National Institute of Standards and
Technology
Department of Commerce

SBIR

SMALL BUSINESS INNOVATION

RESEARCH PROGRAM

PHASE I and PHASE II

AWARDS FOR FISCAL YEAR 2020

INTRODUCTION

Abstracts of Awards for Fiscal Year 2020 SBIR Program

Note: Certain non-ASCII characters may not be represented accurately in this document. In cases where there may be doubt, please direct your questions to sbir@nist.gov.

Fiscal Year 2020 List of Awardees

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70NANB20H121	Awayr, Inc.	Phase I
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FY 2020 PHASE I AWARD

Title: An Optical Imaging System to Characterize Mechanical Deformation at Microscopic Length Scale

Firm: Additive Manufacturing Innovations LLC
65 Main St.
Potsdam, NY 13676

Principal Investigator: Ajit Achuthan

Phone: (315) 262 4998

Email: achuthan@aminnov.com

Award Amount: $99,998.80

Abstract: Additive Manufacturing Innovations LLC will develop a new optical imaging system to characterize microscopic deformation of materials. The system, named as a Mechanical Testing at Microscale system (*MT@micro*), uses a micro-tensile testing device to mechanically load the specimen uniaxially and an optical imaging platform to capture high resolution, in-situ images of the evolution of heterogeneous deformation on the specimen surface for a large global strain. Such an enormous advancement in the characterization capabilities could be achieved by addressing the fundamental challenges of the state-of-the-art technology, primarily the narrow depth of field of the microscope, large rigid body motion of the field of view, and lack of a data processing algorithms to extract critical engineering data from a large number of image frames. *MT@micro* will have three innovative solutions to address these challenges: 1) a smart imaging subsystem, 2) a features detection and tracking subsystem, and 3) a material modeling subsystem. Solutions will be developed following an interdisciplinary approach. The proposed system is expected to advance the mechanical characterization at microscale with an optical imaging technique into a robust material design and development tool.

Commercial Applications: The customer discovery interviews conducted by our team as part of our participation in NSF I-Corps site program validated a large demand for the characterization of microscopic deformation of materials among scientists and

engineers who work in defense, aerospace, automotive, healthcare, and manufacturing sectors. This demand is growing exponentially due to an emerging interest in tailoring material microstructure to derive high-performance materials and structural components with spatially gradient properties.

Title: Advanced Measurement Probe System for Non-Nulling Velocity Testing

Firm: AirFlow Sciences Corp.
12190 Hubbard St.
Livonia, MI 48150

Principal Investigator: Matthew Gentry

Phone: (724) 525-0300

Email: mgentry@airflowciences.com

Award Amount: $100,000.00

Abstract: Industrial facilities and power plants that burn fossil fuels exhaust the combustion products to atmosphere through their smokestacks. Stack pollutant emissions are quantified using manual testing method developed in the 1960s, which are prone to error due to biases from human operators and any non-axial flow in a stack.

NIST has been working on an improved technique of performing 3D flow testing for smokestacks, which significantly reduce the complexity, duration, and potential for error. Advanced data acquisition systems were developed to accommodate the NIST test methodology. These systems are highly accurate but still rely on human intervention to move and control the test probe. The systems are also relying on probe technology and manufacturing techniques developed 30 years ago.

This project will develop an advanced probe movement system suitable for the “non-muling” technique. The system requires highly accurate probe positioning with the capability of moving up to four probes simultaneously. The probe movement will be computer-controlled and coordinated with the data collection operations of the existing non-mulling hardware. The project will also investigate the optimum prove geometry and manufacturing techniques. A prime objective will be to optimize the manufacturability and cost to the end-user of the non-mulling probe.

Commercial Applications: The equipment developed during this research will apply to smokestacks at large industrial facilities, allowing them to more accurately quantify and minimize their pollution emissions. The system will be accurate but easy to use, allowing stack testing personnel (from the plant site or third-party stack testing companies) to obtain high-quality data with less effort than current methods. In addition, the instrumentation will be applicable to other industrial personnel that use EPA Method 2F test procedures. This encompasses activities such as large horsepower fan performance testing, combustion optimization of boilers, an HVAC equipment testing at nuclear power plants.

