

**Proposal for the Establishment of a Board of Trustees Approved
Center or Institute**

Proposed name of Center or Institute:

Louisville Automation and Robotics Research Institute (LARRI)

Physical Address/Location: Shumaker Research Building RM 246, Shumaker Research

Building 246, 2210 S Brook St, Louisville, KY 40208

University official to whom Center or Institute reports: Emmanuel Collins, Dean, Speed School

Name(s) and title(s) of individual(s) submitting this proposal:

Dan O. Popa, Professor and Endowed Chair on Advanced Manufacturing, Electrical and Computer Engineering, Speed School, Director of LARRI

Anticipated Date of Initiation of this Center or Institute:

01/01/2020

Existing Center or Institute the proposed Center or Institute is intended to replace (if applicable):

____N/A_____

Establishment Request Outline

1. A. Institute Rationale

Robotics and Automation are fast growing research areas of national importance with numerous applications including manufacturing, logistics, health, rehabilitation, and many others. For example, “intelligent and integrated manufacturing” environments have been identified by the Office of the President of the USA as one of the top three priorities for industry in the US since 2011. At the same time, the Advanced Manufacturing Partnership (AMP) program was also introduced as a way to revitalize US manufacturing. And, stressing human-robot cooperation, the National Robotics Initiative (NRI) was launched a year later as an outcome of AMP. Since 2012, US government agencies, including NSF, USDA, NIH, and DoD have invested heavily in robotics research, in excess of \$250M annually, and that trend has continued under the current administration. This investment spurred innovation at many US institutions and promoted follow-on multi-million dollar applied industrial research with a growth rate of over 15% per year. Industrial R&D activities in robotics and automation are widespread in the economy, including in large corporations such as car manufacturers (e.g., Tesla, Daimler, GM, etc.), equipment manufacturers (e.g., Rockwell, Caterpillar, Siemens, etc.), internet giants (e.g., Google, Apple, etc.), e-commerce and logistics (e.g., Amazon, UPS, etc.), and have led to the establishment of numerous startups in cities such as San Francisco/Bay Area, Boston, and Pittsburgh.

Despite this investment and the many growth opportunities, the state of Kentucky in general, and the University of Louisville in particular, have not taken advantage of the robotics and automation R&D boom. Our state has not invested in robotics education, and as a result it has not produced graduates ready to work in related industries despite the fact that it is part of the Midwest Robot Cluster. The cluster includes states such as Michigan, Illinois, Kentucky, Ohio, Indiana and Pennsylvania and contains a significant portion of the national installed industrial robot base and the highest concentration of robotics and systems integrator companies in the country. In addition to companies engaged in manufacturing and logistics, the state of Kentucky and the city of Louisville are also host to a large number of healthcare corporations, including national providers (Kindred, Humana), local hospitals (Norton, ULH), and a large number of home care providers. Therefore, by establishing a Robotics and Automation Research Institute, UofL will gain significant new opportunities for attracting research funding from both government and industry sources, while providing cutting-edge education and training opportunities for advanced robotics and automation professionals.

From a technical standpoint, mastering Robotics and Automation technologies require expertise in multiple engineering disciplines (mechanical, electrical, computer science, bio-engineering, material science) as well as in multiple application domains (e.g., health, medical, rehabilitation, manufacturing, etc.). As a result, robotics programs at other Universities around the country are cross-cutting and multi-disciplinary, involving many departments from Engineering, and, recently, from several schools such as Medicine, Brain sciences and Psychology. Well established examples of research institutes in robotics include the Media Labs at MIT, the Robotics Institute at CMU, and the Institute for Robotics and Intelligent Machines (IRIM) at Georgia Tech. There are currently over 25 universities offering an undergraduate or graduate degree in Robotics.

The objectives of the new Louisville Robotics and Automation Research Institute (LARRI) will be to: 1) Combine the expertise and existing research funding of UofL faculty in emerging research areas related to robotics and automation, 2) Be responsive to synergistic funding opportunities from the federal government, industry, and private donors, and 3) Create new cross-department educational opportunities and programs. The expertise and programs at the institute will also attract new faculty, researchers and graduate student hires, and will result in new state of the art facilities, which are indispensable for carrying out internationally competitive, large R&D projects. The new LARRI facilities will include human-robot collaborative spaces for manufacturing and logistics, healthcare and home environments.

Robotics and Automation has been recently identified as one of the 7 focus research areas at Speed School, along with Advanced Manufacturing, Big Data, Biomedical devices, Smart Infrastructure, Energy and Sustainability and Micro-Nano Technology. LARRI research programs will work synergistically with experts in these related domains to fulfill research and education needs related to robotics at UofL according to its mission statement 2: “practicing and applying research, scholarship and creative activity”. In addition, robotics will play a central role in Speed

School's efforts to attract and retain student talent at UofL, compatible with its mission statement 1: "teaching diverse undergraduate, graduate, and professional students in order to develop engaged citizens, leaders, and scholars". Finally, by engaging in local outreach events to K-12 students, and to industry, LARRI will fulfill UofL mission statement 3: "providing engaged service and outreach that improve the quality of life for local and global communities."

To establish the institute, we propose a three phase approach and corresponding performance metrics outlined below:

Phase 1 (FY2020):

- Combine faculty expertise and existing funding at SSoE in related areas to Robotics and Automation and establish competency areas.
- Leverage relationships with other research areas of strength at SSoE.
- Organize outreach/collaborations with other UofL schools and research centers.
- Fundraise for the establishment of a new robotics laboratory facility at SSoE.
- Plan hiring process for new tenure-track, term and research faculty.
- Target institute research expenditures in excess of \$2M in FY2020.

Phase 2 (FY2021)

- Commence hiring process for new tenure-track, term and research faculty.
- Refine and execute plans for a new LARRI facility.
- Establish regional reputation and start new educational initiatives (such as robotics certificate).
- Continue to obtain extramural funding from federal and industry sources (examples: GE Appliance Park, UPS, Cummins).
- Organize strategy for future I/UCRC, SBIR/STTR and I-Corps outreach components of the institute.
- Target research expenditures in excess of \$2M in FY2021.

Phase 3 (FY2022 and beyond)

- Establish national and international reputation.
- Continue hiring process for new tenure-track, term and research faculty.
- Increase the number of students and educational programs supported by the institute.
- Target research expenditures to increase \$500k/year every year to an eventual annual expenditure figure of \$5M/year.
- Target larger funding initiatives by participating in NSF-ERC, and large DoD programs.

