laying industry, and of special value to my company as we launch the *AdvanCE* FS96 into these key markets.

We are currently working with Dr. Brehm-Stecher on a Grow Iowa project focused on use of our DNA PROFiler instrument for advanced microbial detection. We have made excellent progress on this project - important milestones include presentation of our results at two international scientific meetings and training of one MS student (expected graduation August 2010). A news release detailing our progress can be found here: <http://www.news.iastate.edu/news/2010/may/StecherAATI>. Grow Iowa support has also been invaluable in facilitating one collaborative proposal for external funding from the National Science Foundation, to be submitted June 9<sup>th</sup>.

**The goal of our new proposal is to leverage Grow Iowa funds to replicate these successes and help advance a separate analysis platform, the *AdvanCE* FS96, into new markets.** Like the DNAPROFiler, the FS96 system is also based on capillary electrophoresis, a core technological strength of my company. However, these two systems are *fundamentally different*. While the DNA PROFiler is designed to detect end-labeled pieces of single stranded DNA, no external labeling is needed for the FS96, which analyzes native double stranded DNA (dsDNA). Unique characteristics of the FS96 include its ability to resolve dsDNA fragments as small as 3 base pairs, vastly improved sensitivity and reproducibility over traditional gel-based separations and an advanced software interface providing integrated pattern recognition and analysis capabilities. **The FS96 is an open-ended system whose critical advantages may be applied to almost any assay requiring sensitive, high-resolution analysis of dsDNA fragments. Therefore, the proposed work has the potential for substantial and broad impact on the DNA analysis market.**

Dr. Brehm-Stecher's lab has recently been awarded an FS96 from an outside donor through the ISU Foundation and is therefore uniquely positioned for success with the proposed work. Based on preliminary data from Dr. Brehm-Stecher's lab, I feel that this work stands a high chance for success. I anticipate that this work will enhance our company's ability to bring novel and beneficial products and applications to market and I strongly recommend that it be funded.

Sincerely,

A handwritten signature in black ink that reads 'Steven J. Lasky'.

Steven J. Lasky, PhD  
President and CEO



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TECHNICAL SERVICE DEPARTMENT  
2583 240<sup>TH</sup> STREET DALLAS CENTER, IOWA 50063

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May 28<sup>th</sup>, 2010

Office of the Vice Provost for Research  
& Economic Development  
Iowa State University  
Ames, IA 50011  
Attn: Grow Iowa Values Fund Grants Competition

To Whom It May Concern:

I am providing this letter in strong support of Dr. Byron Brehm-Stecher's proposal, "**AdvanCEs in Food Safety: Fast Fragment Analysis for Differentiation and Tracking of Foodborne Pathogens,**" which has been submitted to the Grow Iowa Values Fund.

The focus of Dr. Brehm-Stecher's work will be to translate new technical advances in high-throughput parallel capillary electrophoresis technology into practical methods for use in monitoring and control of human pathogens in agricultural production environments. Specifically, Dr. Brehm-Stecher's group will develop advanced solutions for DNA fragment analysis using Advanced Analytical Technologies' *AdvanCE* FS96 platform.

Dr. Brehm-Stecher's approach will lead to improvements in our abilities to differentiate and track pathogens such as *Salmonella* in animal production facilities. We expect that these improvements will provide actionable data upon which effective strategies for pathogen control may be based.

With over 65 million birds, Iowa leads the nation in layer hens and in egg production. Hy-Line International has played a major role in our state's success in this sector. For over 70 years, we have been the leader in the layer breeding industry, expanding the frontiers of genetics and producing the world's best stock. Next-generation microbial testing and tracking approaches are needed to help guarantee the safety of Iowa's layer hen and egg production activities and to protect the integrity of this important economic driver for the state.

We are excited about the prospect of working with Dr. Brehm-Stecher's group as they develop advanced tools that we will be able to leverage for our active pathogen intervention efforts. We look forward to working closely with Dr. Brehm-Stecher to supply his lab with wild-type microbial isolates for further characterization and use in *AdvanCE* FS96 methods development. The preliminary results from Dr. Brehm-Stecher's lab clearly demonstrate the potential of their approach and I strongly recommend that this important work be funded.

Sincerely,

Kelly Bassett, MS  
Technical Services Laboratory Manager  
Hy-Line International



May 27, 2010

Office of the Vice Provost for Research  
& Economic Development  
Iowa State University  
Ames, IA 50011  
Attn: Grow Iowa Values Fund Grants Competition

To Whom It May Concern:

I am writing this letter in support of Dr. Byron Brehm-Stecher's recent application for funding from the Grow Iowa Values Fund grants program. The work proposed by Dr. Brehm-Stecher, "**AdvanCEs in Food Safety: Fast Fragment Analysis for Differentiation and Tracking of Foodborne Pathogens**", will leverage the superior resolving power, sensitivity and reproducibility of Advanced Analytical's *AdvanCE* FS96 system for next-level analysis of microbial pathogen DNA in support of food safety efforts.