Title: Awayr Security: Validating the NIST Phish Scale Toward Artificial Intelligence Approaches Toward Human Cybersecurity

Firm: Awayr, Inc.
500 Massachusetts Ave.
Cambridge, MA 02139

Principal Investigator: Adam Beal

Phone: (303) 350-9175

Email: BEAL@GETAWAYR.COM

Award Amount: $99,999.41

Abstract: Remote operated social engineering (ROSE) attacks account for a surprising share of successful cyberattack. For example, The Verizon Data Breach Incident Response 2019 report found that approximately 94% of all malicious code was introduced into systems via email. Threat actors, illegally, benefit from knowledge gained from repeated massive remote operated social engineering operations. Defensive actors can leverage simulation, but unlike the advanced state of computer penetration simulation, human behavior in the face of social engineering is presently not easy to simulate. This means that descriptive and predictive understanding of the human attack surface is vested in threat actors. Defensive forces today operate at a

disadvantage, despite the efforts of a rapidly growing market: phishing alone is projected to grow to USD 1,401.6 Million by 2022. This clear and present problem is one Awayr can address through next-generation predictive models of vulnerability in cybersecurity. Specifically, this Phase I will prove out the technical and business feasibility of using NIST's Phish Scale as the underpinning of Awayr Security. Awayr will 1) validate the Phish scale using a cue-coded phishing email corpus, 2) explore the feasibility of automated cue detection systems, and 3) leverage this understanding toward a 5 year plan.

Commercial Applications: Awayr Security will provide a digital twin for the information workers of an organization. This simulation capability will allow security professionals to test phishing campaigns, bootstrap detection of vulnerable individuals, and better target training. Awayr sees this commercial product as a great equalizer to the asymmetry between ROSE cyberattack and cyberdefense, able to assign a score to individual phishing email difficulty, and to individual user security orientation. Awayr will then look toward a future where lessons and datasets collected toward email security can be applied to other ROSE domains, including chat, vishing, and social media.

Title: Feasibility of Using a High-speed AI-driven Experimental Platform to Develop an Optimized DNA Template for Cell-free Protein Expression

Firm: BigHat BioSciences
733 Industrial Road
San Carlos, CA 94070

Principal Investigator: Peyton Greenside

Phone: (650) 394-7679

Email: peyton@bighatbio.com

Award Amount: $100,000.00

Abstract: BigHat Biociences will demonstrate the feasibility of using a high-speed artificial intelligence (AI)-driven experimental platform to optimize the DNA template for cell-free protein synthesis (CFPS) to maximize protein expression. Their platform is designed to rapidly find an optimal DNA sequence among millions of possible sequences through repeated design build-test cycles: AI is used to design the DNA template for each consecutive iteration based on the results from previous cycles, CFPS is used to build the protein from the DNA template, and testing is used to determine the protein yield. Using published datasets, BigHat Biosciences will run simulations to show that their platform can find optimal sequences among >250,000 possibilities based on experimental testing of only about 1% of those sequences. As a proof-of concept case, they plan to optimize a ~30-nucleotide expression cassette region encompassing the sequences from the start of the ribosomal binding site through codon 5 of the protein coding sequence. It has been historically intractable to optimize cassette regions over ~10-nt because the search space if simply too large for comprehensive experimental exploration. The Phase I project aims to demonstrate the feasibility of optimizing larger cassette and coding regions through tight coupling of computational and experimental evaluation.

Commercial Applications: BigHat Biosciences' AI-driven experimental platform can accelerate development of therapeutic antibodies by using machine learning to guide antibody engineering for improved biophysical attributes such as stability, solubility, and aggregation, which are important for manufacturing, storing, and delivery. Therapeutic antibodies are one of the most successful and fastest growing classes of drugs, but their development remains a challenging and painstaking endeavor largely due to the difficulty of optimizing multiple critical biophysical properties. Changes to the antibody that improve one property may negatively impact another, creating a complex optimization problem that can best be overcome with AI-guided protein engineering.

Title: Dynamic Incident Intelligence System, Utilizing Adaptation to Real-Time Information

Firm: Emergent Healthcare Solutions LLC
910 Shelley St.
Springfield, OR 97477

Principal Investigator: Paul Schlumpberger

Phone: (503) 475-9058

Email: pausch@emergenthes.com

Award Amount: $104,525.00

Abstract: Emergent Healthcare Solutions will research the feasibility of a dynamic cloud-based incident Intelligence System called Emergent Cloud. Emergent Cloud is an application service providing firefighters and Emergency Medical Technicians access to an interactive incident roadmap and real-time workflow and record keeping. The general aim of the project is to revolutionize the user experience and data management workflow for first responders to greatly enhance the accuracy of the collected date in real-time and to reduce the mental load and workload of first responders. Emergent Healthcare Solutions aims to transform the first responder user experience from an antiquated after-the-fact collection platform to a real-time, largely automated, user-friendly data management platform.

