Rensselaer School of Science

"Scientia pro Vitae"

Performance Plan
FY 2018

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The core mission of the School of Science is *to advance the interdisciplinary frontiers of science through leadership in research and education.* We will accomplish our mission by maximizing existing synergies with the other four Schools while simultaneously focusing on only the most impactful areas of research in basic and applied science. Through a strategy of Institute-wide cooperation, we will also develop innovative pedagogies that will provide students with a rich educational experience that will motivate and enable them to seek the highest levels of intellectual achievement and personal growth. We will use our knowledge, discoveries, and inventions to change the world.

The School of Science Performance Plan and associated budget is designed to realize the goals of the Rensselaer Plan 2024 by focusing on a forward-looking multi-year strategy based on the FY2018 Institute-Wide Highest Priorities (IWHPs). Foremost among these are Diversity and Inclusion throughout all of our recruiting, retention and hiring activities. We will leverage our recent diversity hiring success and redouble our efforts in that area. We will also lead developments within IDEA, the Jefferson Project, CISL, TERM, cMDIS and other Global Challenge-Linked Research, as well as Next Generation Teaching (TLC), Cognition and Learning, the Innovation Ecosystem, CLASS, and Resource Generation. We will align our activities with the Rensselaer Signature Thrusts and associated Science Themes: *Data Analytics and Predictive Modeling*; *Water, Energy, Resilience & Sustainability*; *Computational Science, Security and Simulation; Biomedical Science & Applications*; and *Materials at the Nanoscale: MGI@RPI.*

In this Performance Plan, we articulate a set of coherent, specific, measureable actions designed to:

- Improve the educational experience and attract a diverse cohort of students to Science
- Promote world-class scientific research across the School and the Institute, strategically focusing on areas that offer the greatest potential and that build on our strengths
- Develop an infrastructure that allows for substantial and long-term growth
- Grow a diverse faculty by recruiting world-class endowed chairs and Constellation chairs
- Focus on Diversity and Inclusion in all recruiting, retention and student success
- Advance the School of Science to a position of leadership in Data Science and Analytics

By executing the actions described in the Performance Plan, in the next three years we plan to reach a faculty size to 105, external research funding of $30M, and increase undergraduate and graduate enrollments to 1,800 and 375, respectively. These and other supporting actions will result in significant advancement in recognition for our educational and research programs. For FY18, we aim for external research funding of $26M, a faculty size of 102, and undergraduate and graduate enrollments of 1,700 and 335, respectively. We project to award, during this same year, 350, 115 and 55 students with Bachelor's, Master's, and Ph.D. degrees, respectively.

In order for Rensselaer Polytechnic Institute to fully realize our vision as a world-class technological research university ("The New Polytechnic") with global reach and impact, Science at Rensselaer must grow in capacity and reputation to a level that meets or exceeds that of our traditional strength in Engineering. Meeting this fundamental goal on behalf of the University is at the heart of the School of Science Performance Plan.

Section I - The State of Science at Rensselaer: Current Strengths and Challenges

1.1 The State of Science at Rensselaer

Science at Rensselaer has developed considerable momentum in recent years, and we are well positioned to take the next steps toward top-25 status. To realize this goal, we need to grow towards a top-50 faculty profile. We currently face significant challenges in faculty size, diversity and demographics. We are proud to be a vibrant scientific community, thanks to the contributions of our students, alumni, staff, and faculty, as well as support from the Institute leadership. With recent investments, Rensselaer has emerged as a recognized center of scientific education and discovery, with increasingly global reach and global impact. We now need to leverage these investments, increase the pace of hiring and infrastructure renewal, and move the School of Science to the next level in fundamental and data-driven science.

The key mission of the School of Science is *to advance the interdisciplinary frontiers of science through leadership in research and education*. This mission includes focused research in the basic and applied sciences and providing access to rich educational experiences (Summer Arch, Art_x@Rensselaer…etc) that will motivate and enable our increasingly diverse students to seek the highest levels of intellectual achievement and personal growth by developing multicultural sophistication and a global view. We will work tirelessly to accomplish this mission, and by executing this Performance Plan, we can advance all of these goals significantly.

1.2 Strengths and Challenges

The School of Science has both a strong foundation on which to build, and major opportunities to explore. We have significant research expenditures and have increased enrollments steadily over recent years in ways that are aligned with our IWHPs. We have high quality faculty who embrace Rensselaer's strategic direction and mission. Our undergraduate students are among the finest in the Nation, and the quality of our graduate students is high and increasing. We are a collaborative group – cross-department, cross-school, and multidisciplinary activities are common. We embrace the opportunity to imagine a future with increased levels of scholarship and discovery, and are building on our strengths.

Our primary challenges are in the areas of faculty size and facilities/infrastructure. Virtually all of the IWHPs are advanced through growing the faculty – this enhances research achievement, funding, and student-faculty ratios. The SoS faculty size has only recently increased after having decreased about 15% over the previous 10 years. We must therefore commit to a continued emphasis on aggressive and inclusive hiring starting with filling vacant endowed chair and constellation positions. Our opportunity to meet this challenge comes with resource requirements. However not meeting this challenge will endanger Rensselaer's rankings and our future impact, so we must meet the challenge through a combination of fundraising and creative leveraging, as well as potential budget reprioritization. We must also ensure that the School, and in fact the whole institution, is poised in the years ahead to execute faculty hiring in an agile, inclusive and equitable fashion.

An additional challenge lies in the area of facilities and infrastructure. School of Science teaching and research activities are spread across many buildings on campus, and many of our facilities are aging. Cutting edge science research and instruction require great minds, but also great infrastructure. The time has come to upgrade our Science infrastructure, and we've begun to take some of the necessary steps. We must plan for this investment and begin updating immediately. Additional needed support in the form of highly-targeted additions of staff is also needed – this is especially important in light of the Summer Arch and to address the recent enrollment surge, especially in Physics and Computer Science. Such investments will result in a direct return through increased attention of faculty and students to research. We have made positive steps – we must now continue to follow through on them.

Section II - Goals, Actions Plans and Metrics in support of Institute-Wide Highest Priorities
The priorities presented in this Performance Plan for Science at Rensselaer are directly responsive to and encompassed by the Institute-Wide Highest Priorities (IWHPS), which were derived from discussions of the implementation of the Rensselaer Plan 2024. As a result, this section is organized so that each initiative and action is affiliated with the appropriate IWHP, with discussion of the traceability to relevant Signature Thrusts and other key areas highlighted in the Rensselaer Plan 2024. This alignment of the Institute's goals and the goals for the SoS is critical – only through such alignment can the School of Science enable Rensselaer to advance.

2.1 Global Challenge-Linked Research

Creating new knowledge relevant to understanding the fundamental workings of life and matter, networks and information, and applying that knowledge to address major global challenges across disciplines, is key to the School of Science strategy to become transformative through crossing boundaries. In support of this goal we have begun to view the work in the School through the lens of our five interdisciplinary **Science Themes:**

- *Data Analytics & Predictive Modeling: "Data to Action"*
- *Water, Energy, Resilience & Sustainability*
- *Computational Science, Security & Simulation*
- *Biomedical Science & Applications*
- *Materials at the Nanoscale: MGI@RPI*

These Science Themes allow us to conceive of and execute our research plans, hiring plans and even our educational opportunities *strategically* rather than piecemeal. The Science Themes should be thought of as complementary to both the Signature Thrusts (Table 3) and the research initiatives (Table 4) – they are essentially the School of Science "lens" on the Signature Thrusts and research initiatives and are highly correlated with the activities within them.

Table 3. Mapping of Science Themes to Institute Signature Thrusts

	Data Analytics & Predictive Modeling	Water, Energy, Resilience & Sustainability	Computational Science, Security and Simulation	Biomedical Science & Applications	Materials at the Nanoscale: MGI@RPI
Biotech & LS	★	★	★	★	★
IT	★	★	★	★	★
Nanotech	★	★	★	★	★
Media/Arts	★	★	★	★	
Energy/Env.	★	★	★		★

The Science Themes are also complementary to the cluster areas targeted for hiring in the Schools of Engineering and HASS. Finally, the Science Themes complement each other – for example, proposed work in the Jefferson Project addresses both the Water, Energy, Resilience & Sustainability theme as well as the Computational Science, Security & Simulation Theme, among others. Fundamental understanding of materials through the new Center for Materials Devices and Integrated Systems (cMDIS) clearly addresses the Data Analytics and Predictive Modeling theme while also being applicable to the Materials at the Nanoscale theme, and the Water, Energy, Resilience & Sustainability theme. CISL similarly crosses multiple these as well. Essentially all the themes have overlap – we will seek to maximize these intersections in our hiring and research plans as we leverage one of Rensselaer's true strengths – our defining characteristics as the "New Polytechnic" – to drive interdisciplinary scholarship across thematic areas, Departments and Schools.

Table 4. Mapping of Science Themes to Key Research Initiatives

	Data Analytics & Predictive Modeling	Water, Energy, Resilience & Sustainability	Computational Science, Security & Simulation	Biomedical Science & Applications	Materials at the Nanoscale: MGI@RPI
IDEA	★	★	★	★	★
Jefferson	★	★	★		
Mt. Sinai	★		★	★	★
cMDIS	★	★	★	★	★
CISL	★		★	★	★

Nonetheless, to achieve the ambitious goals of the Rensselaer Plan 2024, we must continue to grow our research programs by implementing a strategic faculty recruitment program starting with endowed chairs and constellation positions. We will accomplish this using a two-pronged approach. First, existing research programs will be expanded by focusing on core research strengths in the School, particularly in those areas in which significant external funding opportunities are expected in the years ahead. Second, new interdisciplinary research programs will be developed in alignment with (or that are complementary to) several areas of

key research initiatives. These initiatives include the Rensselaer IDEA, the Jefferson Project at Lake George, our partnership with the Icahn School of Medicine at Mt. Sinai, the Gates Foundation, and coordination with cMDIS.