1. B. Activities facilitated by LARRI

The Institute's Research Areas of Competence are based on the expertise of participating faculty, and include:

- o Human-Robot Collaboration
- o Automation and Robotics for Material Handling
- o Assembly, 3D Printing, and Manufacturing Automation
- o Precision, micro, and nano robotics
- o Intelligent Systems and machine learning
- o Motion planning for dynamic systems
- o Decentralized control of automation and robot systems
- o Soft and Wearable Robotics
- o Rehabilitation Robotics
- o Social and Service Robotics (Medical, Nursing, Aging in Place, Drug Treatment, Entertainment)
- o Networked Robots
- o Manned and un-manned aeronautical and astronautical vehicles (Drones)
- o Control and Observation of Uncertain Nonlinear Systems
- o Rapid Real-Time Control Systems Technology

- Distributed circuits, sensors and systems for robotics
- Sensors and control systems for smart manufacturing
- Smart home/building automation

In addition to faculty, LARRI will employ several full-time and part-time staff, who will be tasked with carrying out successful research and development tasks, executing existing projects, as well as attracting new funding. These employees will coordinate their activities with the participating center faculty and students. They will also help maintain institute laboratories and help secure future funding for the Institute (especially from industry and DoD). These capabilities are not currently available in a single lab or department and require considerable pooling of expertise and modern research facilities to deliver on promises to funding agencies in a timely and professional manner.

2. Oversight of LARRI

Oversight of Institute will be carried out by 1) Dean of Engineering, Emmanuel Collins, starting in Year 1 and 2) The SSoE Dean and an advisory board composed of senior individuals from Industry, Government and Academia, starting in Year 2.

3. LARRI Faculty

Participating faculty and their role include a leadership team, and a group of faculty participating in a Research Council (RC) for the institute. The role of the RC is to advise the director on technical directions pursued by the institute. Furthermore, the listed Time Commitment has been confirmed by each faculty member individually and will be listed in the 2020 approved departmental work plans.

1. Dan Popa, ECE, SSoE – Role: Director, Expertise in robotics and automation, Time commitment: 50%.
2. Olfa Nasraoui, CECS, SSoE – Role: Associate Director for intelligent systems. Time commitment: 40%
3. Cindy Harnett, ECE, SSoE - Role: Research council member, Expertise in soft robotics and microrobotics. Time commitment – 35%
4. Adrian Lauf, CECS, SSoE - Research council member, Expertise in aerial systems. Time commitment: 25%.
5. Mike McIntyre, ECE, SSoE- Role: Research council member, Expertise in control and energy systems. Time commitment – 20%.
6. Karla Welch, ECE, SSoE – Role: Research council member, Expertise in human-machine interaction. Time commitment – 20%.
7. Tommy Roussel, BioE, SSoE –Research council member, Expertise in bioinstrumentation. Time commitment – 15%.
8. John Naber, ECE, SSoE – Role: Industry liaison, Expertise in embedded sensing and computing. Time commitment – 15%.
9. Zhixia Li, CE, SSoE, Research council member, Expertise in autonomous driving systems. Time commitment – 15%.
10. Chris Richards, ME, SSoE – Role: Research council Member, Expertise in control systems. Time commitment – 10%.
11. Tamer Inanc, ECE, SSoE - Research council member, Expertise in control systems theory. Time commitment – 10%.

The Institute Director, Dan Popa, has not yet been appointed by the Board of Trustees. In addition to these core faculty, LARRI will also collaborate with several affiliated faculty, who are active collaborators on LARRI projects including:

12. Lihui Bai, IE, SSoE
13. Thad Druffel, Conn, SSoE
14. Kevin Walsh, ECE, MNTC, SSoE
15. Shamus McNamara, ECE, MNTC, SSoE
16. Bruce Alphenaar, ECE, SSoE
17. Monica Gentili, IE, SSoE
18. Kunal Kate, ME, SSoE

19. Gina Bertocci, BE, SSoE
20. Keng Hsu, ME, SSoE
21. Hui Zhang, CECS, SSoE
22. Hichem Frigui, CECS, SSoE
23. Nihat Altiparmak, CECS, SSoE
24. Robert Cohn, ECE, ERINC, SSoE
25. Jason Saleem, IE, SSoE
26. Cindi Logsdon, School of Nursing
27. Diane Orr Chlebowy, School of Nursing
28. Greg Barnes, SOM, Neurology, UofL Autism Center
29. Mark Running, A&S Biology
30. David Schultz, A&S Biology

Currently, faculty participation in LARRI is determined by research interests and voluntary association. Once faculty move into a physical space dedicated for the institute, the Institute director and the Research Council will discuss and approve a separate set of affiliation rules that determine their participation. We also plan to invite faculty members from other Kentucky institutions to affiliate with LARRI, such as our NSF EPSCOR colleagues from UK, EKU, WKU and MoSU, so that our institute will become the state-wide leader in robotics and automation research.

4. Projected Financial Information of LARRI

The institute will be funded by three methods. 1) Extramural research funds from active projects. At first, these sources will account for most of the institute's expenditures; 2) Support from faculty Endowments, RIF funds and SSoE Dean's office startup; 3) University support from C-RIF and other University gifts from private donors and corporations. We expect that these funds will increase over time once the institute is established.

In FY 2020 and FY 2021 the institute has extramural projects with a guaranteed research expenditure of \$2M per year. We anticipate that funding will increase by \$500k annually in FY 22-24.

In FY 2020 and FY 2021, the Office of the Dean of Engineering is supporting the mission of LARRI by providing salary and fringe benefits to hire a full time Program Coordinator and to supplement the salary of a research assistant professor. The value of this contribution is \$100k and is expected to continue in FY 2022-2024. Furthermore, \$50k in Endowment funds will be used to support institute activities in FY 2020 from Dan Popa's Vogt AM endowment, and from the Logistics and Distribution Institute (LODI), a close automation partner of LARRI. This amount is expected to be \$70k in FY 2021 and then \$30k in subsequent years. Center RIF is anticipated to be \$50k and greater in FY 2021 and beyond.

LARRI will engage in industrial collaborations in the Louisville area and beyond and will roll out an ambitious company membership and donor program that is expected to raise \$200k in FY 2021, increasing by \$100k every year after that.

The list of active related funds in FY2020 that will become part of LARRI include grants totaling almost \$10M:

1. NSF Project EPSCOR RII Track-1: Kentucky Advanced Manufacturing Partnership for Enhanced Robotics and Structures, *PI: Rodney Andrews (UK), Budget of subcontract to UofL \$5,304,000, UofL PI Dan Popa, co-PI Tommy Roussel, John Naber, Cindy Harnett, Olfa Nasraoui, Karla Welch 2019-2024.*
2. NSF Project CMMI 1734383: Light-Powered Microrobots for Future Microfactories, 2017-2021, *PI: Dan Popa, Budget \$765k, 2017-2021.*
3. NSF Project NSF MRI Award #1828355: MRI: Development of a Multiscale Additive Manufacturing Instrument with Integrated 3D Printing and Robotic Assembly, *PI: Dan Popa, Co-PI Cindy Harnett, Budget \$2,188,000 (extramural \$1,538,000), 2018-2021.*
4. NASA Kentucky Space Grant Consortium and EPSCoR Programs: Combined Static and Dynamic Anti-Windup Architectures for Landers and Ascent Vehicles Experiencing Large Disturbances, *PI: Chris Richards, \$64,296, 2019-2020.*