Commercial Applications: There are currently no products in the Emergency Services record-keeping market that address automated data collection to facilitate real-time decision making in the field, However, market research shows an immediate need and interest in this innovation. Fire and Rescue departments are the first potential customers, with an estimated 29,819 fire departments in the US and 46% of them providing medical services. The Emergent Healthcare Solutions team has extensive experience in product commercialization and marketing and has potential clients specifically interested in this product.

Title: An Integrated Data System for Machine Learning based Prediction of Radio Frequency Integrated Circuits (RFIC)

Firm: HelloMaxwell, Inc.
32 Tower Road
Lexington, MA 02421

Principal Investigator: Qiang Cui

Phone: (336)-541-4257

Email: qiangcui@mit.edu

Award Amount: $106,500.00

Abstract: Radio frequency integrated circuits (RFICs) are key components for wireless communication system. RFIC's hard-to model parasitic effects and poor simulation accuracy require multiple trial-and-error tape-outs (fabrications) to meet product specs. Tape-out is very slow (2 months) and very costly (as high as $2M). In the coming 5G era, this problem gets worse as mmWave frequency parasitic effects are even harder to model, thus more tape-out rounds are needed HelloMaxwell research combines physics-based models and customized machine learning (ML) to predict RFIC performance. This prediction method can improve RFIC's prediction accuracy by 97%, which means engineers can reduce the RFIC development time by at least one tape-out round. In order to achieve this improvement, the ML training needs sufficient compatible data across design, simulation and test. Today's RF semiconductor companies have indeed enough RFIC data points, however the existing data system is fragmented and inconsistent, so impractical for ML training. To overcome this problem, HelloMaxwell will design an integrated RFIC data system during this Phase I project. The proposed work sets the foundation for ML algorithm research planned for NIST Phase II, paving the way for commercializing our novel technology for the modern communications system.

Commercial Applications: Based on over 100 thorough customer interviews conducted during the National Science Foundation's i-Corps program, the technology has very large commercial application potential. Though there are numerous applications for the technology, HelloMaxwell will first target the $50B global radio frequency integrated circuits (RFICs) industry. Out of the $50B, about $15B is spent on tape-out or tape-out related activities. Saving just one tape-out each product presents $3B market opportunity. The beachhead customer segment will be RF companies who design complex RFIC products for mobile phone applications.

Title: High-Precision TEM Topography Mapping

Firm: NanoElectronic Imaging, Inc.
1518 S Centinela Ave.
Los Angeles, CA 90025

Principal Investigator: William Hubbard

Phone: (617) 347-6436

Email: bhubbard@nanoelectronicimaging.com

Award Amount: $99,991.73

Abstract: NanoElectronic Imaging, Inc. (NEI) is developing techniques for mapping signals in the transmission electron microscope (TEM) that are normally inaccessible. In this Phase I SBIR project, NEI will build on preliminary results to develop a quantitative,

TEM-based topographic mapping technique with the potential for atomic resolution in all three spatial dimensions. This precision would be akin to an AFM-in-TEM. The technique is based on scanning TEM electron beam-induced current (STEM EBIC) imaging, which maps pixel-by-pixel the current generated in a TEM sample by the electron beam. This project will quantify the relationship between a new EBIC signal (previously discounted as ``noise'') and topography. STEM EBIC has already been demonstrated at atomic resolution laterally, and preliminary results suggest that near-atomic resolution in height is possible. In this Phase I project, the new signal's signal-to-noise will be maximized, and its exact relationship to height will be quantified by direct comparison to atomic force microscope (AFM) topographic maps. Finally, a statistical analysis of height precision, along with calibration procedures, will be developed. The reach goal of this project is to demonstrate topographic resolution comparable to, or even surpassing, NIST's traceable AFM.

Commercial Applications: Despite its fantastic spatial resolution, standard STEM is blind to many electronic, thermal, and physical signals that directly relate to microelectronic device function and failure. NEI is developing a STEM EBIC imaging system that reveals these signals. The topographic imaging capability targeted by this Phase I project is an example. TEMs are ubiquitous in industry and academia, but TEM-based methods for measuring thickness and topography are awkward and inaccurate, and thus seldom used. STEM EBIC topography could make this capability accessible. A TEM-based topographic mapping technique competitive with AFM would be a truly disruptive development for sample characterization.