As a nation, we are at a critical crossroads in food safety. The advances in food production and processing required to meet the demands of a growing world must also be complemented with new technologies designed to help ensure the safety and wholesomeness of the food that is produced. Dr. Brehm-Stecher's group is actively involved in research directed at developing the next generation of tools required to meet society's demands for a safer food supply.

Iowa leads the nation in corn, soy, hog and egg production. The safe production and processing of these agricultural products is key to maintaining Iowa's cornerstone position in the nation's farm economy. I believe that the approach proposed by Dr. Brehm-Stecher and his colleagues at Advanced Analytical will provide the advances in rapid microbiological analyses needed to ensure the safety, quality and economic value of Iowan agricultural products.

Sincerely,

A handwritten signature in black ink, appearing to read 'David Sengpiel'.

David Sengpiel  
Senior investment manager

## **A Programmable Software Pattern Analyzer (PSPA): Critical Safety Improvement for Transportation Control Systems**

**PI:** Suraj C. Kothari, Electrical & Computer Eng., 515-294-7212, [kothari@iastate.edu](mailto:kothari@iastate.edu)

**Company:** EnSoft Corp. founded in 2002, 7 full-time & 2 part-time employs, Jeremias Saucedo, CTO, [pi@ensoftcorp.com](mailto:pi@ensoftcorp.com), (515)-296-3253, <http://www.ensoftcorp.com/>

### EXECUTIVE SUMMARY

There is a pressing need for a new technology to ensure reliability of software. A personal computer can be rebooted, but in a safety-critical system like an automobile or an airplane, a crash can mean loss of human lives and waste of millions of dollars. And it happens; in 1996, the Ariane 5, a \$500 million rocket launched by the European Space Agency, exploded 40 seconds after lift-off due to a software error in the guidance system. Computers and software are used pervasively in transportation control systems; they now account for 40% of the value of a new car.<sup>1</sup> Even with thorough testing, the ESA did not catch the problem before launch. Since the test cases grow exponentially, complete testing is impossible for large programs.

However, there can be an alternative to testing. Just as the MRI and the CT scan have advanced medical diagnostics and the precision with which surgeons can operate, we propose to develop a powerful new tool to analyze and modify critical software. While testing software can observe and infer from inputs and outputs, it cannot gain deeper knowledge of the internal structure and functioning of software. We are developing the Programmable Software Pattern Analyzer (PSPA) as an extension of EnSoft technology to address this challenge. The PSPA will discover underlying programming patterns and use those to validate safety-critical functioning of crucial software.

Our validation method is based on the pattern analysis exercises we have done using EnSoft's Atlas tool for program mining. Currently, it takes about two hours per exercise. A typical validation problem (such as the Linux kernel validation case study we propose here) would require a few thousand such exercises. The PSPA will offer the programming capability to perform thousands of program analysis exercises in few seconds. While it is possible to write C or Java programs to do pattern analysis of software, it is very time consuming and tedious. We estimate that a pattern analysis program that takes a couple of hours with the PSPA would take several months if one were to write it in C or Java. Like the spreadsheet, it would be a domain-specific programming environment to make a certain type of programming much easier.

In the 2007 GIVF project, we collaborated with EnSoft to develop a new product called SimMerge. Since its release in June 2009, SimMerge has been adopted by 31 companies, as well as by the NASA Orion Project.<sup>2</sup> EnSoft specializes in tools for developing safety-critical control software and its current customers include more than 100 companies, the vast majority of which are *Global Fortune 500* companies. The PSPA technology will meet a critical need of many of these companies.

The ISU work will focus on: (a) Programmable query language and graph reduction algorithms for analyzing programming patterns, and (b) Case study to exemplify the benefits of the PSPA technology. The EnSoft work will focus on coding for a PSPA prototype by extending Atlas, their query-based program mining tool.

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<sup>1</sup> "Toyota and the Curse of Software," the Wall Street Journal, February 4, 2010.