5. NASA Kentucky Space Grant Consortium and EPSCoR Programs: Stability Analysis and Synthesis of an Adaptive Control System with Anti-Windup Compensation for Flexible Spacecraft, *PI: Chris Richards, \$108,143, 2019-2020.*
6. NSF/NIH Project SCH: INT: Adaptive Partnership for the Robotic Treatment of Autism, *PI: Dan Popa, co-PI Karla Welch, Budget, \$1,198,471, 2019-2023.*
7. NSF EFRI C3 SoRo: Soft Curved Reconfigurable Anisotropic Mechanisms, *PI Nick Gravish (UCSD), U of Louisville Subcontract: PI Cindy Harnett, Budget \$500,000, 2019-2023.*
8. Industry Contract “Linear Motor Control Development for Vapor Compressor Application: Phase 11,” *GE Appliances, \$65,966, PI: M.L. McIntyre, 2019-2020.*

Total active grants in FY 2020: \$10M in extramural funding. Estimated C-RIF in FY 2020: \$50k

5. LARRI Operation Costs

Institute staff salaries: include a research (non-tenure track) faculty in FY 2020 (\$75k), two research faculty in FY 2021 (\$150k), projected raises for these faculty (\$200k) in FY 2022, three research faculty in FY 2023 (\$300k), projected raises in their salaries in FY 2024 (\$350k) and 4 research faculty hires in FY 2025 (\$450k). Corresponding fringes for these faculty are calculated at 28.5% fringe rate. These funds will primarily come from research contracts and grants, from SSoE Dean’s startup, and from LARRI faculty Endowments.

Institute staff support salaries: include money to support program coordinators, assistants, research scientists, postdoctoral associates and undergraduate assistants. These funds are calculated as follows: In FY 2020, LARRI will hire a program coordinator (\$65k salary), a half time program assistant (\$25k salary), a research scientist (\$65k salary), two postdocs (\$95k salary), and 3 undergraduate assistants (\$30k salary). A total of \$360k, including salary and fringes is budgeted for 7 staff support personnel.

Student salaries: The center will support approximately 15 full-time graduate students in FY 2020, and also provide summer salaries for 10 LARRI affiliated faculty. These funds will come mostly from research projects in FY2020. The number of graduate students supported is expected to climb to 20 in FY 2022, 25 in FY 2023, 30 in FY 2024, and 35 in FY 2025. We have also budgeted tuition in the amount of \$10k per student in our budget (these will vary depending on student status between the full in-state amount of approximately \$18k and the reduced amount of \$4.5k). In FY 2021, we anticipate an additional research scientist and upgrading the program assistant to full time for a total of \$473k for support staff. In FY 2022, an additional research scientist position will be added. The number of support staff will increase to 11 in FY 2023, 13 in FY 2024, and 15 in FY 2025.

The total faculty, staff and student salaries amount to \$943,675 in FY 2020, \$1,155,700 in FY 2021, \$1,465,975 in FY 2022, \$1,853,350 in FY 2023, \$2,202,175 in FY 2024, and \$2,615,250 in FY 2025.

Operating expenses: Operating expenses from extramural projects, C-RIF, Endowment funds will be used for miscellaneous daily operation of the center, including procuring computers and network infrastructure, data storage, office stationery and software, food for social events, funds to support a weekly research seminar and invited speakers, and other similar costs. Materials and equipment will be provided exclusively from active research projects in FY 2020. In later years, with securing additional funds for a new Engineering building, additional funds to equip laboratories will be made available to the institute. The anticipated operating costs amount to \$1,170,000 in FY 2020, \$1,250,000 in FY 2021, \$1,530,000 in FY 2022, \$1,735,000 in FY 2023, \$1,990,000 in FY 2024, and \$2,195,000 in FY 2025.

The total LARRI expenditures are projected to amount to \$2,113,675 in FY 2020, \$2,405,700 in FY 2021, \$2,995,975 in FY 2022, \$3,588,350 in FY 2023, \$4,192,175 in FY 2024, and \$4,810,250 in FY 2025.

6. LARRI staff needs

LARRI positions planned for FY 2020 include 8 support staff and 1 research faculty:

- A research coordinator (program manager), overseeing the post-award project execution and reporting on behalf of LARRI participating faculty (salary ~\$65k).
- A full-time research assistant (coordinator), helping to facilitate media, communication, and meeting activities of the participating faculty (salary ~\$50k).

- A research scientist/engineer I, providing technical leadership in research areas of competence for the institute, and interacting with industry (starting salary ~\$65k).
- A research assistant professor, helping to lead projects and provide technical leadership in research areas of competence for the institute (starting salary ~\$75k).
- Two postdoctoral researches, providing technical leadership in research areas of competence for the institute, salary (~47.5k each).
- Three undergraduate research assistants (salary ~\$10k each).

In FY 2021 and FY 2022, an additional research engineer will be hired each year. By 2025 the number of LARRI support staff will be 15, research faculty will be 4 and students will be 35.

In addition, there will be two assistant professors that will be hired in FY 2021 in the departments of ECE and CECS, respectively. Their startup package costs are reflected in increased equipment and material costs for LARRI, which have been budgeted in the NSF EPSCOR grant recently awarded to UofL.

7. LARRI space needs

LARRI laboratories will consist of active research labs and office space allocated to participating faculty in FY 2019 and for the next three years of operation. This includes office space in SRB (252, 246, 253) and lab space in SRB (213,214,215) and WS Speed (218, 219). Space needs in FY 2020 for LARRI full time administrative and technical staff was requested and approved on *SRB third floor* and amount to approximately 1000 ft². Space needs for the two new faculty hires (including lab space) will require an additional 2000 ft², possibly found in Stephenson Hall 5th floor.

The Dean's office at SSoE is currently engaged in strategic planning and fund raising for a new engineering building that is anticipated to house both the Conn Center and LARRI. An architectural planning firm completed space needs surveys and will provide initial drawings and cost estimates for this project.

As of February 2020, LARRI is also considering moving into the Humana Gym building owned by the UofL Foundation, with over 30,000 ft² of space. We are currently engaged in estimating renovations, moving, and operating costs at this new location, and have engaged the EVPRI's office for further discussions.

8. Equipment and other infrastructure

Equipment will be provided exclusively from active research projects in FY 2020 and the existing research labs of LARRI faculty. The new NSF EPSCOR grant provides startup funding for hiring two new SSoE faculty in the area of robotics who will participate in LARRI. In later years, with securing additional funds for a new Engineering building, additional funds to equip laboratories will be made available to the institute.

9. Dean of Engineering Support

The Dean of Engineering at Speed School provided the following support statement (see Letter)

“This letter serves as a strong endorsement for the Louisville Automation and Robotics Research Institute (LARRI), a new initiative at the J.B. Speed School of Engineering. LARRI is emerging due to a strong group of 12 core faculty with nationally recognized expertise and a strong record of extramural funding.