Title: Standardizing Grease Sampling and Characterization By Automated Online Device

Firm: Poseidon Systems
200 Canal View Blvd.
Rochester, NY 14623

Principal Investigator: Ryan Brewer

Phone: (585) 633-8550

Email: ryan.brewer@poseidonsys.com

Award Amount: $98,750.00

Abstract: Scheduled grease sampling is one of the more reliable methods for detecting mechanical issues within machinery. Offline laboratory-based analysis of the grease can indicate component failures, such as spalling via high concentrations of ferrous particulates. However, consistency, costs, and frequency of sampling are less than ideal. Manually collecting grease samples can put personnel in danger due to the location of the sampling location and potential for other machinery still in operation. In

addition, grease sampling is a bit of an art form requiring experience with consistency in how samples are taken directly affecting the results and benefits. To help address, Poseidon Systems will develop a repeatable inline grease sampling mechanism to automatically monitor the ferrous particle content of grease from an in-operation machine. The device will automatically collect samples from the target bearings in a repeatable controlled manner. These samples will then be analyzed by the device for ferrous particle content in order to provide in situ indication of wear debris contamination. The ferrous content could then be trended over time and monitored remotely for condition monitoring of these crucial grease packed bearings.

Commercial Applications: During the Phase II effort, Poseidon Systems will mature the prototype design created during the Phase I effort further enhance system capability and robustness. Phase II efforts will focus on improving the design developed during Phase I needed to make the automated grease sampler a commercially viable system. The goal is to create a robust system that can be deployed on a variety of systems. A specific targeted market is the wind energy generation sector. Scheduled grease sampling is one of the more reliable methods for detecting issues with the large critical bearings in today's wind turbines. Offline laboratory-based analysis of the grease from generator, pitch (blade), yaw, and main bearings can indicate component failures, such as spalling via high concentrations of ferrous particulates. However, consistency, costs and frequency of sampling are less than ideal. A critical need will be in the offshore wind industry. Manually collecting grease samples from the planned offshore arrays will be even more costly and difficult to schedule. New active pitch and yaw control systems maximizing power production will increase the wear on corresponding components, thus leading to stronger need to monitor the health state of those components robust system that can be deployed on a variety of systems. A specific targeted market is the wind energy generation sector. Scheduled grease sampling is one of the more reliable methods for detecting issues with the large critical bearings in today's wind turbines. Offline laboratory-based analysis of the grease from generator, pitch (blade), yaw, and main bearings can indicate component failures, such as spalling via high concentrations of ferrous particulates. However, consistency, costs and frequency of sampling are less than ideal. A critical need will be in the offshore wind industry. Manually collecting grease samples from the planned offshore arrays will be even more costly and difficult to schedule. New active pitch and yaw control systems maximizing power production will increase the wear on corresponding components, thus leading to stronger need to monitor the health state of those components.

Title: Pyrocast: Wildfire Forecasting & Data Services

Firm: Reax Engineering Inc.
1921 University Ave.
Berkeley, CA 94704

Principal Investigator: Christopher Lautenberger

Phone: (510) 387-2155

Email: lautenberger@reaxengineering.com

Award Amount: $100,000.00

Abstract: This work will develop a real-time wildfire forecast system that automatically detects and forecasts the spread of every fire in the Continental US and updates each forecast in real-time as additional information becomes available. Fire forecast data, which are generated “in the cloud” using high performance computing resources, are transferred to a web server hosting a mobile-friendly web map that facilitates visualization by stakeholders such as first responders and government entities. Subscribers will also be able to initiate a fire spread forecast by clicking a location on the web map and specifying an ignition time; the resultant forecast will then also be visible to others, enabling coordination among first responders and other agencies. This system also quantifies near-term fire risk by modeling ignition and spread of millions of hypothetical fires at various times in the future. This provides a means to quantify spatially and temporally granular near term fire risk in terms of fire size and number of structures impacted to inform decisions regarding resource allocation and fire prevention.

Commercial Applications: There is clear commercial potential for this fire forecasting system. Government agencies (federal, state, and local), first responders, and public utilities desperately need reliable fire forecast data to make informed decisions relative to issuing effective warnings to the public, strategic allocation of suppression resources, fire prevention via powerline de-energization and other measures, and evacuations during ongoing fires. Through a subscription-based service, the fire forecasting system developed under this work will provide data that meets those needs.

Title: ENT: Extended Nestor Tagging

Firm: RedShred
5520 Research Park Drive
Baltimore, MD 21228

Principal Investigator: Maryam Esmaeilkhanian

Phone: (443) 681-9938

Email: mesmaeilkhanian@redshred.com

Award Amount: $100,000.00

Abstract: In order for manufacturers to adopt data-driven decision making, they must tap into unstructured data that sits unused. The process of annotation and knowledge

extraction from unstructured text data is a time consuming and challenging bottleneck to adopting machine learning at scale. This Phase I SBIR will implement an enhanced cloud-based platform enabling maintenance and other organizational users to tag and extract knowledge from large volumes of unstructured text data more efficiently. In Nestor, NIST provides an NLP toolkit that assigns tags and rules to unstructured data by a ranked tagging procedure. Combining this approach with RedShred's state of the art enrichment platform will accelerate an organization's ability to rapidly develop and deploy these models to support evolving organizational needs. The extended system, ENT, will include customizable ranking allowing organizations to tailor which data are prioritized based on business value as well as interactive UI dashboards providing real-time feedback. This combined system provides a valuable low-friction solution to accelerate adoption of NLP technologies in manufacturing to unlock value from previously idle log data repositories.