<sup>2</sup> [http://www.nasa.gov/mission\\_pages/constellation/orion/orion\\_announcement.html](http://www.nasa.gov/mission_pages/constellation/orion/orion_announcement.html)

## 1. The Proposed Research and Deliverables

While a compiler can check simple syntactic errors such as a non-matching parenthesis, the PSPA is needed to analyze, understand, and validate the complex semantics of a program. Juichi Takahashi, a Distinguished SONY Engineer, recently pointed out the challenge of analyzing even software as ubiquitous as the Linux kernel (about one million lines of C code) for a common software error: mismatches between locking and unlocking<sup>3</sup>. An unmatched locking can lead to a deadlock in the system and can cause the system to hang and have to be rebooted. Takahashi presented a graph to show how the number of test cases grows exponentially – from 6 to 11340 as the number of concurrent threads increases from 2 to 6. Using Atlas queries, we can quickly find that the kernel has 1446 threads that use locking. By extrapolating the Takahashi graph, the number of test cases for 1446 threads will be  $2.2 \times 10^{991}$  – much bigger than  $1.5 \times 10^{82}$ , the estimated number of atoms in the entire universe.

By validating the Linux kernel with the PSPA, we will demonstrate that pattern recognition can accomplish what Takahashi shows is impossible using traditional testing. Using Atlas, a query-based tool for mining software, we analyzed a few locking instances in the Linux kernel and discovered some programming patterns that we can use to infer matching without performing tests. Our analysis was an interactive process: write a sequence of Atlas queries and then discover patterns by manually reducing the program relationship graphs produced by the Atlas. Without Atlas, this discovery process would be difficult and time consuming: two hours per instance with Atlas versus 20 hours without Atlas (an improvement factor of 10).

This project is about crossing the next barrier. There are a few thousand instances to analyze and the analysis, with some variation, must be repeated a few times to discover all the patterns and validate the entire Linux kernel. As an analogy, equate Atlas to a calculator and analyzing a locking instance to performing a complex computation with a number. A calculator is a powerful and useful tool, but the spreadsheet has a much greater degree of power and usefulness. It can apply the computation to thousands of numbers simultaneously and it can analyze large data sets to find or verify interesting patterns. Atlas is like a calculator and the PSPA will be like a spreadsheet. Unlike C or Java, the spreadsheet is a much easier programming environment to use with tables of numbers. Similarly, query-based programming with the PSPA will be a much easier programming environment for the pattern analysis of software instead of writing the analysis program in C or Java. With the PSPA, it will be possible to analyze thousands of instances of locking, all at once, in few seconds (roughly an improvement factor of 10,000 over the current analysis with the Atlas).

Dr. Kothari has pioneered the research on patterned-based software analysis. It started with automatic parallelization<sup>4</sup> and the research has continued for the last 15 years with several Ph.D. and M.S. students and recently it has gained more visibility<sup>5</sup>. This research led to the founding of EnSoft Corp. and Dr. Kothari's research group has the unique expertise to help EnSoft with the PSPA project.

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<sup>3</sup> Dr. Takahashi gave an invited talk at the International Symposium on Software Reliability Engineering, 2009.

<sup>4</sup> It got \$480,000 funding from EPA, led to two patents and the ParAgent tool for automated parallelization of climate models used by EPA and NCAR.

<sup>5</sup> In 2008, Dr. Kothari was invited to give the keynote address at the IEEE International Conference on Program Comprehension. In 2009, he was invited to give a talk at the European Space Consortium meeting. Also, he was invited to co-chair the Embedded Software Reliability (ESR-09) workshop.

We will design a programmable interface analogous to how Java Database Connectivity (JDBC) handles the interaction between Java and SQL. We will design graph reduction algorithms for analyzing and validating software patterns. We will analyze the Linux kernel; either validate it, or find the errors by locating locking mismatches. The case study will provide EnSoft a significant marketing collateral to promote the PSA technology.

Deliverable (starting date 8/15/10)	Completion
1. A query-based programming environment for analyzing software patterns (ISU & EnSoft) – EnSoft will do the actual coding for the PSA prototype	5/15/11
2. A graph reduction algorithms for matching and validating software patterns (ISU)	8/31/11
3. Case study to exemplify the benefits of the PSPA technology (ISU & EnSoft)	3/15/12

## 2. Commercial Viability

EnSoft develops custom software analysis tools, works with clients to iterate and improve these tools, and then delivers a comprehensive toolkit to the larger market. EnSoft's first commercial success was SimDiff which was created to meet a need identified by Rockwell Collins. SimDiff's purpose was to automate a part of their tedious and laborious auditing process which involves computing differences between graphical models of a flight control system as it evolves. SimDiff was then released in the market in 2006. In 2009, EnSoft released a synergistic new product called the SimMerge.