The discussion above motivates the research strategies that the School of Science will pursue over the next several years. These strategies are outlined below and are organized into three major groups: ***Transformational Molecules and Materials***, ***Planetary Resilience,*** and ***Data to Action for Human Health***. These groups serve to highlight relationships between the strategies and to define key differentiators that these strategies are expected to achieve for the School of Science and Rensselaer.

2.1.1 Transformational Molecules and Materials

Overview: The strategies in this section will promote and advance leadership in the design and synthesis of new molecules and materials that address Global Challenges in healthcare, energy and the built environment.

Strategy 2.1.1.1: *Drive research growth in materials-related data science ("MGI@RPI") through connected co-development of the Rensselaer IDEA and cMDIS through hiring priorities.*

Description: Computer Science and Tetherless World Constellation Professor Jim Hendler is leading the Rensselaer IDEA for the Institute together with IDEA co-Director and Mathematics and Computer Science Professor Kristin Bennett. The IDEA Steering Committee has a large representation from the School of Science, across all of our key disciplines. To be successful, IDEA must support the concept of *Data to Action*, which in this case, means strong connection with the application areas of hard and soft materials. The School of Science will strongly support IDEA through active coordination of synergistic research and pedagogical opportunities, as well as new faculty hires that are aligned with our cross-cutting priorities.

Action Plan (FY18 and Beyond):

- Coordinate and message progress in materials-related data science, data analytics, and information research efforts through the Rensselaer IDEA
- Facilitate faculty research discussions across IDEA and cMDIS through seminars and luncheons
- Involve the Rensselaer IDEA and cMDIS leadership in Science faculty searches

Metrics/Milestones:
IDEA & cMDIS-aligned thematic faculty searches for open endowed chair and constellation positions begin (4Q, FY17)
Searches finish with successful hires (3Q, FY18)
Three new SoS materials-related collaborations initiated (1Q, FY19)
Three new SoS materials-related collaborations resulting in proposal submissions (1Q, FY20)

Required Resources: Resources for hiring faculty are requested elsewhere. Resources for consolidating data- and information-intensive work in the Rensselaer IDEA are being developed

and linked with the Data INCITE Laboratory and IDEA Cloud infrastructure. Some projects may require seed investments to launch, and some level of continuing investment in faculty leadership and key staff to succeed. Each must succeed through external industrial, federal and philanthropic fundraising activities, but this can only happen when potentiated by enabling resources invested by Rensselaer (such as faculty lines and KIP opportunities). KIP seed resources are articulated and requested through the VP for Research Performance Plan.

Risks: Risks are minimal. This strategy contributes to an exciting opportunity to position Rensselaer as a leader in addressing highly impactful global challenges. Our only risk is not to commit fully to these initiatives.

Strategy 2.1.1.2: *Drive research growth through accelerating development of the Icahn School of Medicine and Mt. Sinai partnership in support of new therapeutic compounds.*

Description: The new partnership with the Icahn School of Medicine at Mt. Sinai presents great opportunities, especially for School of Science students who will be able to take advantage of new academic offerings. Joint research programs are also likely, and we will support VPR and CBIS in their efforts to establish those programs in FY18. Finally, we have proposed several new endowed chair and constellation faculty hires in this plan that could help leverage the new partnership.

Action Plan (FY18 and Beyond):

- Promote and stimulate cooperative research emphasizing healthcare analytics and wet-lab projects
- Stimulate data sharing and exchange of students, together with WebEx Luncheons between institutions based on the *"Dean's Seminar Series"* program

Metrics/Milestones:
First joint projects initiated (2Q, FY18)
Initial project collaborations achieve submitted proposal status (4Q, FY18)

Required Resources: Some projects may require seed investments to launch, and some level of continuing investment in faculty leadership and key staff to succeed. Each must succeed through external federal and philanthropic fundraising activities, but this can only happen when enabling resources are invested by Rensselaer. Such resources are articulated and requested through the VP for Research Performance Plan.

Risks: Risks are minimal. This strategy contributes to be an exciting opportunity to position Rensselaer as a leader in addressing highly impactful global challenges. Our only risk is not to commit fully to these initiatives.

2.1.2 Planetary Resilience

Overview: The strategies in this section will create and support a data-driven innovation ecosystem focused on planetary sustainability and infrastructure resilience through leadership in renewable energy, fresh water ecology, and cyber security.

Strategy 2.1.2.1: *Drive research growth through accelerating development of the Jefferson Project at Lake George and planning for expansion into an Environmental Center*

Description: With the elevation of Professor Rick Relyea to Director of the DFWI as well as his status as Director of the Jefferson Project, the transition of the DFWI to a highly capable institute research platform has made great strides. Many of the faculty involved in the DWFI/JP effort are from the School of Science, so the center of gravity of the effort remains there. The Jefferson Project seeks to establish a strategic partnership that will serve as a global model for sustained ecosystem understanding and protection, focusing on Lake George, a world-class natural resource now threatened with permanent degradation from a range of environmental stressors. An unprecedented array of new tools for applied scientific research will fuse monitoring, modeling, simulation, forecasting, and experimentation to inform and compel decision-making that leads to lasting protection of Lake George. By creating predictive capacities that harness science to light the path forward, this powerful new model will deliver ecological and market benefits that are widely felt, in the U.S. and worldwide.

The flagship Jefferson Project Helen Jo and John Kelly III Visualization Laboratory officially launched last Fall and expanded its use of models, sensors, and experiments to explore the effects and mitigation strategies for biological and abiotic stressors. Early work is focusing on the creation of several models including a circulation and hydrologic model, a food web model and a semantic model of the lake environment. These models will be fused with data from an unprecedented array of sensors and observations within and surrounding the lake, and in this way the Project is well aligned with the goals of IDEA. Finally, the meaning of the observations and the future scenarios predicted by the models will be validated through experiment, using both land-based mesocosms and a state-of-the-art floating mesocosm facility on the lake.

The science on the Lake must be fused with solutions-oriented understanding of how to best mitigate the lake stressors to keep the lake environment healthy. This will require collaboration with the Lake George community and makes an excellent case study for social scientists interested in how community action can drive environmental resilience. Also, the sensor suites need the collaboration of Engineering faculty to leverage state of the art capability. Finally, an advanced cyberinfrastructure and visualization capability will be needed to fully leverage the network of observations and data produced in the Project.

Key partners in the Jefferson Project include RPI, IBM and the FUND for Lake George. Each is expected to put forward resources in support of the Project. However, additional fund raising is needed to fully support the Project, and the School of Science stands ready to do its part.

Action Plan (FY18 and Beyond):

- Promote and support research within the Darrin Fresh Water Institute and the Jefferson Project through linked hiring priorities
- Create an infrastructure that drives Rensselaer's leadership in freshwater ecology as well as expanding into a leadership position in data-driven ecology across disciplines.

Metrics/Milestones:
Five new Jefferson Project-centric efforts initiated (2Q, FY18)
Coordination with the JP Director and VPR and fundraising to enable and realize the first set of in-lake mesocosms (1Q, FY18)
Create and implement a new "project map" and "fundraising map" with the JP leadership and VPR that empowers project expansion (1Q, FY18)

Required Resources: Continuing investment in key staff recruiting and retention are needed to succeed. Each must succeed through external federal and philanthropic fundraising activities. Such resources are articulated and requested through the VP for Research Performance Plan.

Risks: Risks are minimal. This strategy contributes to an exciting opportunity to position Rensselaer as a leader in addressing highly impactful global challenges. Our only risk is not to commit fully to these initiatives.

Strategy 2.1.2.2: *Drive research growth in renewable and traditional energy informatics through coordination with the Rensselaer IDEA.*

Description: Smart Grid technology and remote management of renewable energy systems (wind farms) represent examples of where the strengths of the Rensselaer IDEA can be combined with signal processing expertise to produce predictive models for energy optimization and failure mode predictions. Leadership in these areas is a critical step towards addressing societal resilience and energy independence issues.

Action Plan (FY18 and Beyond):

- Integrate and message energy-related data science, data analytics, and information research efforts within the Rensselaer IDEA
- Coordinate with the Rensselaer IDEA leadership to inform endowed chair and constellation faculty searches that will enable its rapid development
- Identify data analytics projects with GE Renewables and other alternative energy producers

Metrics/Milestones:
Three new SoS energy-related collaborations (2Q, FY18)
Searches begin for new contributing endowed chair and constellation faculty (4Q, FY17)
Searches finish with successful hires (3Q, FY18)

Required Resources: Resources for hiring endowed chair and constellation faculty are requested elsewhere. Resources for consolidating data- and information-intensive work in the Rensselaer IDEA will be small and redirected from existing sources. Some projects may require seed investments to launch, and some level of continuing investment in faculty leadership and key staff to succeed. Each must succeed through external federal and philanthropic fundraising activities. Such resources are articulated and requested through the VP for Research Performance Plan.