Currently, the Institute is supported by over \$10M in active projects and has adequate resources to support its operations. LARRI is on a promising trajectory to generate over \$2M in research expenditures per year and will be instrumental in attracting additional funding for large projects from both federal agencies and industry. Furthermore, LARRI will contribute to attracting young, talented researchers and faculty to UofL, and in the creation of new educational programs and certificates at SSoE to benefit our diverse and growing STEM student enrollments.

As Dean of Speed School of Engineering, I verify that the financial commitment made to LARRI is sustainable for a minimum of 5 years.”

Additional laboratory and office space, as well as funding support for research staff will be needed to support future projects. Estimated costs for new facilities needed in 3 years-time are estimated at \$25M raised from private and/or state sources. Estimated additional operating costs in 3 years-time are estimated at \$500k per year to support permanent institute staff positions, and will be raised from industry consortia, university and private donors. If this

funding is not available, the institute will continue to grow into existing laboratory and office facilities at UofL, although at a slower pace.

10. LARRI evaluation and reporting

A. LARRI evaluation criteria will include:

- Research/Scholarly Outcomes
 - Number of peer reviewed publications and international conference presentations. Target 1 conf +2 journal/faculty/Year. Total: 60/Year for institute.
 - Number of Ph.D. and M.S. theses completed with support from LARRI. 2 Ph.D., 1 M.S. / faculty / 3 years, 20 total/year.
 - Number of undergraduates involved in research including minority and underrepresented groups. 10 UG/year, 40% minority.
 - Number of downloads or requests to shared open source software products from LARRI, Y1: 1, Y2: 10, Y3, 100, Y4: 1000, Y5: 10000
- Outreach Outcomes
 - Number of events and participants during outreach: at least 12 events per year, 100 participants/year.
 - Number of hardware and software demos given to visitors to labs participating in LARRI: Y1 (5), Y2 (10), Y3 (15), Y4 (20), Y5 (25).
 - Website or social media Engagement Metrics such as the number of visits/posts Y2:100, Y3:200, Y4:400, Y5:800
- Funding Outcomes
 - Number of proposals funded for junior faculty in the center (assistant/associate level), including NSF Career (Y1 = 2), (Y2=2, 2 new hires), (Y3=4), (Y4=4), (Y5=6),
 - Number of collaborative grant proposals submitted/funded to funding agencies: Y1: 10/2, Y2: 20/4, Y3: 30/6, Y4:40/8, Y5:50/10, ~ 30 grants \$500k average per grant, \$15M awards over 5 years.
 - Research expenditures: \$1M (Y1), \$1.5M (Y2), \$2M (Y3), \$2.5M (Y4), \$3M (Y5). Center funding will be pursued for the following programs:
 - NSF IUCRC Node (Y1) – 100k
 - NSF STC/ERC – proposal by Y2, funded by Y5 (\$4M)
 - DoD MURI – proposal by Y3, funded by Y4 (\$4M)
 - NIH – proposal by Y2, funded by Y3 (\$2M)
- Infrastructure Outcomes
 - Physical testbeds: Y1 (3), Y2 (5), Y3 (7), Y4 (9), Y5 (10).
 - Virtual (software testbeds): Y1 (1), Y2 (2), Y3(3), Y4 (4), Y5(5).
- Industry Outcomes
 - Number of patents, spin-off or company projects resulting from the research: Y1 (2), Y2 (4), Y3 (6), Y4 (8), Y5 (10).
 - Number of industry contracts with technology resulting from the research: Y1 (2), Y2 (2), Y3 (2), Y4 (2), Y5 (2).
 - Number of NNMI Institute Memberships: 2 (ARM and NextFlex).

Outcome Data will be collected annually by two methods 1) self-reporting in the Institute Annual Report and 2) the SSoE Associate Dean of Research and Facilities. Data will be shared with the Dean's office and the Research Council, and (starting with year 2) the Institute's Advisory Board (IAB). The institute director and activities will be evaluated every 5 years by the Dean, IAB, and the Institute Research Council.

B. LARRI's Annual report will be compiled for SSoE Dean at the end of each fiscal year and will summarize:

- 1) Technical project highlights and accomplishments, research expenditures, papers published.
- 2) Number of students engaged in research and outreach activities by the institute.

- 3) Number of patents submitted and awarded by LARRI faculty and staff, and industrial companies engaged.
- 4) Other accomplishments of institute members (for example awards for service in national and international organizations, boards, and awards).

**University of Louisville
Centers and Institutes Budget Form**

Center/Institute: Louisville Automation & Robotics Research Institute (LARRI)									
Unit Home (i.e. A&S, Med...) __ Speed School _____									
Amounts and Sources of Revenue									
Fiscal Year		Current 2020	Projected 2021	Projected 2022	Projected 2023	Projected 2024	Projected 2025		
1. Regular State		0	0	0	0	0	0		
Appropriation & Fees									
a. New Allocation		0	0	0	0	0	0		
b. Internal Reallocation		0	0	0	0	0	0		
2. Institutional Restricted Endowment	Note: From LODI	\$ 20,000	\$ 40,000	\$ -	\$ -	\$ -	\$ -		
3. Institutional Unrestricted Endowment	Note: From Vogt Endowment	\$ 30,000	\$ 30,000	\$ 30,000	\$ 30,000	\$ 30,000	\$ 30,000		
4. Gifts				\$ -	\$ -	\$ -	\$ -		
5. Extraordinary State Appropriation		-	-	-	-	-	-		
6. Grants and	Note: Approximate but close spending for FY 20-21, projected	\$ 2,000,000	\$ 2,000,000	\$ 2,500,000	\$ 3,000,000	\$ 3,500,000	\$ 4,000,000		
7. Center RIF		\$0	\$50,000	\$50,000	\$65,000	\$70,000	\$75,000		
8. Capitation	Note: Company Memberships	-	\$ 200,000	\$ 300,000	\$ 400,000	\$ 500,000	\$ 600,000		
9. Capital	Note: From Dean of Engineering	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000		
10. Renovation		-	-	-	-	-	-		
11. Library Support		-	-	-	-	-	-		
12. Surplus Funds		-	-	-	-	-	-		
TOTAL REVENUES		\$2,150,000	\$2,420,000	\$2,980,000	\$3,595,000	\$4,200,000	\$4,805,000		