The commonality between EnSoft's existing products and the PSA is that both are needed for the development of reliable control software, and therefore the PSA can be marketed to EnSoft's growing pool of customers across a broad spectrum of industries, including aerospace, automobile, communication, defense, integrated circuits, trucks, tractors, and heavy machinery. These customers have control software in C and C++. EnSoft's current automobile customers include BMW, Daimler Chrysler, Delphi, Denso, Ford, GM, Honda, Jaguar, Land Rover, MagnaPowerTrain, Magneti Marelli, Mazda, Mitsubishi, Porsche, Renault, TRW, Toyota, Volkswagen, and Volvo. EnSoft's current aerospace customers include BAE Systems, Boeing, Airbus, GE, Gulfstream Aerospace, Honeywell, Lockheed Martin, Northrop Grumman, Raytheon, Rockwell Collins, Smiths Aerospace, and Swedish Space Corporation.

EnSoft has built customized tools for Rockwell and Toyota<sup>6</sup>. GE, Caterpillar, and Cisco have shared with EnSoft their needs for a program analysis tool. These companies provide an immediate opportunity for EnSoft to market the PSPA.

The PSPA can provide significant return on investment to companies. Besides defect analysis and validation, the PSPA will spawn many other innovative uses for companies to benefit from the new technology. For example, the PSPA could be used to generate documentation for legacy software. The lack of software documentation is a significant problem for many companies, and using the PSPA to generate documentation will be a great benefit to them.

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<sup>6</sup> EnSoft has ongoing projects with Rockwell and Toyota. In June, EnSoft has a meeting set up with a Toyota Executive from Japan to discuss their needs for tools.

In addition, based on our knowledge of the manual auditing process used in industry for validating safety-critical properties of software, we estimate that the automation enabled by the PSPA can result in 90 to 95 percent savings of time over the manual auditing process. Moreover, the automated analysis will be more in-depth than the manual analysis. Novel design optimizations will be possible with the in-depth information revealed by the automated analysis. The proposed case study will exemplify these benefits of the PSPA technology.

### **3. Growth Opportunities**

The growth opportunities for tools to develop critical control software are quite evident from the response to EnSoft's SimDiff and SimMerge products, which have been adopted by 102 companies in 14 countries including the US, UK, Germany, France, Italy, Spain, Japan, India, and China. The PSPA product will be marketed to this significant pool of customers. These customers have stayed with EnSoft even after National Instruments (NI) introduced the ecDIFF product to compete with EnSoft's SimDiff. Customers find SimDiff superior to ecDIFF in terms of speed, accuracy, the user interface, and the capability to handle large Simulink models. SimMerge with an advanced merge capability to support teamwork and multiple product lines has further strengthened EnSoft's position in the market. This GIVF project will help EnSoft develop another strategically important product, the PSPA.

In spite of the recession, EnSoft became profitable in 2008. This has enabled EnSoft to focus on growth. It has hired an experienced consultant to assist with marketing. It has established distributors in Europe and Japan. In 2009 EnSoft visited companies in Europe and Japan to market EnSoft's products and understand their future needs. EnSoft is working on enterprise and concurrent license models to facilitate large sales of licenses. Recently, EnSoft has successfully negotiated a price for 600 licenses for a division in an automobile company in Japan. The PSPA will benefit from these business expansion activities.

### **4. Impact: Economic Development & Benefits to ISU**

ISU students and faculty have benefited and received awards for the research done in collaboration with EnSoft<sup>7</sup>. This partnership has contributed to the economic development in Iowa through jobs created at EnSoft and the products sold in the international market. The research experience has enabled Dr. Kothari to create an innovative graduate course, valued immensely by off-campus students from other Iowa companies.

Over the past 3 years, EnSoft annual revenues grew 112.45 percent, and it is expected to grow 200 percent or more over the next three years. The PSPA technology can start generating revenues in late 2012, beginning with service contracts to analyze codes for customers. As a service, EnSoft expects to generate about \$30,000 per month through one service contract, requiring one full-time PSPA trained software engineer. Over the next three years, EnSoft expects to add 5 to 8 full-time positions 3 to 4 part-time positions.

EnSoft has created high-tech jobs in Iowa and it has been successful in retaining some of the best graduates from ISU. Besides \$30,000 in-kind support, EnSoft has committed \$20,000 to support a graduate student at ISU to work on this project. With more products and a significant pool of customers, EnSoft will continue to grow and be able to provide more funding to support research at ISU.

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<sup>7</sup> Jason Stanek received the ISU Research Excellence Award in 2009 for his Ph.D. research under Dr. Kothari's supervision. Dr. Kothari received the Prometheus Award for innovative teaching of software engineering.