Risks: Risks are minimal. This strategy contributes to an exciting opportunity to position Rensselaer as a leader in addressing highly impactful global challenges. Our only risk is not to commit fully to these initiatives.

Strategy 2.1.2.3: *Develop leadership in Cyberinfrastructure resilience and Cybersecurity.*

Description: In addition to ecosystem sustainability and climate change mitigation, planetary resilience in human terms increasingly requires that the computational infrastructure which enables civilized society be resilient against cyber attacks, and must enable trusted electronic communications for commerce, government and personal information exchange. These challenges motivate our emphasis on computational "resilience" in several areas, including network "trust", cybersecurity, data privacy and a secure "internet of things" (IOT).

Action Plan (FY18 and Beyond):

- Coordinate new endowed chair and constellation faculty position proposals with existing trust and cybersecurity positions
- Create a critical mass of research and pedagogy around computational security and trust

Metrics/Milestones:
Two new cybersecurity / data privacy thrust areas defined (1Q, FY18)
Three new cyber-related CSCI/IDEA collaborations (3Q, FY18)
Searches begin for new contributing faculty (3Q, FY17)
Searches for new endowed chair and constellation positions finish with successful hires (3Q, FY18)

Required Resources: Resources for hiring faculty are requested elsewhere. Resources for consolidating data- and information-intensive work in the Rensselaer IDEA will be small and redirected from existing sources. Some projects may require seed investments to launch, and some level of continuing investment in faculty leadership and key staff to succeed. Each must succeed through external federal and philanthropic fundraising activities. Such resources are articulated and requested through the VP for Research Performance Plan.

Risks: Risks are minimal. This strategy contributes to an exciting opportunity to position Rensselaer as a leader in addressing highly impactful global challenges. Our only risk is not to commit fully to these initiatives.

2.1.3 Data to Action for Human Health

Overview: The strategies in this section will create and support a data-driven innovation ecosystem focused on Healthcare Analytics and Health Informatics.

Strategy 2.1.3.1: *Leverage and grow the Data Analytics and Healthcare Informatics capabilities of IDEA, CCI and EMPAC to support first- and third-world healthcare projects of global significance.*

Description: The powerful capabilities of the IDEA/CCI/EMPAC/CISL platforms and the Rensselaer faculty involved in their development and use provides the environment needed to support large "Big Data" informatics projects across multiple disciplines, including third-world child health remediation as well as mining electronic medical records to identify hidden causal relationships in modern healthcare.

Action Plan (FY18 and Beyond):

- Identify partners and establish formal connections with healthcare provider networks (such as CDPHP)
- Expand partnerships with health data repositories (such as Optum Labs)
- Build on third-world health informatics projects with global partners (such as the Gates Foundation)

Metrics/Milestones:
Whitepapers with two external partners (3Q, FY17)
First collaborative efforts initiated (1Q, FY18)
Plan in place for supporting projects utilizing large-scale healthcare data (4Q, FY18)

Required Resources: Some projects may require seed investments to launch, and some level of continuing investment in faculty leadership and key staff to succeed. Each must succeed through external federal and philanthropic fundraising activities, but this can only happen after seed resources are invested by Rensselaer. Such resources are articulated and requested through the VP for Research Performance Plan.

Risks: Risks are minimal. This strategy contributes to an exciting opportunity to position Rensselaer as a leader in addressing highly impactful global challenges. Our only risk is not to commit fully to these initiatives.

Strategy 2.1.3.2: *Drive research growth in predictive Healthcare informatics modeling through coordination with the Rensselaer IDEA.*

Description: Computer Science and Tetherless World Constellation Professor Jim Hendler is leading The Rensselaer IDEA for the Institute together with Math and Computer Science Professor Kristin Bennett. The Steering Committee has a large representation from the School of Science, across all our key disciplines. To be successful, IDEA must support the concept of Data to Action, which means strong connection with application areas such as energy and healthcare. We have submitted significant proposals in areas of interest for IDEA, particularly in its new form inclusive of the DSRC. We will continue to support IDEA in all ways needed, including dedicating the time of current faculty as well as dedicate new faculty lines to this effort.

Action Plan (FY18 and Beyond):

- Integrate and message healthcare-related data science, data analytics, and information research efforts within the Rensselaer IDEA

- Coordinate with the Rensselaer IDEA leadership to inform endowed chair and constellation searches that will enable its rapid development

Metrics/Milestones:
Three new SoS healthcare-related collaborations (4Q, FY17)
Searches begin for new endowed chair and constellation faculty (3Q, FY17)
Searches finish with successful hires (3Q, FY18)

Required Resources: Resources for hiring faculty are requested elsewhere. Resources for consolidating data- and information-intensive work in the Rensselaer IDEA will be small and redirected from existing sources. Some projects may require seed investments to launch, and some level of continuing investment in faculty leadership and key staff to succeed. Each must succeed through external federal and philanthropic fundraising activities. Such resources are articulated and requested within the VP for Research Performance Plan.

Risks: Risks are minimal. This strategy contributes to an exciting opportunity to position Rensselaer as a leader in addressing highly impactful global challenges. Our only risk is not to commit fully to these initiatives.

2.2 Hiring, Promotion, Tenure

Strategy 2.2.1: *Expand the global impact of our research through faculty hiring to fill Constellation and endowed Chairs (TERM, BCBI, cMDIS and CISL), as well asTeaching Fellows aligned with the Signature Thrusts and IWHPs including IDEA, Biotech/Mt. Sinai, cMDIS, CISL, the Jefferson Project at Lake George, and pedagogical inovation.*

Description: Faculty Renewal, Expansion, and Retention is the *sine qua non* of the SoS Performance Plan. This is the foundation upon which virtually all of the rest of our goals are built. For increasing research expenditures, increasing student numbers, and advancing Department and Institute rankings, there can be no single action more imperative to take for the future of the School of Science than growing our faculty by the addition of outstanding new endowed chair and constellation professors whose work aligns with Rensselaer's strategic directions. The continuing concept of <u>treating the School of Science as a continuum of interconnected multidisciplinary science themes</u> will enable us to hire faculty with the greatest alignment with IWHPs while maintaining discipline-specific accreditation in mind and to hire teaching fellows who will allow us to accelerate our innovation in pedagogy.

Background: The *challenge* that contributes to our motivation for Faculty Renewal, Expansion and Retention is best understood by examining some statistics. As previously discussed, the total faculty numbers in Science are only recently recovering from their 15% decrease over the last 10-15 years. Of greater concern, the total number of Assistant Professors in the SoS is currently 16, but the number of likely retirees among the senior ranks is larger than this over the next three years. These statistics (Table 5) continue to motivate a serious need for faculty renewal at all ranks.

In addition to simply addressing demographic concerns, we must grow the overall number of the faculty to keep with the Rensselaer goal to increase faculty size. Consistent with the Institute goals as stated in the Rensselaer Plan 2024, our goal is to grow the overall faculty size by 5-8 T&TT faculty by the end of this three-year planning cycle beginning with endowed chair and constellation positions. The long-term aspirational goal is to have 150 T&TT faculty members in the School of Science by the bicentennial.

Table 5. Professors in the School of Science

Department	Full Professors (Including Chairs)		Associate Professors (Including Chairs)		Assistant Professors	
	Now	FY'18 *	Now	FY'18 *	Now	FY'18 *
Biology	7	7	5	5	4	4
Chem. & Chem. Bio.	8	10	3	2	2	2
Computer Science	13	15	6	5	5	6
Earth & Env. Sciences	4	4	2	2	2	2
Mathematical Sciences	16	15	3	3	1	2
Physics, ApPhys. & Ast.	14	13	4	4	2	2
TOTAL	**62**	**64**	**23**	**21**	**16**	**18**

* FY18 Projection based on likely P & T decisions, faculty hires, and announced retirements. Subject to change.

Action Plan (FY18 and Beyond):

- Complete the hiring for the faculty positions approved for FY17 (see Appendix 3)
- Hire ten Teaching Fellows, endowed chair and constellation faculty in multidisciplinary science theme areas, and three replacement Teaching Fellows in FY18 (see Appendix 3)
- Hire nine Teaching Fellows, endowed chair and constellation faculty in multidisciplinary science theme areas, and three replacement Teaching Fellows in FY19 (see Appendix 3)
- Hire additional new faculty in multidisciplinary science theme areas and four replacement faculty in FY20 (see Appendix 3 and Table 6)

Metrics/Milestones:
Successfully fill the positions listed above for FY18 (4Q, FY18)
Successfully fill the positions listed above for FY19 (4Q, FY19)
Successfully fill the positions listed above for FY20 (4Q, FY20)
School annual research expenditures reach $27M (4Q, FY18)
School annual research expenditures reach $30M (4Q, FY19)
School annual research expenditures reach $32M (4Q, FY20)
Improved faculty diversity (URM and women)
Improved URM retention and graduation rates

Resource Requirements: Hiring ten Teaching Fellows will require primarily salary dollars of about $950K. The same is true for hiring the three replacement Teaching Fellows, which will require about $285K. Hiring endowed chair and constellation faculty will require both startup and salary most of which will come from endowment funds.

Risks: The main risk for this aggressive hiring plan is startup funding. The Dean will approve each Search Committee Chair and meet with each committee to establish a timeline and a strategy for each position, including a focus on diversity. Second, there is a risk of losing highly motivated and qualified candidates due to lack of agility in our administrative processes.