Commercial Applications: ENT fills gaps in existing market solutions by leveraging NLP to analyze work orders and manuals in manufacturing and maintenance. Technicians gain efficiencies by reducing time recording work order data without significant changes to existing workflows. Data scientists gain an order of magnitude increase in time-savings to clean, organize and tag data for downstream analytics. Nestor has demonstrated significant impact by reducing tagging time from 12 hours to 45 minutes for 1,200 work orders. By deploying ENT at scale organizations reduce the $50+billion spent on maintenance costs annually by putting existing organizational data and processes to work.

Title: High Throughput, High-Pressure Small-Angle Neutron Scattering Sample Environment

Firm: STF Technologies LLC
18 Shea Way
Newark, DE 19713

Principal Investigator: Ryan Dombrowski

Phone: (716) 799-5935

Email: rdombrowski@stf-technologies.com

Award Amount: $100,000.00

Abstract: STF Technologies addresses a need of the neutron user community by creating a minimum viable prototype of the only high-throughput hydrostatic pressure small angle neutron scattering sample environment (HTHP-SANS-SE). Our HTHP-SANS-SE will greatly improve the ease of use and reliability of measurements under extreme environments, thereby increasing throughput on the beamline and expanding feasibility. Current HP-SANS cells are difficult to load/unload and require significant

sample amounts, often prohibitive for soft matter users. The HTHP-SANS-SE will be controlled via existing data acquisition software (NICE) and enable queueing multiple cells compatible with standard sample block environments, to optimize the use of beamtime while greatly simplifying support required from beamtime scientists.

Commercial Applications: STF Technologies addresses a significant unmet need to improved HP-SANS measurement capabilities for R&D in healthcare/biology, energy, and consumer products. A reliable, efficient HP-SANS sample environment will maximize valuable beamtime, increasing operational efficiencies and improve output at neutron scattering facilities, such as NCNR, and programs such as nSOFT. Their commercialization plan envisions stages Phase I/II/III development that directly meets the needs of our primary target customers (beamline facilities(by improving support of HP-SANS users and efficiency. This well-defined initial market is p art of the rapidly growing $1.12b total SANS market, and complements other SANS SE produces engineered by STF Technologies.

Title: Model-Based Application of NIST Cybersecurity Standards

Firm: WW Technology Group
4519 Mustering Drum
Ellicott City, MD 21042

Principal Investigator: Richard Le Boeuf

Phone: (254) 485-7809

Email: rleboeuf@wwtechnology.com

Award Amount: $100,000.00

Abstract: The innovation will use a model-based approach to streamline understanding and application of standards. NIST standards addressing cybersecurity, presented in the form of documents, spreadsheets, and database tools, provide thousands of complimentary and overlapping items for users to track. Significant effort is expended understanding the standards before attention can be focused on the system of interest. Model-based representations of both the standards and cyber-physical systems in a single tool will provide advantages over current costly and labor-intensive approaches. The tool will give stakeholders at all organizational levels access to the information specific to their domain, enable a better understanding of both the standards and the system, and be the basis for analyses and generation of certification artifacts. WW Technology Group will model NIST SP 800-53, NIST SP 800-53A, the NIST Cybersecurity Framework, NIST IR 8183, and the new Cybersecurity Maturity Model Certification (CMMC) standards and trace them to a cyber-physical system model. Analyses will be developed to automatically assess compliance gaps in the system relative to the standards. Stakeholder-specific reports with analysis results and

recommendations will be generated automatically. The extensible tool will improve the efficiency of understanding and applying existing, evolving, and new NIST standards.

Commercial Applications: A tool providing model-based representations of both standards and cyber-physical systems and their interrelationships has potential commercial applications in civilian government, DoD, commercial, and academic markets. Cybersecurity risks have been increasing in all sectors and legal and regulatory requirements pertaining to cybersecurity continue to mature. So, a tool that continually captures those requirements and the system characteristics throughout the system life cycle will be useful in many areas. It could be applied in organizations generating, using, assessing, or authorizing systems. It would also be useful for academic institutions for improving cybersecurity standards coverage in degree and certificate programs.