Expenditures for the Center/Institute									
Fiscal Year			Current 2020	Projected 2021	Projected 2022	Projected 2023	Projected 2024	Projected 2025	Projected 2025
I. Personnel									
1. Full-time Faculty									
a. Full-time Faculty FTE	Note: Research Faculty		1	2	2	3	3		4
b. Total Salaries	Includes raises		\$ 75,000	\$ 150,000	\$ 175,000	\$ 275,000	\$ 350,000	\$ 440,000	
c. Total Fringe Benefits Cost	29%		\$ 21,375	\$ 42,750	\$ 49,875	\$ 78,375	\$ 99,750	\$ 125,400	
COST OF FTF : (b+c)			\$96,375	\$192,750	\$224,875	\$353,375	\$449,750	\$565,400	
2. Part-time Faculty									
a. Part-time Faculty FTE									
b. Total Salaries									
COST OF PTF: (b)			\$0	\$0	\$0	\$0	\$0	\$0	\$0
3. Graduate Assistants (GA)									
a. Graduate Assistant FTE			15	15	20	25	30	35	
b. Total GA Stipends			\$ 337,500.00	\$ 337,500.00	\$ 450,000.00	\$ 562,500.00	\$ 675,000.00	\$ 787,500.00	
COST OF GA: (b)			\$487,500	\$487,500	\$650,000	\$812,500	\$975,000	\$1,137,500	
4. Staff Support (SS)									
a. Support Staff FTE			8	9	10	11	13	15	
b. Total Staff Salaries			\$ 280,000	\$ 370,000	\$ 435,000	\$ 510,000	\$ 605,000	\$ 700,000	
c. Total Fringe Benefits Cost			\$ 79,800	\$ 105,450	\$ 123,975	\$ 145,350	\$ 172,425	\$ 199,500	
COST OF SS: (b+c)			\$359,800	\$475,450	\$558,975	\$655,350	\$777,425	\$899,500	
TOTAL PERSONNEL COST			\$943,675	\$1,155,700	\$1,433,850	\$1,821,225	\$2,202,175	\$2,602,400	

	<u>II. Operating Cost</u>								
	1. Supplies, Including equipment Maintenance		\$150,000	\$175,000	\$200,000	\$250,000	\$300,000	\$350,000	
	2. Travel		\$ 20,000	\$ 25,000	\$ 30,000	\$ 35,000	\$ 40,000	\$ 45,000	
	3. Library								
	a. one-time retrospective purchasing								
	b. Book and journal acquisitions								
	c. Computerized information system								
	4. Student Support-Tuition Remission								
	5. Equipment		\$ 500,000	\$ 500,000	\$ 650,000	\$ 700,000	\$ 750,000	\$ 800,000	
	6. Off-campus Facilities								
	7. Accreditation								
	8. Other (expl: University F&A)		\$ 500,000	\$ 550,000	\$ 650,000	\$ 750,000	\$ 900,000	\$ 1,000,000	
	TOTAL OPERATING COST		\$ 1,170,000	\$ 1,250,000	\$ 1,530,000	\$ 1,735,000	\$ 1,990,000	\$ 2,195,000	
	<u>III. Capital Cost</u>								
	1. Facilities								
	a. New Construction								
	b. Renovation								
	c. Furnishings								
	TOTAL CAPITAL COST		\$0	\$0	\$0	\$0	\$0	\$0	\$0
	TOTAL EXPENDITURES		\$2,113,675	\$2,405,700	\$2,963,850	\$3,556,225	\$4,192,175	\$4,797,400	
	TOTAL REVENUES (from above)		\$2,150,000	\$2,420,000	\$2,980,000	\$3,595,000	\$4,200,000	\$4,805,000	

List all current employees paid from the center/institute budget (faculty, staff, graduate asst. or other temp. employees.)				
1.Full-time Faculty (FTE)				
Name	Full-time Equivalent (FTE)	Status Perm. or Temp.	Total Salary	Salary paid by the program/center/institute
TBD	1	1	75000	75000
Total				
2. Part-Time Faculty (PTE)				
Name	Full-time Equivalent (FTE)	Status Perm. or Temp.	Total Salary	Salary paid by the program/center/institute
Total				
3. Graduate Assistants (GA)				
Name	Full-time Equivalent (FTE)	Status Perm. or Temp.	Total Salary	Salary paid by the program/center/institute
TBD	15	Temp	\$ 337,500.00	337500
Total				
4. Staff Support (SS)				
Name	Full-time Equivalent (FTE)	Status Perm. or Temp.	Total Salary	Salary paid by the program/center/institute
TBD	6.5	Perm	\$ 280,000.00	\$ 280,000.00
Total				
Note: the total FTE and salary amounts should be equal to the personnel cost information (Current year) listed in the departmental expenditures.				
Revised 8.12.19				

EVALUATION OF LIBRARY RESOURCES

ESSENTIAL TO THE SUPPORT OF:

**THE ESTABLISHMENT OF THE LOUISVILLE AUTOMATION
AND ROBOTICS RESEARCH INSTITUTE (LARRI)**

Sarah Drerup

STEM Librarian

Dean Robert E. Fox, Jr.

University Libraries

September, 2019

BACKGROUND

The University of Louisville (UofL) Libraries are comprised of five separate libraries: Ekstrom Library serving humanities, social sciences, life sciences, business, engineering, physical sciences, and technology; Kornhauser Health Sciences Library; Anderson Music Library; Bridwell Art Library; and the Law Library. University Archives and Special Collections center is also part of the UofL library system. Resources relevant to materials and energy science are primarily found in Ekstrom Library.

UofL's library system supports the instructional and research needs of over 22,000 full and part-time students and more than 7,000 faculty and staff. UofL belongs to the Association of Research Libraries (ARL), an organization of North American libraries affiliated with 123 large, comprehensive research institutions, as well as the State-Assisted Academic Library Council of Kentucky (SAALCK), and Kentuckiana Metroversity, a consortium of Louisville area libraries.

UofL's Speed School of Engineering currently offers multiple ABET accredited programs and maintains a number of centers and institutes specializing in interdisciplinary research. The proposed Louisville Automation and Robotics Research Institute (LARRI) will foster cross-department collaboration and expand upon a growing field in science and engineering. Sections of this report compares UofL's library resources to two benchmark institutions with dedicated facilities for robotics and automation. Stevens Institute of Technology has a Robotics and Automation Lab and Carnegie Mellon University has The Robotics Institute.

COLLECTIONS

Books

According to WorldCat, UofL has around 500 eBooks and Print Books related to Robotics and Automation and Control Systems that have been published within the last ten years. The majority are housed at Ekstrom library or available electronically in eBook format. Robotics and Automation and Control Systems is an emerging field and having more current resources is imperative to the advancement of research and maintaining support for the institute. Both benchmark institutions had subscriptions to Knovel Engineering Technical Reference Information by Elsevier. Knovel contains reference handbooks, ebooks, and other information resources. Stevens Institute of Technology also has a subscription to AccessEngineering by McGraw Hill which contains over two thousand reference titles and handbooks on robotics and automation. As funds allow, Ekstrom Library will make efforts to add newly published ebooks or purchase a subscription to Access Engineering or Knovel to increase our holdings and support researchers in robotics and automation and control systems.