Table 6. IWHP-Linked School of Science Searches and Hiring Plans FY20-FY22

Theme	*IDEA*	*JP*	*Icahn*	*cMDIS*	*CISL*
Data Analytics & Predictive Modeling					
Assistant CSCI Computational Economics and Algorithms FY21					
BCBI Constellation PAPA Biocomputation (Garcia replacement)					
Assistant PAPA Condensed Matter Theorist (Quantum Monte Carlo) FY20					
Assistant PAPA Data-Driven Observational Astronomy FY20					
Assistant BIO Quantitative Biology (Data-Driven) FY21					
Water, Energy, Resilience & Sustainability					
Assistant/Associate E&ES Environmental Chemistry FY20					
Assistant E&ES Geoinformatics and Data Science FY21					
Assistant BIO Ecology and Environmental Biology FY20					
Assistant PAPA Complex Networks (Physics) FY22					
Computational Science, Security & Simulation					
CISL Constellation Ricketts II Chair (CSCI) Human-Computer Interactions FY20					
Assistant MATH Mathematical and Computational Non-linear Opt FY20					
Assistant CSCI Artificial Intelligence / Cognitive Computing FY20					
Assistant CSCI Next Generation Computing FY20					
Assistant CSCI Security and Privacy / IoTs FY21					
Assistant PAPA Astrophysics (HPC-centric) FY21					
Biomedical Science & Applications					
TERM Constellation Chair (TBD) FY20					
D'Ambra Chair CHEM Organic Synthetic Chemistry FY20					
Assistant BIO Neurobiology FY21					
Assistant MATH Data-driven Modeling and Analysis in Biomedicine FY21					
Assistant/Associate CHEM Medicinal Chemistry/Drug Discovery FY21					
Assistant/Associate CHEM Computational Chemistry FY20					
Materials at the Nanoscale: MGI@RPI					
Assistant/Associate CHEM Inorganic **or** Polymer/Materials Chemistry FY20					
Assistant PAPA Condensed Matter Experimentalist FY21					
Assistant PAPA Condensed Matter Experimentalist FY22					

2.3 Pedagogical Innovation: Educating the Leaders of Tomorrow

Overview: The goal of our teaching and learning activities in this Performance Plan revolve around putting our "Discovery Across Boundaries" mindset into action in our curriculum. Focusing more on the integrative learning activities described below will serve our students by exposing them to the true interconnectivity of scientific inquiry, but engaging them in more real-world challenges earlier in their academic careers and by exposing them to the most cutting edge scientific approaches. To accomplish this, faculty engagement must be an integral component of our plans.

Strategy 2.3.1: *Enhance curricular and extracurricular activities to get students into "real science" and infused with "Data Dexterity" earlier in their learning experience by investigating global challenge problems and the interdisciplinary nature of scientific inquiry.*

Description: We live in a data and computationally intensive world – with this strategy; we will integrate modern data analysis and computational modeling tools into introductory courses across SoS curricula. We will seek to integrate "Grand Challenges" based questions into introductory methods classes that illustrate the interdisciplinary nature of real-work problems. And we will develop extracurricular activities that reinforce these concepts in exciting opportunities for students outside of the classroom.

Action Plan (FY18 and Beyond):

- Introduce modern data analysis techniques into the Math curriculum (DATUM).
- Utilize in the BIOL-1010 Introduction to Biology and other courses as key places to increase "Data Dexterity" in the Freshman Year.
- Develop a new discovery-based BIOL-4740 Cell Biology Laboratory using gift funds
- Introduce global challenge problems into courses across the School.
- Utilize Art_X examples throughout the Science curriculum.
- Enhance the Rensselaer Center for Open Source Software and tailor it to attract greater student diversity into Computer Science.
- Better position existing and determine new interdisciplinary concentrations
- Better position and strengthen existing interdisciplinary majors
- Create an "Innovator in the Classroom" Program to match alumni innovators with faculty to increase exposure of our students to entrepreneurs, non-academic innovators, and alternative career opportunities

Metrics/Milestones:

Initial updates to the Math curriculum (3Q, FY17)
Expanded updates to the Math curriculum (4Q, FY18)
Infusion of data-intensive exercises into BIOL-1010 (1Q, FY18)
In cooperation with IDEA and SoE, implement capstone Data INCITE Laboratory (4Q, FY17)
The number of courses in the School that include discussion of a global challenge problem reach 25 (4Q, FY17)
The number of courses in the School that include discussion of a global challenge problem reach 50 (4Q, FY20)

100+ students involved with the Rensselaer Center for Open Source Software each semester, and introduce an "RCOS Summer" as part of the CSCI Summer Arch program (4Q, FY18)
The percentage of women and underrepresented minority students involved with the Rensselaer Center for Open Source Software reaches 33% (4Q, FY19)
Leverage existing courses to create new concentrations in : (2Q, FY18)
Each Department proposes at least one new interdisciplinary concentration (1Q, FY19)

Resource Requirements: Resources will be required to implement this plan, especially leveraging the capabilities at EMPAC already being used in the Virtual Bridge Program development. We will need to begin planning to institutionalize our HHMI mentor programs across multiple SoS disciplines.

Risks: Changing core curriculum is always a difficult process, but we will continue working with the Undergraduate Dean to smoothly implement new curricular developments. We will take a systematic approach to reduce the risk of failure.

Strategy 2.3.2: *Infuse Art_X@Rensselaer concepts across the School of Science to illustrate the interdependencies between scientific discovery, innovation and artistic creativity, and showcase "the Art in, and of, Science, and the Science in, and of, Art".*

Description: Creativity as embodied in art and discovery of new knowledge as embodied in science go hand in hand and build off of each other. It is important for our students to see this and to understand this. To accomplish this, we will encourage faculty to get together to explore ways that this important cross fertilization can be introduced into science courses and we will develop teaching materials that use this intersection to illustrate relevant science principles.

Action Plan (FY18 and Beyond):

- Create recognition-based incentives for groups of faculty getting together to explore the integration of artistic creativity and science discovery into science courses.
- Promote Art_X science activity within the Teaching and Learning Collaboratory
- Modify core curricula for introductory science courses to illustrate the "Art in, and of Science, and the Science in, and of Art".
- Create and deploy the RCOS software "Digital Passport" (aka "Venue") mobile application to allow student attendance of important area cultural and campus events to be tracked and used for course credit. This app will enable elements of CLASS by incorporating social media components that will encourage students to go to the designated events in groups and provide feedback and discussions about their content and value.

Metrics/Milestones:
Three faculty-driven Art_X whitepapers (4Q, FY17)
Beta version of "Venue" deployed (2Q, FY17)

Resource Requirements: The School will cover the cost of the Art_X incentives from its existing resources. To follow up on the alpha test, the Venue "app" Beta development will cost an additional $18k in FY18, and will need ongoing support from DotCIO.

Risks: There is little to lose and much to gain by successfully bringing artistic creativity and scientific discovery together in the minds of the students.

Strategy 2.3.3: *In collaboration with SoE and HASS, develop the Challenge Studio concept to enable interdisciplinary groups of students to address complex global challenge problems.*

Description: The Challenge Studio is a lively venue that encourages students from all disciplines to work together to solve complex problems through multi-disciplinary inquiry. This exciting interdisciplinary environment fosters invention and creativity, innovation and leadership. Students learn to respect diversity of thought and develop an awareness of the social and cultural context of their work.

In its physical embodiment, the Challenge Studio will be a lively maker, thinker, and inventor space where teams of students (engineers and artists, scientists and architects, and social scientists and young entrepreneurs) come together to think and create. The central Challenge Studio space will be networked with a number of robust fabrication facilities across the campus to achieve much more than the sum of its parts.

Members of the Challenge Studio will attend workshops and seminars that expose them to the skills that are essential to tackle problems that have global impact. Members will also be supported by faculty mentors, technical staff, and funding for participation in challenge competitions.

The Challenge Studio will foster invention and creativity, innovation and leadership, diversity of thought, and respect for culture. It will act as a springboard to developing leadership and entrepreneurship with the ambition to change the world for the better.

The overarching goals for the Challenge Studio are to:

- Provide a creative environment and physical space for students and faculty with diverse backgrounds, cultures, experiences, and education to come together to work on today's grand challenges.
- Support projects proposed by students and teams of students based on their societal value, impact, and significance.
- Pursue projects that promote in depth interaction between students, faculty, and staff.
- Support innovative curricula (e.g., Inventor's Studio, Innovation Spine) that resonate with the goals of the Challenge Studio.

Action Plan (FY18 and Beyond):

- Assemble multi-disciplinary teams of students and faculty in an environment designed to creatively address the grand challenges of our day to catalyze the leadership and entrepreneurial spirit of our students and faculty.
- Position the Challenge Studio among the fundraising goals for the Capital Campaign

- Build interdisciplinary teams of students and guiding faculty to address complex problems using the Challenge Studio and the Data INCITE Lab (DATUM)
- Link the Challenge Studio concept with GE Renewables and real-world problem solving in wind farm data analysis

Metrics/Milestones:
First Challenge Studio problems defined (4Q, FY17)
First interdisciplinary team of students formed (1Q, FY18)
Five interdisciplinary teams formed (1Q, FY19)

Resource Requirements: Required resources will depend on the specific problems chosen.

Risks: There is little to lose and much to gain using the Challenge Studio model to enhance the student experience.