FY 2020 PHASE II AWARD

Title: Advanced Instrumentation for Non-Nulling Stack Velocity Testing

Firm: Airflow Sciences Corp.
12190 Hubbard St.
Livonia, MI 48150

Principal Investigator: Matthew Gentry

Phone: 734-525-0300

Email: mgentry@airflowsciences.com

Award Amount: $400,000

Abstract: Industrial facilities, manufacturing plants, and electric power plants that burn fossil fuels exhaust the combustion products to atmosphere through their smokestacks. Stack pollutant emissions are quantified using manual testing methods developed in the 1960s, which are prone to error if complex flow patterns exist, which is common. Recently, NIST has been working on an improved technique of performing 3D flow testing for smokestacks, which will greatly reduce the complexity, duration, and potential for human error. Advanced data acquisition systems and software are required to accommodate the NIST test methodology. These systems must be highly accurate but also able to operate in potential harsh environmental conditions since the testing is conducted year round on outdoor platforms of smokestacks. The Phase II SBIR will continue the research and development of the Phase I effort for NIST. During Phase I, a prototype data acquisition device was developed, and proved to successfully meet the project goals, proving feasibility of the system. During the Phase II effort, the

development will be expanded to create a complete system, capable of full-scale testing at industrial plants. A test site in Michigan will be selected, likely a DTE Energy site, to prove out the system and verify operation.
Commercial Applications: The instrumentation developed during this research will be applicable to smokestacks at large industrial facilities, allowing them to more accurately quantify and minimize their pollution emissions. The system will be accurate but easy to use, allowing stack testing personnel (from the plant site or from third-party stack testing companies) to obtain high-quality data with less effort than current methods. In addition, the instrumentation will be applicable to other industrial personnel that use EPA Method 2F test procedures. This encompasses activities such as large horsepower fan performance testing, combustion optimization of boilers, and HVAC equipment testing at nuclear power plants.

Title: Direct Performance Evaluation of Additive Manufacturing Process Plans

Firm: Intact Solutions, Inc.
211 S Paterson St.
Madison, WI 53703

Principal Investigator: Goldy Kumar

Phone: 608-334-9646

Email: gkumar@intact-solutions.com

Award Amount: $400,000

Abstract: Additive manufacturing is steadily advancing towards fulfilling its promise of customized and on-demand production of functional parts. However, performance of as-manufactured parts can differ significantly from the as-designed parts because the as-manufactured geometry differs from the as-designed geometry and the as-manufactured material properties are unknown. Attempts to predict performance of as-manufactured parts are hampered by the complexity of the as-planned geometry and the unknown material properties. In Phase I, Intact Solutions successfully demonstrated the feasibility of performing accurate structural simulation directly from AM plans while querying material information directly from NIST's AMMD. This was achieved by extending our moment-based interoperable simulation technology that incorporates material properties through a combination of analytical, experimental, and data-driven methods.

In Phase II, Intact Solutions will develop a novel Part-Scale Process–Structure–Property–Performance (PSPP) architecture and implement a robust commercial grade system for performance prediction of AM parts. The developed system will support adaptive exploration of process and design spaces through direct integration with AM

material databases, as well as simulated data. In addition to rigorous validation and testing, we will demonstrate how our system can be used to evaluate, compare, and optimize AM process plans, leading to significant savings and improved performance.

Commercial Applications: The ability to computationally assess performance and optimize process planning of AM components directly from process plans will lead to dramatic savings in time and cost in additive manufacturing throughout US industry.

The technology will serve three major customers: (1) manufacturing service industry that depends on rapid generation and evaluation of process plans, (2) aerospace, defense, and medical industry where performance of mission-critical printed components is determined by the process plan and its parameters; and (3) small businesses and maker communities that increasingly rely on additive manufacturing but are unable to predict whether 3D printed components will be functional.

Title: Watertight CAD for Integrating Isogeometric Analysis into the Model-Based Enterprise

Firm: nVariate, Inc.
1101 W 34th St.
Austin, TX 78705

Principal Investigator: Benjamin Urick

Phone: 512-934-4765

Email: benurick@nvariate.com

Award Amount: $399,968

Abstract: Today's Computer-Aided Design (CAD) applications utilize restrictive mathematical assumptions to approximate the compound geometric intersections necessary to represent real-world products. As a result, critical information is not represented within the Model-Based Definition (MBD) for downstream users in the digital thread, forcing engineers to manually repair CAD models and convert them into degraded formats, such as polygonal meshes for Finite Element Analysis (FEA). For Isogeometric Analysis (IGA), the problem is worse as the input required is a watertight spline representation, Although there are current solvers in both academia and industry to run IGA models, there is no automated means to produce the watertight spline representation input form CAD models, a gap in the Model-based Enterprise (MBE). nVariate's Watertight CAD technology solves this problem by creating geometrically gap-free representations from trimmed surfaces, natively within the CAD application., This requires minimal change to the user's high-level software interface while the technology fixes the flaws within the CAD model. The resulting model is IGA-ready for existing industrial and academic implementations, as well as for use in forthcoming IGA

ISO standards. This is critical in bridging gap in the MBE, integrating IGA into the digital thread.