## Budget

Category	No.	n- mos.	Mo. Rate	Requested Amount	ISU Cost Share	Company Cost Share	TOTAL
<i>Faculty</i>	<i>1</i>	<i>3.0</i>	<i>\$ 14,150</i>	\$ 14,150	\$ 28,300		\$ 42,450
<i>Grad Student</i>	<i>2</i>		<i>\$ 1,550</i>	\$ 31,388		\$ 10,463	\$ 41,851
<i>Undergrad</i>					\$ -		\$ -
<i>EnSft</i>				\$ -		\$ 30,000	\$ 30,000
						\$ -	\$ -
Salaries & Wages Total				\$ 45,538	\$ 28,300	\$ 40,463	\$ 114,301
Fringe Benefits (28.2% faculty, 13.2% RA)				\$ 8,133	\$ 7,981	\$ 1,381	\$ 17,495
Computer				\$ 2,000		\$ 1,917	\$ 3,917
Travel				\$ 2,500			\$ 2,500
Student Tuition				\$ 18,717		\$ 6,239	\$ 24,956
Materials & Supplies				\$ 500			\$ 500
Other Direct Costs*							\$ -
<b>Total Cost</b>				<b>\$ 77,388</b>	<b>\$ 36,280</b>	<b>\$ 50,000</b>	<b>\$ 163,669</b>

*Includes telecomm, computer use, print/copy, honoraria, services/user fees, postage, etc.*

1. The amount requested for travel will be for conferences and travel to visit Rockwell
2. Cost-share Funds:
  1. EnSoft contribution: \$20,000 in-cash + \$30,000 in-kind.
  2. ISU Contribution: \$18,140 in-cash from Kothari's research and/or incentive fund + \$18,140 in-kind for the month Dr. Kothari will spend on this research during the academic year.



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May 28, 2010

Dear Sir or Madam:

This is a letter to support the Grow Iowa Value Fund (GIVF) proposal being submitted by Professor Kothari.

EnSoft is an ISU-based company founded in May 2002. EnSoft works closely with Iowa companies. For example, we have provided tool-based services to insurance and financial services companies in Des Moines to maintain and evolve their legacy COBOL software; developed several customized tools for Rockwell-Collins; did work for Genova, a small company based in Cedar Rapids; and recently John Deere has begun using our product SimDiff.

In the last three years, EnSoft has grown rapidly. EnSoft's products are now available in English, German, and Japanese. More than 100 companies, including major aerospace, automobile, and defense companies in North America, Europe, and Asia have adopted EnSoft's software tools for developing safety-critical software.

Our past collaboration with ISU has been a great success. EnSoft worked with Dr. Kothari and his graduate student on a research project funded by the GIVF in 2007-08. This research was important for the development of our SimMerge product released in June 2009. Within a year, SimMerge has been licensed by 31 companies in 7 countries. NASA and Lockheed Martin are also using SimMerge for the design of the Orion next-generation spacecraft which will transport astronauts to the Moon, Mars and other destinations.

EnSoft plans to develop a new product, a Programmable Software Analyzer (PSA) for C and C++. The idea for this product is based on the needs of our growing pool of customers who need better tools to develop and maintain their safety-critical software. Dr. Kothari's research lab at ISU can help EnSoft in developing the PSA. Specifically, we need with need help with: (a) design of a query language for program mining, (b) graph-based algorithms for macro analysis, and (c) a case study to exemplify benefits of the PSA technology. These are cutting-edge research topics where Dr. Kothari and his graduate students can help us with their research expertise.

EnSoft will provide funding of \$20,000 to support a graduate student. EnSoft's in kind support is estimated at \$30,000 for 200 hours of an EnSoft Senior Software Engineer's time.

EnSoft has 7 full-time and 2 part-time employees. EnSoft became profitable in 2008. This year, we have hired an experienced business development consultant who can help us grow aggressively. As a technology company, we must continue to bring innovative products to market and keep ahead of our competition. Our collaboration with ISU, where we can access research specialized to our needs, is a key to our success in developing innovative products. We do not have the financial resources to completely fund a research project. This GIVF project will allow us to combine our financial resources with the GIVF funding to support the research we need for developing this new product.

Sincerely,

A handwritten signature in black ink that reads "Jeremias A. Saucedo". The signature is written in a cursive, flowing style.

Jeremias Saucedo  
Chief Technology Officer  
EnSoft Corp.

## A Statement of Impact

In the spring semester, Dr. Kothari taught a graduate course on scalable software engineering based on the knowledge he has gained through his research on program analysis and its applications to software engineering. The course presented an analytical approach to software engineering using the Atlas tool from EnSoft. The course was offered through the Engineering Distance Education service and it had nine off-campus students. Dr. Kothari received highly positive feedback from these students. The following is an unsolicited email from one of the students. This person works as a Project Lead at Rockwell; he has eight years of experience of working on safety-critical avionics software. He has become interested in working on the PSPA project and he plans to join ISU as an off-campus graduate student.