Strategy 2.3.4: *Support the new Teaching and Learning Collaboratory (TLC) in which "Best Practices" in teaching and learning can be developed, disseminated and deployed across the Institute to promote student learning and satisfaction.*

Description: Effective development and deployment of superior educational methods and tools for course delivery requires a strong interdisciplinary commitment that spans multiple Portfolios across the Institute. The mission of the proposed Teaching and Learning Collaboratory is complementary to that of the Challenge Studio but shares a set of core values. It will be a space where faculty members can share knowledge about the best ways to use existing classroom technologies to deliver enriched course materials, engage with Cognitive Science experts to develop and evaluate new pedagogies, and receive practical training in using new "flipped", blended and immersive technologies in courseware. It will provide support for delivering course material to students from remote locations in the event of a public health student/faculty isolation event.

Action Plan (FY18 and Beyond):

- Begin engaging SoS faculty to participate in the Teaching and Learning Collaboratory.
- Support and renew the Collaboratory Steering Committee to determine priorities.
- Coordinate with Institute Advancement to package the Collaboratory and Challenge Studio as major steps towards Transformative education.
- Create/continue a program to encourage faculty to adopt "best practices" cyber-enable pedagogy.

Metrics/Milestones:

- Engage three additional Science faculty "thought leaders" in the core committee of the Teaching and Learning Collaboratory (TLC) (4Q, FY17)
- Track faculty involvement in Collaboratory training seminars and workshops. (1Q, FY18 and on-going)
- Determine credit hours of teaching influenced by Collaboratory methods. (4Q, FY17 and on-going)

- Monitor student performance in cyber-enhanced courses. (1Q, FY18 and on-going)

Resource Requirements: Required resources will be determined in a capital project request.

Risks: There is little to lose and much to gain building the Education Collaborator to enhance the student experience.

Strategy 2.3.5: *Create a "PrizeLab" to support and encourage student groups to compete for the increasing array of prizes, especially in areas aligned with the Global Challenges*

Description: Increasingly, government agencies, NGOs, and even companies are turning to "open innovation" platforms, including extensive use of prizes, to advance innovation and unleash creativity. School of Science students are highly skilled in problem solving, and working on these prize challenges is a great way to hone those skills as well as develop teamwork, real world and cross-disciplinary thinking. In addition, if our students start winning lots of prize competitions, it is great publicity for Rensselaer as a place where students really can "Change the World". Creating a PrizeLab, where students can come together to find existing prize opportunities and form teams to compete for them is a concept that emerged from a retreat convened by the SoS over the summer on "Innovation Entrepreneurship and Science." We will seek to have the PrizeLab be largely student-run, in a model similar to the Rensselaer Center for Open Source Software (RCOS), however part-time faculty and staff oversight will be highly enabling to the student teams. Association of the PrizeLab with the Severino Center and/or the Challenge Studio would make sense longer term, and we propose to do this in concert with HASS.

Action Plan (FY18 and Beyond):

- Expand the PrizeLab by identifying additional external prize opportunities
- Form teams to pursue the prizes identified above

Metrics/Milestones:

- Implementation Plan for PrizeLab complete (4Q, FY17)
- Identify next set of prizes to pursue (1Q, FY18)
- First team formed (1Q, FY18)
- Additional two teams formed (2Q, FY18)

Resource Requirements: The PrizeLab needs a "home" (likely to be shared with the new Data INCITE Lab in Amos Eaton 217), investment of faculty and staff time, and likely ultimately (in the 2nd or 3rd year) a faculty or staff director. We will direct some SoS gift funds towards growing the PrizeLab, and will seek to fund the lab entirely from gift or endowment funds going forward.

Risks: PrizeLab falls much more into the "opportunity" than "risk" category – there is a massive opportunity in open innovation to position our students and Rensselaer to be more competitive and impactful. PrizeLab seeks to leverage this opportunity.

Strategy 2.3.6: *Data Dexterity at Rensselaer – the "Data INCITE Laboratory"*

Description: The data dexterity effort seeks to create cadres of Rensselaer graduates who translate data into actionable insight, communicate these findings and translate them into solutions of compelling problems. Through a cross portfolio effort, Rensselaer will rapidly create a distinctive integrated interdisciplinary undergraduate program in data dexterity by creation of key new efforts and strategic use and enhancement of existing efforts. The data dexterity program began with the premise that all Rensselaer students will have basic data awareness and literacy skills as part of their core undergraduate experience. From this we build in a pathway of data related courses and activities that culminate in the creation of a distinctive cadre of students from many different majors with advanced capabilities in following data dexterity objectives: 1) Use modeling and analysis of data to formulate and solve real world problems in science, engineering, medicine, humanities, architecture, and/or business; 2) Be able to apply quantitative algorithms and techniques to diverse data and interpret their results including an understanding of uncertainty; 3) Communicate effectively the results and insights of data analysis to diverse audience through oral, written, and multi-media presentation; 4) Exploit data cyber-resources and repositories for problem solving and develop awareness of the importance of data stewardship and documentation across the data life cycle; 5) Understand the ethical use and impact of data on society.

Collaborators: IDEA (K. Bennett – Associate Director) / Academic Deans/Schools

<u>Action Plan (Current Year and FY 2018):</u>

- Develop the framework for the Data Interdisciplinary Challenge Intelligent Technology Exploration Laboratory or "Data INCITE" Laboratory
- Support K. Bennett submission of NSF grant in this area as renewal of prior grant.

<u>Action Plan (FY 2019 and 2020):</u>

- Establish multiple pathways to achieve data dexterity through various majors via a sequence of courses as defined in the new curriculum proposal. This would involve two data-intensive experiences – one in the Freshman year (provided within Bio1010 and a specialized course in ITWS), and another discipline-specific experience associated with their senior year courses.
- Expand the Center of Communication Practices to include analysis and communication data as part of its core mission. Teaching Learning Assistants would provide support for use, analysis and communication of data as data dexterity becomes an integral part of the curriculum.
- Implement a data awareness core curriculum available to undergraduates as determined by the Core Curriculum Committee to immediately establish Rensselaer distinctive edge in data dexterity in undergrad education. This approach embodies the Data Dexterity Initiative described above.

Metrics/Milestones:
Grow the "Data INCITE Laboratory" (1Q, FY18)
Engage four IDEA and CSCI faculty as core members of the Data INCITE Laboratory Capstone Experience (2Q, FY18)
Long Term Performance Measure: (Outcome metric)
A cadre of Rensselaer graduates educated in Big Data and highly sought after by industry and academic programs.

Strategy 2.3.7: *Expand the Calculus Virtual Bridge Program*

Description: The School of Science is leading Rensselaer's on-line engagement effort through design of critical tools for hosting course content and development of content for the virtual bridge Calculus course that was experimentally deployed in 1QFY15 and again in 1QFY16 and 1QFY17. Each module consists of about 5-15 minutes of video, broken into smaller videos under 4 minutes each, static text with formulas and key ideas to be displayed alongside the video, a set of 5-10 problems for the students to work after watching each video with an online homework system, and possible discussion topics and a link to a discussion board or chat room so students can discuss the video or get help with the problems. Expansion of this program would involve additional implementation and refreshing of "blended learning" material to optimize delivery. The response to this program has so far been very positive.

Action Plan (FY18 and Beyond):

- Expand the program to more students, focusing on URM student enhancement
- Use Rensselaer students and faculty for online office hours via the discussion board or chat room so students can get help
- Define ways of expanding to other fields of science to stimulate additional diversity

Metrics/Milestones:
Improved average student grades in Calculus I (2Q, FY18)
Improved student retention rates and five-year graduation statistics (4Q, FY20)

Resource Requirements: Resources will be required in order to institutionalize the full deployment of this program as a regular Summer program.

Risks: This schedule has been very aggressive for the completion of the Virtual Bridge Program – continued support for the faculty, staff, and students involved will be required for full realization and successful deployment.

2.4 Student Experience = CLASS

Strategy 2.4.1: *Work with Student Life to develop meaningful, developmentally appropriate opportunities for interactions between students and Science faculty outside of the classroom.*

Description: In collaboration with members of the Student Life portfolio and the other academic deans, we will define and implement a series of events and interaction opportunities

designed to break down barriers of communication between students and faculty. These events will be planned in such a way that they cluster students according to their class level and interests.

Action Plan (FY18 and Beyond):

- Offer 3-4 SoS led CLASS events per year and track their impact.
- Expand the pilot program according to lessons learned during the initial set of events.
- Hold "Dean's Office Hours" both in the SoS Dean's Suite and in the Commons to collect student feedback and foster interactions.

Metrics/Milestones:
The level of involvement will initially be measured by undergraduate participation numbers for each event, and then by student feedback assessment. We will also reach out to CLASS deans for indirect feedback about the success of the program.

Resource Requirements: Minor costs associated with lunches and pizza events.

Risks: No identifiable risks beyond time spent in planning and executing the events.

Strategy 2.4.2: *Collaborate with the Office of Graduate Education and the Student Life portfolio to develop and enhance Graduate CLASS.*

Description: With the addition of new resources in Student Life to support CLASS, and the new emphasis within OGE on enhancing the graduate experience (=CLASS), we will create new mechanisms for enriching the graduate student experience in developmentally appropriate and time-based ways.

Action Plan (FY18 and Beyond):

- Increase School involvement with the Science Graduate Council
- Involve GPDs and GPAs in Graduate Council events
- Hold "Dean's Office Hours" both in the SoS Dean's Suite and at off-site venues to collect graduate student feedback and foster interactions.