Periodicals

UofL has online full-text access to nineteen of the top twenty most frequently used and cited journals on the subjects of Automation and Control Systems and Robotics according to Web of Science:

Rank	Full Journal Title	Total Cites	Journal Impact Factor	Online Full-Text
1	Science Robotics	898	19.400	No Access
2	IEEE Transactions on Cybernetics	13,561	10.387	2013 - Present
3	IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS	61,342	7.503	1982 - Present
4	IEEE Transactions on Industrial Informatics	13,187	7.377	2005 - Present
5	IEEE Transactions on Systems Man Cybernetics-Systems	9,525	7.351	1998 - Present
6	IEEE Transactions on Robotics	15,859	6.483	2004 - Present
7	Soft Robotics	1,179	6.403	2018 - Present
8	AUTOMATICA	40,135	6.355	1963 - Present
9	IEEE CONTROL SYSTEMS MAGAZINE	4,282	6.228	1981 - 1990 (Publication ended 1990)
10	INTERNATIONAL JOURNAL OF ROBOTICS RESEARCH	10,619	6.134	1982 - Present
11	IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY	13,739	5.371	1993 - Present
12	Nonlinear Analysis-Hybrid Systems	1,853	5.266	2007 - Present
13	IEEE Transactions on Automation Science and Engineering	5,165	5.224	2004 - Present
14	IEEE TRANSACTIONS ON AUTOMATIC CONTROL	47,987	5.093	1963 - Present
15	IEEE-ASME TRANSACTIONS ON MECHATRONICS	10,578	4.943	1996 - Present
16	IEEE Transactions on Control of Network Systems	1,347	4.802	2014 - Present
17	ANNUAL REVIEWS IN CONTROL	2,170	4.759	1996 - Present
18	ROBOTICS AND COMPUTER-INTEGRATED MANUFACTURING	4,071	4.392	1988 - 1998 (Publication ended 1998)
19	Journal of Field Robotics	2,797	4.345	1996 - Present
20	ISA TRANSACTIONS	6,115	4.343	1995 - Present

Currently, Ekstrom Library does not have access to Science Robotics. Of the current 200 published articles in Science Robotics, 52 are open access and available to researchers at UofL. As funds allow, Ekstrom Library will make efforts to purchase a subscription to this publication.

Bibliographic Resources

UofL and benchmark institutions have subscriptions to the following databases related to robotics and automation:

- ACM Digital Library
- ASTM Compass – Currently trial subscription basis – ASTM Compass provides access to over two thousand standards, manuals, symposium papers, and journal articles related to robotics and automation
- CompendexWeb
- IEEE Explore
- INSPEC
- ScienceDirect
- Web of Science
- Wiley Online Library

These databases offer abstracts and full-text access to the periodicals listed above in addition to thousands of conference proceedings, book chapters, and patents.

The only major database that both benchmark institutions subscribe to but which UofL does not is Scopus. Scopus, similarly to Web of Science, indexes and provides access to peer-reviewed literature in the sciences.

SERVICES

Inter-Library Loan

Books and periodicals not held by the UofL Libraries are identified through online databases and WorldCat, an online catalog with more than 32 million records describing materials owned by libraries around the world. Requested materials are obtained through UofL's traditional Interlibrary Loan (ILL) service, and supplemented by the University Libraries participation in KUDZU, a consortium of major university libraries in the southeastern United States. Articles and chapters are transferred to requestors via email.

Research Assistance

Each library within the University of Louisville Libraries offers instruction programs designed to meet the needs of its researchers. Ekstrom Library provides research assistance via email, telephone, in-person research appointments, and online chat.

STAFFING

Ekstrom Library has a dedicated STEM librarian who will be the primary point of contact for students and faculty associated with the proposed Louisville Automation and Robotics Research Institute.

CONCLUSION

University of Louisville Libraries' resources appear adequate to support the proposed Louisville Automation and Robotics Research Institute. Currently UofL Libraries supports numerous centers and institutes at the Speed School of Engineering. The Speed School of Engineering does not anticipate a need for any new library books, journals, databases, or other services to support the new institute. However, this review does show that the libraries can strengthen its support of the proposed institute by increasing the number of online resources available to include a permanent subscription to ASTM Compass and new subscriptions to Scopus, Knovel, and AccessEngineering.

September 23, 2019

To Whom It May Concern:

This letter serves as a strong endorsement for the Louisville Automation and Robotics Research Institute (LARRI), a new initiative at the J.B. Speed School of Engineering. LARRI is emerging due to a strong group of 12 core faculty with nationally recognized expertise and a strong record of extramural funding.

Currently, the Institute is supported by over \$10M in active projects and has adequate resources to support its operations. LARRI is on a promising trajectory to generate over \$2M in research expenditures per year and will be instrumental in attracting additional funding for large projects from both federal agencies and industry. Furthermore, LARRI will contribute to attracting young, talented researchers and faculty to UofL, and in the creation of new educational programs and certificates at SSoE to benefit our diverse and growing STEM student enrollments.

As Dean of Speed School of Engineering, I verify that the financial commitment made to LARRI is sustainable for a minimum of 5 years.

Sincerely,



Emmanuel G. Collins



CURRICULUM VITAE

DAN O. POPA

Dept. of Electrical and Computer Engineering, University of Louisville, WS Speed 200, Louisville, KY 40245, Phone: 817-948-4819, email: dan.popa@louisville.edu, web: <http://www.ngs.louisville.edu>

EDUCATION

Rensselaer Polytechnic Institute (September 1994 - April 1998)
Degree: Ph.D. in Electrical Computer and Systems Engineering
Ph.D. Thesis: "Path-Planning and Feedback Stabilization of Nonholonomic Control Systems".
Dartmouth College, Thayer School of Engineering (September 1993 - June 1994)
Degree: M.S. in Engineering
M.S. Thesis: "Simulation of Lumbar Puncture using Force Feedback in Virtual Environments".
Dartmouth College (September 1990 - June 1993)
Degree: A.B. (GPA: 3.8)
Double Major: Mathematics/Computer Science and Engineering.

RESEARCH EXPERTISE and INTERESTS

Robotics & Control Systems
Precision robotics and motion control, Physical and Social Human-robot interaction, Mobile Robot Path Planning.
Micro and Nano Technology, MEMS
Micro and Nano Robotics, Micro/nano assembly and manipulation, MEMS/NEMS control, packaging, actuation, and characterization.

RESEARCH EXPERIENCE

Electrical and Computer Engineering Department, University of Louisville
Professor and Henry Vogt Endowed Chair for Advanced Manufacturing (2016 – present)
Total Funding as PI - \$10M

- PI for NSF Project EPSCOR RII Track-1: Kentucky Advanced Manufacturing Partnership for Enhanced Robotics and Structures, PI: Rodney Andrews (UK), Budget of subcontract to UofL \$5,304,000, UofL PI Dan Popa, 2019-2024.
- PI for NSF/NIH Project SCH: INT: Adaptive Partnership for the Robotic Treatment of Autism, Budget \$1,196,471, 2019-2023.
- PI for NSF Project CMMI 1734383: Light-Powered Microrobots for Future Microfactories, 2017-2021, Budget \$765k, 2017-2021.
- PI for NSF Project NSF MRI Award #1828355: MRI: Development of a Multiscale Additive Manufacturing Instrument with Integrated 3D Printing and Robotic Assembly, Budget \$2,188,000 (extramural \$1,538,000), 2018-2021.
- PI for NSF Project "I-CORPS Teams Multi-modal Robot Skins for Adaptive Human-Machine Interfaces," Budget \$50k, 2016-2018.
- PI for NSF Project "PFI:BIC: Adaptive Nursing Assistants for Physical Tasks in Hospital Environments," 2015-2019, Budget \$1M.
- PI for NSF Project "EAGER:CYBERMANUFACTURING: Design Tools for Nanofactories with Robust Millimetric Assemblers", Budget \$150k, 2015-2017.