Working with EnSoft on cutting-edge research projects has enabled Dr. Kothari to make valuable contribution to software engineering education at ISU. In return, Dr. Kothari has got access to a highly capable and experienced individual to work with him on this research project.

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CONFIDENTIAL  
GIVF FY11-18

## Thoughts on CprE 556...

Dana Dippery [dippery1@iastate.edu]

**Sent:** Sunday, March 28, 2010 12:15 AM

**To:** Kothari, Suraj C [E CPE] [kothari@iastate.edu]

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I would like to express my surprise and excitement in regard to CprE 556. This is my first graduate level class; I graduated from Louisiana State University in 2001 with a Bachelors of Science in Computer Science and a minor in Mathematics (Calculus and discrete). Initially, I expected to have to dust off my Calculus book and relearn the semantics of Greek symbols and obscure theorems. However, I have found your class to be full of very relevant and modern ideas about software engineering. I did not realize that university professors are thinking about the problems that I face daily while working "in the field" and far away from the class room. Some of the topics that I found particularly motivating:

1. Program slicing
2. Analysis of matching pair defects
3. Model-based programming and testing
4. Assistance is how to critically read academic papers
5. Analysis of the Linux kernel (yet to be done as of this writing)

I hope this is not offending, but I thought software engineering at the graduate level was about useless software metrics, business processes and more of the same ol' hot-technology-of-the-moment propaganda. Note, I believe such things are important, but I can easily absorb such information on my own, either through my employer's training or books from Barnes n' Noble. I appreciate that you focus on fundamentals, whether "old" or "new", and show how new technology can often break down into such fundamentals.

I feel qualified to stamp my approval and recommend this course to my peers. I currently have eight years of industrial safety/mission critical software engineering experience. I have worked for Lockheed Martin (Joint Strike Fighter), Northrop Grumman (Joint Strike Fighter), EDS (Travelocity server system). I currently work at Rockwell Collins where I helped to develop a Terrain Awareness/Warning System for commercial aircraft and software-based military radios. I have seen a wide spectrum of software quality (both in terms of processes and products) and feel passionate about making a difference in my industry.

Dr. Kothari, I look forward to meeting you on Thursday and discussing my academic future. I hope to interlace my academic career with my industrial career and would like any thoughts you have on how to most effectively do that.

Regards,  
Dana Dippery

## Proposal for Grow Iowa Values Fund (GIVF) Grant Program

### DESIGN VERIFICATION AND COST EVALUATION OF UHPC TOWERS FOR ENHANCING IOWA'S WIND ENERGY PRODUCTION

PI: Sri Sritharan, Wilson Engineering Professor

Department of Civil, Construction and Environmental Engineering, 394 Town Engineering

Phone: (515) 294-5238; Email: [sri@iastate.edu](mailto:sri@iastate.edu)

#### Company Partners:

- 1) **Iowa Prestressed Concrete (IPC)** – 300 employees, founded in 1958, approximate annual sales \$60 million; contact person: Dan Doran, Director, 601 SW 9th St., Des Moines, IA 50309, Ph: (515) 979-1186, Email: [ddoran@ipcprecast.com](mailto:ddoran@ipcprecast.com);
- 2) **Clipper Windpower, Inc.** (Clipper) – 750 employees globally, founded in 2001, approximate annual sales is \$775 Million, contact person: Tony Chobot, Manager, 6305 Carpinteria Avenue, Suite 300, Carpinteria, CA 93013, Ph: (805) 576-1616; Email: [AChobot@ClipperWind.com](mailto:AChobot@ClipperWind.com); and
- 3) **Lafarge North America** (Lafarge) – 70,000 employees in 80 countries, founded in 1869, approximate annual sales is \$20 Billion, contact person: Vic Perry, Vice-President /General Manager, 12950 Worldgate Drive, Suite 500, Herndon, VA 20170, Ph: (403) 292-9423; E-mail [vic.perry@lafarge-na.com](mailto:vic.perry@lafarge-na.com).

#### EXECUTIVE SUMMARY

In recognition of today's energy challenges, our nation and the state of Iowa are progressively increasing wind energy capacity to meet the *20% Wind Energy by 2030* goal proposed by the Department of Energy (DOE). While efforts are underway by many to improve the turbine technology, this industry has reached a limit of 263 ft (80 m) tall towers due to the choice of construction material, transportation method and erection technique. Use of advanced materials and innovative accelerated construction techniques can cost-effectively overcome this limit, increasing tower height by as much as 50 percent. This increase would enable the wind energy industry to harvest over \$100,000 worth of additional energy annually for each currently used turbine. Such a transformative advancement is needed to increase the wind energy production tenfold to meet the DOE goal within our state.