Metrics/Milestones:
The level of involvement will initially be measured by graduate participation numbers in Council-sponsored events (currently four per year), and then by student feedback assessment. We will also reach out to the new Graduate CLASS dean for indirect feedback about the success of the program.

Resource Requirements: Minor costs associated with lunches and off-site get-togethers.

Risks: No identifiable risks beyond time spent in planning and executing the events.

2.5 Resource Generation

Strategy 2.5.1: *Work with the School of Science constituent advancement officer and the rest of the Institute Advancement team to create the case for investment in critical areas and move out expeditiously to bring in resources, especially for our highest priorities.*

Description: Funding of student scholarships and fellowships, faculty hiring and retention, and facility upgrades are our highest priorities for fundraising. Our hiring goals will require a ~$10M per year investment in spendable startup funding for many years to come if we are to meet Rensselaer's faculty growth goals. And the facilities upgrades require additional investment that has not yet been quantified, but is likely in the range of ~$20-$40M. We are committed to "bridging the gap" in undergraduate scholarships and bringing in new graduate Fellowship endowments. The best institutions give Fellowships to essentially ALL first year PhD students. This will be our long-term goal. Appendix 5 contains a catalog of fund raising goals and departmental priorities.

Action Plan (FY18 and Beyond):

- Engage in aggressive fundraising (including generation of products to be used in fundraising efforts) in support of School of Science initiatives.
- Increase Department-level engagement with alumni and potential donors with specific plans from each Department
- Emphasize the impact of the new Campaign on the "Faculty 500" and "Bridging the Gap" fundraising priorities

Metrics/milestones:
Booked gifts and bequests associated with the School of Science to reach $7M (4Q, FY18)
Two or three new graduate student fellowships designated for Science graduates (4Q, FY18)
Two to three new undergraduate scholarships designated for the School of Science (4Q, FY18)
Annual RCOS funding of at least $100K (4Q, FY18)

Resources required: Travel funds for School-related travel and attendance costs for special IA events will be needed.

Risk: We are currently limited in our ability to attract the best students and faculty by the condition of our facilities, the lack of funding flexibility for small-scale Department initiatives, and the lack of graduate fellowships. Our diversity recruiting would be enhanced by additional undergraduate scholarships as well. Our fundraising goals seek to mitigate these risks. If we are successful, the pressure on Institute E&G funds will be reduced, and our recruiting and retention efforts will be more successful.

Strategy 2.5.2: *Engage the new School of Science Leadership Council to support fundraising and positioning of the School.*

Description: The primary purposes of the Leadership Council will be twofold: To engage our alumni and other supporters in positioning the School for success through philanthropy and networking, and to provide external reference points across our educational and research

endeavors. Members will gain insight and access to the range of activities within the School and in turn will provide their support through advice; through building connections with alumni, friends and industry; and through philanthropy. During FY17, the SoS worked closely with IA leadership to identify an initial group of proposed invitees, and the first meeting took place in 1QFY17. This list includes some of the School's best current donors and those who have strong potential for future support, with focus on ensuring diversity in race and gender, departmental representation, and industry segment. Additional active recruiting is now underway to achieve a membership of 15 people, with a short list of identified candidates in place. The eventual goal is to have a group of well-positioned, high capacity alumni, parents, and friends serving on the Science Leadership Council.

Action Plan (FY18 and beyond):

- Work with senior campus leaders and IA personnel to complete recruiting the first cohort of high-level members to the Science Leadership Council and identify a Chair.
- Hold second and subsequent meetings of the Council (in the Spring of 2017)

Metrics/Milestones:
Initial Council membership identified: 3Q FY16
First Council meeting: 1QFY17
Next Council meeting: 4QFY17
We will measure direct and networked philanthropic activity from SLC members

Resource Requirements: No additional resources are needed beyond Dean's travel to meet and engage prospective members of the Science Leadership Council. Some resources will be required to host the Science Leadership Council members while they are on campus.

Risks: Increasing the School's level of engagement with high level prospects and donors will be critical if we are to successfully address the challenges outlined by President Jackson in The Rensselaer Plan 2024 and, concurrently, meet the financial goals of Rensselaer's upcoming capital campaign. Leadership Councils are a common and effective mechanism for doing that.

Strategy 2.5.3: *In collaboration with IA and SCER, continue to review and update all promotional materials, with a near term focus on the School of Science Departmental websites*

Description: We recently completed a new School brochure and now send a monthly Newsletter to over 12,000 alumni and friends of the School of Science! These great achievements have been enabled by a strong collaboration between the School, DotCIO and SCER, but especially through the dedication and effort of our School of Science staff. Web modernization is the next critical step for promoting the School, and the first steps have already been taken in this direction. The web is the main gateway to the Departments for prospective undergraduate and graduate students, so this action contributes to our key goal of increasing the number and quality of students in the School.

Action Plan (FY18 and beyond):

- Work with SC&ER to create the next generation of the School of Science websites, with modern look and feel.
- Continuously update the School's departmental websites, both the look and feel as well as the content and its underlying implementation (in progress – continuous development)
- Modernize the School's center websites, both the look and feel as well as the content and their underlying implementation

Metrics/milestones:
School of Science website completed and online (3Q, FY17)
Departmental websites completed and online (3Q, FY17)
Next-Generation School and Department Websites online (4Q, FY18)
Center websites completed and online (4Q, FY18)

Resources required: Content and imagery expenses for initial website refresh, plus periodic updates. SC&ER will be engaged in this process, although external web development may be necessary and would constitute an additional expense. This would include portrait photography as well as Departmental graphics.

Risk: Not upgrading our communication currency of content will result in loss of students and alumni engagement.

Portfolio Additional Highest Priorities

Strategy 3.1: *Increase faculty recognition through nominations for prizes, awards, and academy and society memberships*

Description: Outstanding performance in research, teaching and service must be recognized internally and externally with appropriate faculty awards. In recent years, the SoS has held an annual awards reception to recognize faculty, staff, and students who have excelled. This effort must be expanded to systematically nominate faculty, staff, and students for appropriate awards external to the school and those within Rensselaer. Planning for faculty recognition for most awards will be included in the personnel evaluations of each Department Head to ensure accountability for this. For recognition like election to the National Academy, we will create a strategy with the VP for Research and other senior leaders, and implement an annual process to position candidates.

Action Plan (FY18 and beyond):

- Develop a knowledge-base of discipline-specific awards
- Encourage all departments to actively nominate faculty for awards using the knowledge-base as a reference for available awards

Metrics/milestones: (FY18 and ongoing)
Develop a knowledge-base of discipline-specific awards (4Q, FY17)

All departments nominating all eligible faculty members for national awards (4Q, FY18)

Resources required: No new resources needed

Risk: None, if implemented. Opportunity loss risk exists if not effective.

Strategy 3.2: *Continue our focus on laboratory safety through an upgraded SoS safety committee, regular status reviews, and ensuring that appropriate training is received by all.*

Description: In our efforts to be ever vigilant in assuring laboratory safety, we have re-formulated the School safety committee. In the coming year, this committee will establish best-practices guidelines and expectations for lab and other safety, and will ensure that regular inspections are being carried out in all School laboratories. We will also put an increased focus on ensuring all who are required to do so take the needed training. This will require more intensive collaboration with Environmental Health and Safety in HR as we do not have access to data on who has completed the training and who has not. We include all wet-lab active graduate students and undergraduates in our training cohort. Our goal is 100% trained. We will work with Environmental Health & Safety as well as Facilities to ensure that disposal of paper, electronic and chemical waste is relatively easy for faculty and staff and we will expect their participation.

Action Plan (FY18 and beyond):

- Facilitate training of all students in laboratory safety before entering a lab.
- Improve tracking of student training to better identify when training is needed and when it has been completed.
- Maintain a Traincaster Kiosk in a convenient location so that students, faculty and staff have laboratory safety training readily available, and install one in the new SoS HUB

Metrics/Milestones:
Full tracking of student lab safety training (Completed, 2Q, FY16)
Emphasis on maintaining 100% safety training of all students who are in laboratories

Resource Requirements: No new resources needed. If funds are needed for the cleanup, we will redirect within existing resources, as this is an important priority.

Risks: Safety risks are real – this action is meant to put safety front and center in the School. In addition, the condition of our research spaces presents a significant risk to our ability to attract and retain the best faculty and students. Attention to basic upgrades will mitigate this risk.

Strategy 3.3: *Continue and expand our focus on diversity with special efforts in hiring and retaining diverse faculty and staff, creating a welcoming, inclusive climate, and increasing gender diversity in our student body in all Departments, with special focus on Computer Science and Physics, Applied Physics and Astronomy.*

Description: Meeting the global challenges and Institute goals articulated in the Rensselaer Plan 2024 requires the brainpower and innovation of a diverse community of faculty, students

and staff. Bringing together people from diverse backgrounds, with diverse intellectual perspectives, and with diverse sets of experiences is one of the undergirding requirements for a successful future for the School of Science. Specifically, in the FY18 Performance Plan, we will focus on refining our implementation of best practices in hiring to ensure an inclusive hiring process that results in the highest quality diverse talent pool. We will highlight the accomplishments of women and underrepresented faculty in web and print articles as role models for our existing and prospective students and potential hires. Using the newly appointed School of Science faculty "dual mentor" system, we will work to strengthen Department-level mentoring of junior faculty who are on the tenure-track. From the student perspective, we will focus on increasing gender diversity in Computer Science, where only 16% of the majors are women – an increase from 14% last year. Computer Science is the second most popular major with over 802 majors + dual majors, and is ripe for proactive diversification. Physics, Applied Physics and Astronomy will also focus on gender diversity, having risen from 8% to 11% in the past two years.