Electrical Engineering Department, The University of Texas at Arlington
Associate Professor (September 2010 – December 2015)

- PI for "Advanced Human-Machine Interfaces and Assistive Robot Platforms," Qinetiq-NA Contract, 2013-2015, \$400k.
- PI for "NRI: SMALL: Multi-Modal Skin and Garments for Healthcare and Home Robots," NSF grant, 2012-2017, \$1.35M.

- Sellmark Corporation Endowment for Research in Electro Optics and Precision Sighting Technologies, 2012-2017, \$25k.
- PI for “DARPA Robotics Challenge - TRACK B lead by Re2”, Sponsored by DARPA, Oct 2012- Dec 2014, \$300k.
- PI for “Packaging of MEMtronics Filters and Switches - Phase I”, sponsored by MEMtronics, Inc., 2012, \$20k.
- PI for “Robotic Microassembly of Multi-spot Optical Probes-Phase I” sponsored by Alcon R&D, Ltd., Irvine, CA, 2011, \$100k.
- PI for “Human-Robot Interaction System for Early Diagnosis and Treatment of Childhood Autism Spectrum Disorders (RoDiCA)”, sponsor: TxMed consortium, 2011-2013, \$100k.
- PI for “Travel Support for NIST Micro-Robotics Challenge at IEEE ICRA 2011-2013,” sponsor: NSF, \$20k.
- Co-PI for “MRI: Development of a Next-Generation Multimodal Data Management Human-Sensing Instrument for Trustworthy Research Collaboration and Quality of Life Improvement,” NSF-CISE award 2009-2012, \$750k.
- Co-PI for “CPS: Medium: A Novel Human Centric CPS to Improve Motor / Cognitive Assessment and Enable Adaptive Rehabilitation,” NSF-CPS award 2010-2016, \$750k.
- Co-PI for “Texas Microfactory: Deployment of Microsystems Platforms in Hazardous Environments Application to Munitions Monitoring and Enhanced Situational Awareness,” ONR award, 2009-2011, \$3.5M.

Assistant Professor (September 2005-August 2010)

- PI for “3D Wafer Level Packaging of Microsystems for Harsh Environments”, Infotonics Grant, 2005, \$100k.
- PI for “Non-invasive Monitoring for Optimization of Therapeutic Drug Delivery by Biodegradable Fiber to Prostate”, grant funded by ARO, 2005-2008, \$250k.
- PI for “Acquisition of Wafer Bonding Equipment for Microsystems Packaging”, ONR DURIP Award, 2006-2007, \$500k.
- PI for ONR Grant: Embedded Microsensor and Microactuator Arrays for Harsh Environments, 2006-2008, \$2.5M.
- Co-PI for “A micropackaging toolbox for S&A”, ONR award to Bennington Microtechnology Center, Bennington, VT, 2004-2006.
- Co-PI for “Packaging of Heterogeneous Microsystems”, ONR award to Bennington Microtechnology Center, Bennington, VT, 2005-2007..
- Co-PI for ONR Grant “Deployment of Microsystem Platforms in Hazardous Environments”, 2008-2009.
- Co-PI for AirForce SBIR Phase I Award (FA8750-09-C-0069), “Disruptive Techniques for Hybridization of Focal Plane Arrays for Optical Imaging Sensors,” 2009.

Automation and Robotics Research Institute, The University of Texas at Arlington

Research Assistant Professor (September 2004 – August 2005)

New York State Center for Automation Technologies, RPI, Troy, New York

Senior Res. Sci. (July 2003 – August 2004) and Research Scientist (1998 – 2003)

- Responsible for part of the research agenda of the NYSCAT at RPI, and advising junior staff and students. Lead over twenty research projects involving industry including:
 - Co-PI for “Assemblers for NanoTechnology Applications and Manufacturing”, Zyvex, Inc.; Rensselaer Polytechnic Institute; University of Texas at Dallas; University of North Texas; Honeywell Inc., NIST ATP award, 2001-2006.
 - Co-PI for “Biophotonic Sensing of Harmful Pathogens and Biowarfare Agents”, University of Rochester, Rensselaer Polytechnic Institute, RIT, HVCC, under grant from the US Department of Energy, 2003-2005.
 - Co-PI for “NSF: RiverNet: Distributed Sensor Nets for Environmental Infrastructure Monitoring”, National Science Foundation award, 2003-2006.
 - Co-PI for “NSF: GOALI: Precision Motion Control with Iterative Input Refinement”, National Science Foundation award, 2003-2006.

TEACHING EXPERIENCE

- Introduction to Microfabrication and MEMS (ECE 543/544), ECE 500/600 Robotic Manipulation, U of L Department of Electrical and Computer Engineering.
- Linear Systems (EE 3317/3417), Microsystems (EE5349), Robotics (EE 5325, EE 4315), Control Systems (EE 4314, EE 5320), Nonlinear Control (EE 5323), System Identification and Estimation (EE 5327), Intro to EE (EE1105/1106), UT Arlington, Department of Electrical Engineering, 2005- 2015.
- Chair, Electrical Engineering Undergraduate Curriculum Committee, 2009-2012, tasked to renew the EE curriculum.
- Directly supervised 14 Ph.D. Theses as primary advisor.
- Directly supervised 24 M.S. Theses as primary advisor.

HONORS AND AWARDS

- Romanian national team for the International Olympic Competition in Mathematics, 1987.
- Montgomery Scholar, Dartmouth College, 1990-1993.
- Phi-Beta-Kappa, early induction, 1992;
- President's award for best student in computer science, Dartmouth College, 1992.
- Kayamori Best Paper Award at IEEE ICRA Conference, Washington, D.C., May 2002.
- Award of Merit, Zyvex Corporation, December 2003.
- Award of Merit, Automation & Robotics Research Institute, UT Arlington, October 2005.
- Best Paper Award at IEEE RAM Conference, Bangkok, Thailand, December 2006.
- ASME DED Division Award for MNS Micro-Nano Robotics Symposium, September 2009.
- UT Arlington President's Award for Excellence in Teaching, May 2012.
- UT System Regent's Outstanding Teaching Award, August 2013.