Commercial Applications: The product will be a CAD plugin that produces IGA-ready watertight spline representations without the need of any importing or exporting files between applications, file conversions, or unique representations that are non0native to CAD systems. To the frustration of users, an IGA preprocessing tool from CAD data is currently unavailable in the technology space of the MBE. This product uniquely fills that void with the least disruption in the digital thread. T pheroduct will provide substantial benefit to design engineers who create complex and/or precision designs in aerospace, automobile, and medical device industries.

Title: The Full Integration of a Portable Bacterial Concentrator with a Pathogen Detector Device

Firm: OmniVis, LLC
2042 Malibu Dr.
West Lafayette, IN 47906

Principal Investigator: Katherine Clayton

Phone: 415-309-9524

Email: kclayton@omnivistech.com

Award Amount: $400,000

Abstract: This SBIR Phase II project will integrate an easy to use, inexpensive, and portable bacterial concentrator with a handheld pathogen detection system to enable ultra-low cholera pathogen (Vibrio cholerae) detection. Cholera affects communities across 41 countries, including in Yemen, where in the first 5 months of 2020 has had 110,000 suspected cases. Current methods used to detect the cholera pathogen in water involves a 3 to 5-day procedure due to the low concentrations of the bacterium found in the water. The proposed device intakes 1L of water from an environmental water source and concentrates the solution down to 1mL, enriching the bacteria contained within the sample. The enriched sample is then immediately deposited into a handheld detection system to identify low, but dangerous, bacterial levels. OmniVis will expand upon their SBIR Phase I work by designing a user-friendly and fully integrated device for sample-to-answer environmental V. cholerae detection. They will identify a membrane that best captures and releases V. cholerae cells from environmental water, for robust operation in the concentrator. Following, they will design, bench test, and perform user-centered studies on a concentrator that integrates a disposable test kit, to seamlessly integrate our concentrator to a pathogen detector system with minimal user steps. Lastly, they will make mixed cultures of environmentally relevant bacteria, pass the sample through the concentrator, collect, and test the sample. The final step will

provide critical knowledge in the effect complex environments have in detecting Vibrio cholerae and will demonstrate a full sample-to-answer system for water-based pathogen detection.
Commercial Applications: The commercial potential of this project is an inexpensive, portable, and easy to use device that concentrates the Vibrio cholerae in environmental water sources for pathogen testing. Contaminated water sources place populations at risk for contracting cholera where patients exhibit symptoms of severe diarrhea, vomiting, and dehydration and if left untreated, death. OmniVis proposes a concentrator integrated with a detection device for a sensitive test. The platform would enable aid organizations to discover low, but dangerous, levels of Vibrio cholerae. Early detection will save the time and costs currently associated with cholera outbreaks.

Title: Commercialization of NIST Technology for Separating Particles with Light

Firm: Parman Tech, LLC
9231 Shafers Mill Dr.
Frederick, MD 21704

Principal Investigator: John Curry

Phone: 240-405-9670

Email: jjcurry@parmantech.com

Award Amount: $400,000

Abstract: Parman Tech will build a first prototype embodying the NIST-owned technology 'Optical Particle Sorter.' The prototype will demonstrate feasibility of a commercial implementation of this technology. The prototype will also serve as the model for subsequent production of several beta-units to be used for obtaining customer feedback and eventually validation of the product.

Commercial Applications: The technology developed by Parman Tech under this grant will enable the directors of research in companies developing gene therapy and nano-therapeutics to produce safer and more effective treatments for some of the most persistent and devastating human diseases.