Action Plan (FY18 and beyond):

- Highlight the accomplishments of women and underrepresented minorities in web and print models as role models for other students and faculty.
- Raise funds to send more than 30 women Computer Science students to the annual Grace Hopper Celebration of Women and Computing.
- Update hiring guidelines with best practices from the STRIDE Program

Metrics/Milestones:
Updated hiring guidelines - completed (1Q, FY16)
Highlights of women and underrepresented minorities on all School websites (2Q, FY18)
Sufficient funds raised to support participation of at least 30 students and faculty in the Grace Hopper Conference annually (1Q, FY17) [Note: 35 students participated in 1QFY17]
Monthly publication of a new print or web article on the accomplishments of women and underrepresented minorities (1Q, FY17)

Resource Requirements: We will need to raise about *$20-30K per year* to support attendance at the Grace Hopper Celebration of Women and Computing. The SoS will take responsibility for this.

Risks: Ensuring a diverse, inclusive environment is an absolute requirement for future success. The modest levels of support requested here are needed to achieve our diversity goals.

Strategy 3.4: *Work with DotCIO to implement the recommendations of the Academic IT Task Force, specifically focused on staffing and hardware replacement needs.*

Description: Outside of the Computer Science department, there is no technical support for faculty and staff in the SoS when issues arise in computer installation and maintenance, security, networking and communications, data backups, and other related issues. Faculty and staff must fend for themselves or beg for someone to help. This results in significant risk, loss of productivity, security issues, and poor planning and preparation for future technology

failures. It is a significant risk that the SoS can no longer tolerate, and it is simply unacceptable for a modern technological institution. In addition, most grants do not permit purchase of computers (laptops or desktops), and there is no mechanism to regularly replace computers for all staff and faculty. Essentially ALL faculty and staff now REQUIRE computers to do their jobs, whether for teaching or for support functions. Therefore, we must have both guidelines for frequency of replacement and funding to do so.

Action Plan (FY18 and beyond):

- Hire two IT staff members in the School of Science to support IT systems in the School (First recommendation of the IT Task Force).
- Create a program for computer hardware renewal on a cyclic basis (Second recommendation of the IT Task Force)

Metrics/Milestones:
Hire first IT staff member for the School (4Q, FY18)
Plan developed for cyclic replacement of computer hardware (4Q, FY18)
Plan implemented for cyclic replacement of computer hardware (1Q, FY19)

Resource Requirements: According to the highest priority recommendations of the IT Task Force, addressing this action requires addition of at least one full-time staff support person assigned full time to the School of Science.

If we assume that Chaired Professors will cover replacement systems from their Chair Funds, and a 3-year replacement cycle, then replacement systems for 44 people per year will be required. Assuming a cost of $2000/system, the total cost is $88K/year. We request this as an increase to our non-salary E&G budget.

Risks: Lack of academic computing equipment and support is one of the most significant risks in the School. It impacts our ability to recruit faculty, and to execute even the most basic activities of the School. It significantly impacts productivity and poses risks to security and data management. In addition, it contributes to retention issues in the School. Risks are loss of productivity, insecure activities, and loss of faculty.

Strategy 3.5: *Collaborate with the Campus Leadership to gain agreement on next steps for new facilities including a comprehensive space plan for future growth of the School of Science (i.e., Alternatives to the original Center for Science proposal).*

Overview: The Center for Science was widely discussed as the next major building to be constructed on the Rensselaer campus, but is waiting for funding through the upcoming Capital Campaign. As recently as the FY13 Performance Planning process, it was specifically named as one of the five Institute-wide highest priorities, and it is specifically called out as a priority in the Rensselaer Plan 2024 (p. 27). Clearly, until this concept is realized through directed fundraising, alternative space strategies are needed to allow for anticipated and required growth in faculty. Recent discussions have resulted in a change in focus for this project, with

the specific next steps not yet fully defined. Given the prior specific priority and communication about this project, it is important to provide clear expectations going forward.

Action Plan (FY18 and beyond):

- Develop a clear message about the future of the Center for Science and related science facilities on campus
- Complete a new planning focus on space for growth of the School of Science
- In the interim, execute renewal projects described in Appendix 2 to ensure that the School has needed space for student and faculty activities under the Rensselaer Plan 2024.

Metrics/Milestones:
Agreement on key messages about the future of the Center for Science (2Q, FY18)
Complete new planning focus on space for growth of the School (4Q, FY18)
Plan in place for FY18 hiring (4Q, FY18)
Plan in place for FY19 hiring (4Q, FY19)
Complete interim renewal projects as needed (on going)

Resource Requirements:
Resources needed for the School's near-term facility requirements are articulated in the Capitol planning process and summarized in Appendix 2.

Risks:
The School of Science will have difficulty attracting new faculty and expanding our student ranks if the uncertainty regarding future facilities continues. Virtually all of our peer (and even below-peer) institutions had science facilities of similar vintage to the Jonsson Rowland Science Center. They have now essentially all been upgraded or replaced with newer facilities. This is, quite simply, a competitiveness issue for Science at Rensselaer. Thus we must be aggressive in determining our strategy and approach, and in executing it. In the meantime, however, we must begin to renovate existing facilities.

Strategy 3.6: *Hire at least eight additional regular lecturers, Senior Lecturers and Professors or Practice in the School of Science to improve the quality of instruction and course delivery consistency and as a combined measure while T&TT faculty numbers are being increased and class sizes are large, and to support the coming Summer Arch and ongoing enrollment surge.*

Description: As our faculty numbers had decreased by almost 15 in the past 10-15 years and have only recently begun to rise again, our student credit hours taught has increased by 7,600 and our number of lecturers has only increased by five, the majority of whom are being transitioned from one-year GAP-based appointments. An unavoidable consequence of the decline in faculty numbers while student numbers increase is an increase in the number of courses taught by non tenure/tenure-track faculty. This does not necessarily result in decreased quality, however if adjuncts are required to fulfill our teaching responsibilities, the planning is more difficult and the quality and commitment more variable. We do have 12 full- or part-time lecturers in the School of Science who are strong teachers and committed

members of our community. While we rebuild the faculty ranks, the best option to maintain the quality of a Rensselaer education is to hire teaching fellows with two-year appointments and lecturers (and senior lecturers) on renewable three-year contracts, and this requires "hardened" positions within our salary E&G. In this way, our teaching plans will stabilize, our students will receive better, more consistent instruction, and we will have the time we need to rebuild our faculty numbers. Note that if our full faculty hiring plan is approved, that should alleviate the need for these lecturer hires. However, given fiscal constraints, a mix of hires with teaching fellow and lecturer hires may well make sense. Appendix 4 shows details of the hiring plan for Lecturers.

Action Plan (FY18 and beyond):

- Hire eight additional Lecturers, Senior Lecturers or Professors of Practice on three-year contracts by the start of FY18. More specifically, one for Chemistry & Chemical Biology, two in Computer Science, one in Biology, one in Earth and Environmental Sciences, one in Mathematical Sciences, and two in Physics, Applied Physics and Astronomy.
- Near the end of each three-year cycle, re-evaluate the need for lecturers given the current tenured and tenure-track faculty size.
- Predicate Lecturer hires based on changes in teaching need brought about by the Summer Arch phase-in.

Metrics/Milestones:
Six new lecturers hired for the Fall 2017 semester (1Q, FY18)
Dynamic balancing of the lecturer hiring driven by the rate of tenured and tenure-track faculty maintained for optimally meeting the teaching mission of the School (on-going)

Resource Requirements: Hiring six lecturers, Senior Lecturers or Professors of Practice would require funding of the positions at appropriate levels. This will reduce the size of the requested GAP each of these years.

Risks: The biggest risk we face in our delivery of curriculum with increased student numbers and reduced faculty numbers is reputational and financial. Our reputation could be hurt through use of excessive numbers of adjuncts to deliver our courses. Eventually this will impact enrollment and therefore our finances. In addition, we risk continued excessive levels of effort to deal with the "gap" funding issue and scrambling to find qualified adjuncts late in the process if we cannot stabilize the number of teaching faculty. This will impact our ability to recruit the best students.

Summary: Advancing Science and Rensselaer
This Performance Plan lays out specific, coordinated, measureable, achievable actions that, if taken, will propel the Rensselaer School of Science to a new level of excellence, and thus will advance the entire University. These actions will also advance knowledge, and advance the training of the next generation of scientists, and as such are critical to the future prosperity of our region, and the Nation.

Our highest priority actions include:

- Complete FY17 hires and execute planned FY18 hires, including constellation positions, endowed chairs, teaching fellows and lecturers in an inclusive and diversity-focused manner
- Support CLASS, the Rensselaer Teaching and Learning Collaboratory (TLC) and the Challenge Studio
- Establish basic IT support for School activities
- Initiate upgrades of School teaching labs and other facilities
- Stabilize research support, including focused efforts in alignment with the Institute-wide highest Priority initiatives
- Fundraise for Institute and School priorities by growing and leveraging the Science Leadership Council (SLC)
- Increase size and quality of enrollments, and find appropriate mechanisms to "right size" the number of Computer Science majors

We have plans and mechanisms in place to enable us to carry out the proposed actions. We understand the risks involved, and have plans to mitigate them. We are committed to success. It is time for Science at Rensselaer to take our next steps.