Using ultra high performance concrete (UHPC), an innovative turbine tower concept was developed and an Intellectual Property Disclosure and Record (IPDR) on this invention has been filed with the Iowa State University Research Foundation (ISURF). Wind turbine and tower manufacturing companies have shown tremendous interest in the conceived technology. Their partnership is needed to make this technology feasible for field implementations. This proposal seeks a GIVF grant to engage suitable industry partners, complete a detailed design of connections and verify their performance through large-scale testing, and facilitate a value proposition to be completed. Completion of this process will raise marketability of an ISU tower technology and boost confidence in our industry partners so that we can deploy 328 to 394 ft (100 to 120 m) tall innovative UHPC towers in the field. To this end, we have engaged three partners with matching funds: a local precast manufacturing and erection company (*Iowa Prestressed Concrete*), a turbine manufacturing company with a base in Iowa (*Clipper Windpower, Inc.*), and a UHPC material supplier (*Lafarge North America*). Successful completion of this project will increase the productivity of two companies in Iowa, create new jobs, and increase Iowa's wind energy portfolio so that we can efficiently meet the DOE goal within our state.

## BUDGET AND JUSTIFICATION

Duration: Sept. 1, 2010 - Feb. 28, 2012 (18 months)							
	GIVF	COST-SHARE				Total Cost-Share	Total Project Cost
		ISU	IPC	Lafarge North America	Clipper		
<b>SALARY</b>							
PI, Sri Sriharan (1.5 mo. total)	11,346	5,908				5,908	17,254
Research Scientist, Doug Wood (0.75 month)	4,916					-	4,916
MS Graduate student (18 mo. total)	17,350	13,250				13,250	30,600
Post-Doc (3 months)	2,150		7,000			7,000	9,150
Undergraduate hourly	15,600					-	15,600
<b>Subtotal</b>	<b>51,362</b>	<b>19,158</b>	<b>7,000</b>			<b>26,158</b>	<b>77,519</b>
							-
<b>FRINGE BENEFITS</b>							
Faculty @ 28.2% of salary	3,200	1,666				1,666	4,866
P&S @ 34.5%	1,696					-	1,696
RA @ 13.2% of salary	2,290	1,749				1,749	4,039
Post Doc @ 20.2%	434		1,414				434
Undergraduate @ 4.6%	718					-	718
<b>Subtotal</b>	<b>8,338</b>	<b>3,415</b>	<b>1,414</b>			<b>4,829</b>	<b>13,167</b>
							-
Tuition for Graduate Student	-	7,427	-	-		7,427	7,427
							-
Materials and Supplies	5,560	-	6,586			6,586	12,146
Ultrahigh performance concrete	16,000			20,000		20,000	36,000
Precast concrete products			14,000			14,000	14,000
Test frame	9,000					-	9,000
Strain gauges and instrumentation	1,800						1,800
Reaction Frame	5,341						5,341
Demolition	1,800						1,800
Lab fees and rentals	3,800						3,800
Analytical simulation (software and consulting)	4,000						4,000
Turbine loads and related engineering services					20,000	20,000	20,000
Travel	2,000	-	-			-	2,000
							-
In-Kind (Consulting, Labor and Shipping)	-	-	6,000	4,000		10,000	10,000
<b>TOTAL COSTS (IDC, N/A)</b>	<b>109,000</b>	<b>30,000</b>	<b>35,000</b>	<b>24,000</b>	<b>20,000</b>	<b>109,000</b>	<b>218,000</b>

- Salary is requested for 1.0 month for the PI from the project, and cost-sharing 0.52 month. One technician, one post-doc and one undergraduate student will be hired. One MS graduate student will be hired for 18 months, with GIVF supporting 10.2 months and ISU cost-sharing 7.8 months. The funding for the cost-share will come from Wilson Endowed Professorship of the PI.
- Fringe benefit rates are assigned to each position classification. Rates are indicated above.
- Tuition for the MS student will be paid by the College of Engineering for Fall 2010, Spring and Summer 2011, and Fall 2011 when stipend is paid from GIVF and/or cost-sharing account.
- Materials and Supplies costs, applicable lab fees, rentals and testing services are included.
- Travel is requested to attend an AWEA conference and suitable workshops.
- INDUSTRY COST SHARE: IPC (\$35,000), Clipper (\$20,000), and Lafarge North America \$(24,000).