Title: Microcapillary Quartz Sensors for Screening Injectability of High Concentration Protein Formulations

Firm: QATCH Technologies LLC
551 Dairy Glen Rd.
Chapel Hill, NC 217516

Principal Investigator: Zehara Parlak

Phone: 678-908-3112

Email: zehra.parlak@qatchtech.com

Award Amount: $400,000

Abstract: The main focus of this project is to develop a prototype instrument and test cartridges for injectability pre-screening of high concentration protein formulations (HCFs). HCFs are non-Newtonian fluids with shear-thinning behavior and they are formulated to be administered by subcutaneous or muscular injections. The injectability and manufacturability of HCFs depend on the viscosity behavior over a very wide range of shear-rates. In Phase I, QATCH demonstrated the feasibility of wide shear-rate viscosity measurements by its proprietary microcapillary quartz technology. In Phase II, QATCH will determine the 1) Sensor design for wafer-scale productions, 2) Processing steps for deployability of the sensors, 3) Prototype instrument firmware and software, and 4) Linearity and accuracy of the viscosity measurements on a wide range of solutions. The finalized prototype will be tested by external partners and be ready to be deployed to industry experts.

Commercial Applications: Injectable protein-based therapeutics are preferred by patients and health-care providers over IV infusion, yet only 40% of the recently approved protein-based therapeutics are injectable. Because, biopharma researchers do not have proper analytical tools for optimizing protein molecules for injectability and selecting injectable candidates in early drug development. QATCH aims to fix this by its proprietary injectability screening technology, which is an extremely low sample volume and broad dynamic range viscometer for protein formulations. This technology will not only enable early stage injectability screening of protein formulations, but also deliver significant material and time savings for biopharmaceutical industry.

Title: Easy-to-use, Autonomous Bin-picking and Assembly Operations for the Manufacturing Industry

Firm: Robotic Materials Inc.
1860 38th St.
Boulder, CO 80309

Principal Investigator: Nikolaus Correll

Phone: 303-717-1436

Email: nikolaus@roboticmaterials.com

Award Amount: $400,000

Abstract: Robotic Materials will develop a series of object manipulation primitives to pick up and assemble standard mechanical parts such as screws, gears and pulleys that can be configured without any programming skills. Building up on a smart robotic gripper, 3D perception and machine learning algorithms, they will design a graphical user interface that allows an user to label arbitrary 3D objects, identify assembly points, and issue pick-up and assembly commands, which are modeled by standard industrial assembly tasks that have been identified by NIST's manufacturing group. Specifically, they will provide routines for peg-in-hole and hole-on-peg assemblies that are defined by circular or rectangular holes or extrusions, as well as pick-up routines for arbitrary objects from clutter or in bins. The underlying algorithms have already been validated, making the focus of this proposal to develop interfaces that make their configuration as simple as possible, only requiring a user to present an individual object, labeling it, and selecting a desired action. This Phase II project will extend this approach to a larger class of objects and tasks and lead to deployment with real users.

Commercial Applications: Making operations such as bin picking and assembly available to non-programmers at a fraction of the cost of existing systems will dramatically broaden the possible applications for collaborative robots and enable use cases that were previously too expensive or too difficult to automate. Combining 3D perception and computation inside the gripper also enables automation in spaces where space constraints prevented the use of external camera systems. Not requiring any additional infrastructure also enables quickly adapting a robot for different applications, even at the same day.

Title: Advanced Manufacturing and Material Measurements Software Tool WEAVE for the Accelerating and Automation of SEM image analysis in the Semiconductor Industry

Firm: SandBox Semiconductor Inc.
54 Rainey St.
Austin, TX 78701

Principal Investigator: Meghali Chopra

Phone: 214-288-7926

Email: meghali.chopra@sandboxsemiconductor.com

Award Amount: $399,991

Abstract: The goal of this project is to create the software Weave™ to automate the extraction of critical dimensions (CDs) from scanning electron microscope (SEM)

images for the microelectronics industry. Current best practices for extraction of CDs are that personnel analyze the images one by one, which is tedious, prone to human bias, time-consuming and expensive. Successful implementation of Weave™ will save almost 10% of process engineers' time, freeing them for more productive and creative work. Two methods will be developed, tested and compared for edge and material detection and automated extraction of CDs; level set (LS) contour or edge detection and machine learning (ML) edge detection. Both methods will be developed because both show promise for this application, and they need to be evaluated for speed and accuracy on a variety of typical device nanostructures. The software will allow the user to import a prototypical image and specify the measurements to be extracted. The user then submits all the images with similar features (e.g., trenches or finfets) to be analyzed, and the software will produce tables of CD measurements and annotated images. Weave™ will plug directly into our current SandBox™ Studio software tool providing semiconductor process engineers with an end-to-end recipe development solution.

Commercial Applications: Semiconductor process engineers currently spend at least 10% of their time extracting measurements from microscope images, a procedure that is prone to significant human error. The development of Weave™ in this research will enable these process engineers to improve the accuracy of their process metrology workflows, reduce their total metrology costs, and accelerate their process development cycles. Weave™ will be deployed as a plug-in for SandBox™ Studio and as a standalone software.