PUBLICATIONS

226 total: 2 books, 8 book chapters and editorials, 33 journal papers, 130 conference papers, 42 invited presentations and abstracts, 11 patents issued or pending. Google Scholar h-Index=25, i10-index=81

CURRENT PROFESSIONAL ACTIVITIES AND AFFILIATIONS

- Head of the Next Generation Systems Group (NGS), and director of the Multiscale Robotics and Systems Labs (MuRSeL), <http://www.ngs.louisville.edu> , 2016-present.
- Head of the Next Generation Systems Group (NGS), and director of the Multiscale Robotics and Systems Lab (MuRSeL), <http://ngs.uta.edu> , 2011-2015.
- Senior Editor, IEEE Transaction on Automation Science and Engineering (T-ASE), 2017-present.
- Senior Editor, IEEE Robotics and Automation Letters (RA-L), 2018-present.
- Current Member of IEEE, ASME Intermittent Member of ACM, IMAPS, SME, SPIE, AUVSI.
- IEEE Robotics and Automation Society Competition Co-Chair, member of Conference Activities Board for IEEE-RAS (2013-2016).
- Associate Editor, IEEE Transaction on Automation Science and Engineering (T-ASE), 2008-present.
- Associate Editor, Springer Journal of Micro Bio Robotics (JMBR), 2012-2013.
- Organizer, IEEE RAS MicroRobotics Challenge, Karlsruhe, Germany, May 2013, Hong Kong, China, June 2014.
- Chair, SPIE-Sensors and Technology Applications (STA) Conference, Sensors for Next Generation Robotics, Baltimore, Maryland, 2013, 2014, 2015, 2016.
- Symposium Organizer on Micro-Mechanisms and Robotics at ASME MNS Conferences, 2009-2014.
- Symposium Organizer on Micro & Nano Scale Assembly Systems at ASME MSEC Conference, 2011.
- Workshop Organizer on Automation at Microscale at IEEE CASE 2010, IEEE ICRA 2011, 2019, IEEE IROS 2011.
- IEEE CASE 2013 Program Co-Chair, Madison, Wisconsin, IEEE CASE 2016 Program Chair.
- Reviewer for the following journals: IEEE Transactions on Robotics, IEEE Transactions on Mechatronics, IEEE/ASME Journal of MEMS, Journal of Intelligent and Robotic Systems, IEEE Transactions on Automation Science and Engineering, IEEE Journal of Control Systems Technology, IEEE Journal of Optimal Control, Applications and Methods, ACM Transactions on Mobile Computing, IEEE Journal on Systems, Man and Cybernetics.

- Conference Program Committee Activities: IEEE ICRA 2014, 2013, CASE 2014, CASE 2013, IROS 2014, 2013, MNS 2014, 2013, ICRA 2012, ICRA 2013, IROS 2011, CASE 2011, IEEE ICRA 2011, IEEE CASE 2010, IEEE ISAM 2009, ASME MNS 2009, 2010, 2011, IEEE NANO 2008, IEEE CASE 2007, IEEE IROS 2006-2007, ACM SAWN 2006.
- NSF Review Panel on Nanomanufacturing, 2006, Cyber-Physical Systems, 2009, Robust Intelligence 2011, NRI 2012, NEU, 2012, REU 2012, SCH 2013, CPS 2013, Nanomanufacturing 2013, NRI, 2014, 2015, 2017, IIS-RI 2015,2017,2018, SCH 2016, EFRI 2018, 2019, S&AS 2017, 2018.
- Technical Committees Current Membership
 - IEEE Robotics and Automation Society Committee on Micro-Nano Robotics
 - ASME Micro-Nano Systems Committee (MNS).

February 10, 2020

Dear Faculty Senate:

This letter is regarding the near-future hire of two tenure-track assistant professors on Speed School faculty, a commitment in support of the Louisville Automation and Robotics Research Institute (LARRI). These two positions are permanent. One is associated with the Department of Computer Science and Engineering, and the other with the Department of Electrical and Computer Engineering.

For the first three years, the new faculty hires will receive start-up support from Dr. Popa's NSF EPSCOR KAMPERS grant. The support consists of salary for summer research months, support for graduate students, and materials and equipment to set up experimental laboratories at LARRI.

Sincerely,



Emmanuel G. Collins
Dean, J.B. Speed School of Engineering



July 26, 2018

Dan Popa, Ph.D.
Professor and Endowed Chair in Advanced Manufacturing
Department of Electrical and Computer Engineering
WS 200
Speed School of Engineering
University of Louisville
Louisville, KY 40292

Dear Dr. Popa:

As Interim Executive Vice President for Research and Innovation at the University of Louisville (UofL), I am pleased to strongly support your NSF EPSCoR Track-1 grant proposal entitled "Kentucky Partnership for Augmented Structures and Robotic Systems." Your proposal combines an impressive array of multidisciplinary breakthroughs in robotics, machine learning, organic electronic sensing and 3D printing to create the next generation technologies capable of enhancing the productivity gains in the American manufacturing industry, as well as the Commonwealth of Kentucky. You have assembled an outstanding team of investigators consisting of a dozen researchers from the Speed School of Engineering and the Department of Biology together with multiple institutions across our state including University of Kentucky, Morehead State University, Western Kentucky University and others. With regard to the impact to UofL, the requested \$1M+ per year in funding from NSF EPSCoR will ensure your success in effectively building the vital research infrastructure (i.e. laboratory equipment, support of young faculty, graduate students and two new faculty hires in the robotics area) critical to one of UofL's strategic research initiatives – Human-Machine Interfaces related to Advanced Manufacturing.

To demonstrate the University of Louisville's strong commitment to this key initiative, we are pleased to offer significant institutional support, when this grant is funded. Specifically, the University will commit over the duration of the award: 1) two new faculty lines to support this research focus (equates to ~\$485,000); 2) ~\$590,000 (the time/effort and associated unrecovered F&A for participating faculty); and, 3) \$225,482 (~\$45K per year) in cash to ensure the success of your project and the ability to achieve its goals. The cash funds may be used to 1) supplement supplies used for robots and sensors in your project; and, 2) supplement graduate student support in the form of salary and tuition. I am convinced of the transformative nature of the team's research program. Indeed, you are a leader in Human-Machine Interfaces; thus, findings from your research have the potential to fundamentally change the way we utilize robotics, machine learning, sensors and 3D printing to elevate America's prowess to be the world leader in Advanced Manufacturing.

The University of Louisville is committed to Human-Machine Interface and Advanced Manufacturing research. Indeed, they are two of our Programs of Distinction. Your research

will enhance the general research capabilities at the University and the overall Human-Machine Interface and Advanced Manufacturing initiatives at UofL. We wish you great success with your application and look forward to the contributions that your team will make to the future of these fields. Thus, we are strongly supportive of this grant application and happy to provide this level of institutional support.

Sincerely yours,

A handwritten signature in blue ink, appearing to read 'R. S. Keynton', with a horizontal line extending to the right.

Robert S. Keynton, Ph.D.
Interim Executive Vice President for Research and Innovation
Professor and Lutz Endowed Chair
Department of Bioengineering
Director – UofL W.H. Coulter Foundation Translational Research Partnership Program
Fellow – American Institute for Medical & Biological Engineering
Fellow – National Academy of Inventors

LARRI Organizational Chart