I N N O V A T I V E P R E C A S T S O L U T I O N S

IPC, INC.  
601 SW 9TH STREET, SUITE B  
DES MOINES, IOWA 50309-4528  
515.243.5518 OR 800.826.0464  
FAX 515.243.5502

**Sri Sritharan**

Wilson Engineering Professor  
376 Town Engineering Bldg.  
Dept. of Civil, Construction & Environmental Engineering  
Iowa State University  
Ames, IA 50011-3232

**May 29, 2010**

Subject: Industry Partnership in Precast Concrete Turbine Tower research

Dear Sri:

This letter is to formalize our commitment to provide \$15,000 in cash and \$20,000 in-kind contribution of precast engineering and production services associated with a GIVF project to research the feasibility and performance of a precast turbine tower.

Our correspondence and future references should be addressed to my attention in care of our new company:

Contact: Dan Doran, Director  
IPC Inc., dba Cretex Energy  
601 SW 9<sup>th</sup> St.  
Des Moines, IA 50309  
(515) 979-1186

IPC is an Iowa precast concrete manufacturer with three plants in the state: Iowa Falls, Des Moines and West Burlington. Our annual sales have historically been at the \$60 million level with a payroll in excess of 300 individuals. The recent economic crisis has hit our commercial construction segment badly—sales are down 70%--, and we've laid off over 200 employees company-wide and closed the West Burlington facility.

Should our efforts in this research be successful, we would reactivate our West Burlington facility to become a dedicated precast tower manufacturing facility. This could mean 120 or more recovered Iowa Jobs. The West Burlington facility is a large, established plant with a rail spur on site. This plant can support production in excess of \$25 million annually, and has historically operated at that level in the recent past.

Sincerely,

*Dan Doran*

**Dan Doran**  
**Director of Sales**  
**IPC, Inc./Cretex Energy**



Clipper Windpower, Inc.  
6305 Carpinteria Ave., Suite 300  
Carpinteria, CA 93013  
Tel: +1 (805) 690 3275  
Fax: +1 (805) 899 1115  
Web: [www.clipperwind.com](http://www.clipperwind.com)

May 27, 2010

Sri Sritharan  
Wilson Engineering Professor  
Associate Chair and Director of Graduate Education (DOGE)  
376 Town Engineering Bldg.  
Dept. of Civil, Construction & Environmental Engineering  
Iowa State University  
Ames, IA 50011-3232

Ph: (515) 294-5238;  
Fax: (515) 294-8216;  
Email: [sri@iastate.edu](mailto:sri@iastate.edu)

Dear Sri,

As a global leader in wind turbine technology, turbine design and manufacturing, and as a large wind project developer, Clipper Windpower, Inc. enthusiastically supports the project being proposed by Iowa State University.

Clipper is a pioneering company in U.S. wind development with wind farms throughout the US and wind turbines manufactured domestically. We have subsidiary companies in turbine design and manufacturing, wind farm support services (siting, installation, operations, maintenance, and management), as well as major wind energy project development. Currently, Clipper Windpower's wind resource portfolio totals over 9,000 MW, and contains projects throughout the US and Latin America including Iowa, Texas, and Wyoming. In addition, we have numerous other projects under development including the world's largest project of 5,050 MW planned for South Dakota.

As part of our participation in this project, Clipper will work with Iowa State on the proposed scope of work on a fixed price basis. We are prepared to commit \$20,000 of in-kind contribution to the project. This in-kind contribution will come in the form of engineering support and providing you with some loads data subject to the execution of a sub-contract between Clipper and Iowa State for this project in the event of an award for your successful proposal.

We can envision that the technology that emerges from this will be of great interest to the wind power industry in the U.S. We look forward to assisting your team in any manner that can further its mission.

Sincerely,

A handwritten signature in blue ink that reads "Garry L. Pealer".

Garry L. Pealer  
Corporate Secretary / Treasurer



May 26, 2010

Sri Sritharan, PhD, PE  
Wilson Engineering Professor & Associate Chair  
Director of Graduate Education  
Department of Civil, Construction & Environmental Engineering  
Iowa State University  
376 Town Engineering Bldg.,  
Ames, IA 50011-3232

Dear Sri:

Re: GIVF Proposal for Wind Turbines

This letter is to confirm Lafarge's intent to collaborate with 'in-kind' contributions on the above project study.

Lafarge is prepared to provide 'in-kind' the following:

- 8 cubic yards of Ductal (delivered) – value - \$ 20,000
- Product Training & Technical Support – value - \$4000

We look forward to working with ISU and your team on this interesting collaboration.

Yours very truly

A handwritten signature in blue ink, appearing to read 'V. Perry', written over the text 'Yours very truly'.

V.H.(Vic) Perry, FEC, FCSCE, MASc., P.Eng.,  
Vice-President & General Manager Ductal®