Supplementary Material for Section II – Including Tables 1 & 2 and Appendices 1 - 4

Table 1: Investment and Return in the School of Science

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18*	FY20*
T&TT Faculty	108	103	103	97	96	99	101	101	102	105
New Hires	2	1	1	8	6	6	5	5	3	6
UG Students	1,286	1,282	1,309	1,265	1,310	1,357	1,467	1,686	1,650	1,700
Grad Students	320	334	347	350	339	369	345	315	350	375
Credit Hours	67,352	67,018	67,256	68,927	71,153	71,635	74,625	78,300 *	78,000	80,000
BS Awarded	289	278	313	321	298	281	302	320*	350	400
MS Awarded	96	98	79	97	79	106	104	110*	115	120
Ph.D. Awarded	51	41	49	41	40	45	43	50*	55	60
Members of Academy	3	3	3	3	3	2	2	2	3	4
Research Expend. ($M)	23.8	25.7	26.2	24.9	21.3	23.4	21.1	25.0 *	27.0	30.0
Research Awards ($M)	31.1	25.5	28.2	22.3	27.3	21.7	21.9	25.0 *	27.0	30.0

* Projected

Table 2: Benchmarks with Peer Schools of Science

	Rensselaer Now	MIT †#	CMU †#	Rice †#	Georgia Tech †#	Rensselaer Goal (FY20)
Tenured & Tenure-Track Faculty	101	399	204 (326*)	130	265	105
Undergraduate Students	1,686	1,566	1,342	1,186	2,424	1,700
/ T&TT Faculty	16.7	3.9	6.6	9.1	9.1	16.2
Graduate Students	315	1,985	1,286	542	1,499	375
/ T&TT Faculty	3.1	4.9	6.3	4.2	5.7	3.6
Total Students	2,001	3,551	2,628	1,728	3,923	2,075
/ T&TT Faculty	19.8	8.9	12.9	13.3	14.8	19.8
BS Awarded	302	502	325	324	515	400
/ T&TT Faculty	3.0	1.3	1.6	2.5	1.9	3.8
MS Awarded	104	232	321	91	281	120
/ T&TT Faculty	1.0	0.58	1.6	0.7	1.1	1.1
Ph.D. Awarded	43	255	114	76	87	60
/ T&TT Faculty	0.43	0.64	0.56	0.58	0.33	0.57
Total Degrees Awarded	449	989	760	491	883	580
/ T&TT Faculty	4.45	2.5	3.7	3.78	3.3	5.5
Research Volume ($M)	$21.9	$285.25	$147.00	$48.60	$90.00	$30.00
/ T&TT Faculty	$0.22	$0.71	$0.72	$0.37	$0.34	$0.29
** Faculty of all types* *† Member of the AAU* *# As of 2012*	School of Science	School of Science + Computer Sci. from School of Engineering	College of Science + School of Computer Science	School of Natural Sci + Computer Sci. from School of Engineering	College of Science + School of Computer Science	School of Science

Appendix 3: SoS Tenured and Tenure-Track Hiring Plan and Priorities, FY17-22

	FY17 (in progress)	FY18	Total Hires Through FY18
Biological Sciences	**Assistant** Developmental Cellular/Neuroscience	**Teaching Fellow**	**Faculty: 1** **Fellow: 1**
Chemistry & Chemical Biology	**Associate/Full** D'Ambra Chair, Medicinal/ Organic Chemistry	**Teaching Fellow**	**Faculty: 1** **Fellow: 2**
		Teaching Fellow	
Computer Science	**Assistant** Goldberg Replacement (Thematic)	**Teaching Fellow**	**Faculty: 2** **Fellow: 3**
	Full Ricketts Chair, Computational Network Science	**Teaching Fellow**	
		Teaching Fellow	
Earth and Env. Sciences	**Associate/Full** Environmental Science (Thematic)	**Teaching Fellow**	**Faculty: 1** **Fellow: 1**
Mathematical Sciences	**Assistant** Modeling & Simulation/Complex Systems	**Teaching Fellow**	**Faculty: 1** **Fellow: 1**
Physics, Applied Physics & Astronomy	**Constellation Professor** Computational Biology (Garcia Replacement, BCBI)	**Teaching Fellow**	**Faculty: 1** **Fellow: 2**
		Teaching Fellow	
Constellations	**Constellation Professor(s)** Tissue Engineering & Regenerative Med (Dept TBD)	**Constellation Professor(s)** Tissue Engineering & Regenerative Med (Dept TBD)	
	Constellation Professor(s) Computational Science & Engineering (Dept TBD)	**Constellation Professor(s)** Computational Science & Engineering (Dept TBD)	
	Constellation Professor(s) CISL (Dept TBD)	**Constellation Professor(s)** CISL (Dept TBD)	
Total	***7 + Constellations***	**10 Fellows *+ Constellations***	**7 Faculty + 10 Fellows *+ Constellations***
Replacement Positions		**3 Fellows**	
Grand Total	***7 + Constellations***	**13 Fellows *+ Constellations***	***7 Faculty + 13 Fellows + Constellations***

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	FY19	FY20	Total Hires Through FY20
Biological Sciences	**Teaching Fellow**	**Assistant** Ecology and Environmental Biology	**Faculty: 2** **Fellow: 3**
	Teaching Fellow		
Chemistry & Chemical Biology	**Teaching Fellow**	**Assistant/Associate** Computational Chemistry	**Faculty: 3** **Fellow: 3**
		Assistant/Associate Inorganic or Polymer/Materials Chemistry	
Computer Science	**Teaching Fellow**	**Assistant** Artificial Intelligence / Cognitive Computing	**Faculty: 5** **Fellow: 5**
	Teaching Fellow	**Assistant** Next Generation Computing	
		Full Ricketts II Chair, Human-Computer Interaction	
Earth and Env. Sciences	**Teaching Fellow**	**Assistant/Associate** Environmental Chemistry	**Faculty: 2** **Fellow: 2**
Mathematical Sciences	**Teaching Fellow**	**Assistant** Mathematical and Computational Non-Linear Optimization	**Faculty: 2** **Fellow: 2**
Physics, Applied Physics & Astronomy	**Teaching Fellow**	**Assistant** Data-Driven Observational Astronomy	**Faculty: 3** **Fellow: 4**
	Teaching Fellow	**Assistant** Condensed Matter Theorist (Quantum Monte Carlo)	
Constellations	**Constellation Professor(s)** Tissue Engineering & Regenerative Med (Dept TBD)	**Constellation Professor(s)** Tissue Engineering & Regenerative Med (Dept TBD)	
	Constellation Professor(s) Computational Science & Engineering (Dept TBD)	**Constellation Professor(s)** Computational Science & Engineering (Dept TBD)	
	Constellation Professor(s) CISL (Dept TBD)	**Constellation Professor(s)** CISL (Dept TBD)	
Total	***9 Fellows + Constellations***	**10 Faculty *+ Constellations***	**17 faculty + 19 fellow *+ Constellations***
Replacement Positions	***3 Fellows***	**3 Faculty**	
Grand Total	***12 Fellows + Constellations***	**13 Faculty *+ Constellations***	***20 faculty + 25* fellow *+ Constellations***

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	FY21	FY22	Total FY17-22 Hires
Biological Sciences	**Assistant** Quantitative Biology (Data Driven)		**Faculty: 4** **Fellow: 3**
	Assistant Neurobiology		
Chemistry & Chemical Biology	**Assistant/Associate** Medicinal Chemistry / Drug Discovery		**Faculty: 4** **Fellow: 3**
Computer Science	**Assistant** Computational Economics and Algorithms		**Faculty: 7** **Fellow: 5**
	Assistant Security and Privacy / IoTs		
Earth and Environmental Sciences	**Assistant** Geoinformatics and Data Science		**Faculty: 3** **Fellow: 2**
Mathematical Sciences	**Assistant** Data-Driven Modeling and Analysis in Biomedicine		**Faculty: 3** **Fellow: 2**
Physics, Applied Physics & Astronomy	**Assistant** Condensed Matter Experimentalist	**Assistant** Complex Networks	**Faculty: 7** **Fellow: 4**
	Assistant Astrophysics (HPC-Centric)	**Assistant** Condensed Matter Experimentalist	
Constellations	**Constellation Professor(s)** Tissue Engineering & Regenerative Med (Dept TBD)	**Constellation Professor(s)** Tissue Engineering & Regenerative Med (Dept TBD)	
	Constellation Professor(s) Computational Science & Engineering (Dept TBD)	**Constellation Professor(s)** Computational Science & Engineering (Dept TBD)	
	Constellation Professor(s) CISL (Dept TBD)	**Constellation Professor(s)** CISL (Dept TBD)	
Total	**10 *+ Constellations***	**2 *+ Constellations***	**28 faculty + 19 fellow *+ Constellations***
Replacement Positions	**4**	**4**	
Grand Total	**14 *+ Constellations***	**6 *+ Constellations***	**39 faculty + 25 fellow *+ Constellations***

Appendix 4: SoS Lecturer Hiring Plan and Priorities, FY18-20

Department	FY'18	FY'19	FY'20
Biological Sciences	1		
Chemistry & Chemical Biology	1		
Computer Science	2	1	
Earth & Environmental Sciences	1		
Mathematical Sciences	1	1	1
Physics, Applied Physics and Astronomy	2		
Information Technology and Web Science			
Total	**8**	**2**	**1**