

# **The Critical Role of Computing to Virginia Tech**

## ***Computing Drives Information Technology***

Computer science is a rapidly evolving discipline fueling the information technology revolution. The effects of this revolution are increasingly evident in the global economy, our personal lives, the structure and operation of organizations, and the culture of modern technological societies. The rapid and accelerating impact of the information revolution - centered in a computing discipline scarcely less than 50 years of age - stands as one of the marvels of progress in this, or any other, era of human history.

## ***Computing Enables Other Disciplines***

By its very nature computing is an enabling force in many areas of human activity. From mapping the human genome to the engineering of high performance aircraft, progress in science and engineering is critically dependent upon computing. In addition, modern business and governmental practices are based on computer-based information systems that keep records, control inventories, manage financial assets, and disseminate information. Even medicine, education, and library services are being transformed through the possibilities opened by digital technologies.

## ***Computer Science is the Connecting Link***

Only Computer Science as a discipline and a department is concerned with exporting inventions to and deriving inspiration from all of the varied disciplines that are enabled by computing. While other disciplines use computing, invent new aspects of computing focused on their main activity, and interact with closely related areas that also use computing, Computer Science is uniquely positioned to establish synergistic relationship across the entire spectrum of disciplines involved with computing. This position is reflected in the multi-disciplinary, collaborative proposals for new areas of research and education contained in this agenda.

## ***Improving the University's Ranking***

As a land grant institution with a historically strong reputation in science and engineering and with a current emphasis on information technology, the overall ranking of the university is correlated with the ranking of the Department of Computer Science. Investments that improve the ranking of the Department of Computer Science have a multiplier effect on the overall advancement of the university as a whole because of the collaborative relationships between computer science and other science and engineering departments.

# The Vision of Computer Science at Virginia Tech

## *We Collaborate!*

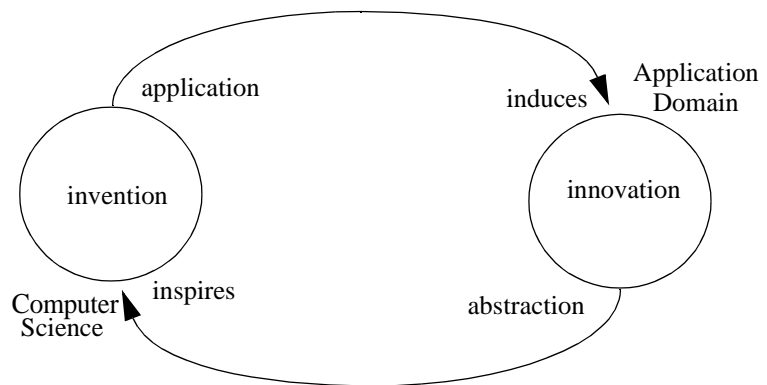
At Virginia Tech, Computer Science measures success by discoveries that advance the state of computing and, through collaborations with colleagues in other disciplines, enable progress in other disciplines. While the benefits of collaboration across disciplines is rewarding it is also difficult due to the differences in backgrounds, expertise, technical language, and disciplinary culture. Despite these difficulties, computer scientists at Virginia Tech have active collaborations with colleagues in the life sciences, the physical sciences, engineering, the library, and education.

## *How Computer Scientists Collaborate*

The collaboration between computer scientists and their colleagues in other fields of study follows a cycle of invention and innovation.

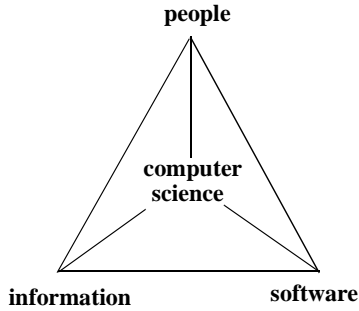
One way for the cycle to begin is by a computer scientist learning about a problem in the other field of study, the “application domain.” To obtain a computational-based solution to this problem, the computer scientist forms an “abstraction” of the problem. Abstraction in this context means that the computer scientist extracts those, and only those, aspects of the problem that are relevant to the development of a computer-based solution.

This step is difficult because the computer scientist must be sure that all - and only - the relevant aspects of the problem have been extracted. This step often involves extensive interactions with experts in the application domain. The abstracted problem serves to inspire the invention of new new knowledge in computer science - tools, technologies, methods, and theories. This new knowledge is used to develop a computational solution to the abstracted problem. The application of this solution induces innovation in the application domain from which the problem was obtained. The cycle can also begin by the invention of new knowledge in computer science that “goes looking” for a problem to be solved. In either case, each innovation leads to new questions and problems, fueling the invention of additional knowledge in computer science and further innovation in the other fields of study. Computer scientists also play the role of a transfer agent between different fields of study. A computational invention originally inspired by one application domain may be later applied in other fields of study. In other cases, the computer scientists generalizes the result obtained in one domain so that the result can be applied in other domains. As a result, computer scientists can disseminate enabling technologies through many domains.



*The Collaborative Cycle*

*The Focus of Computer Science*

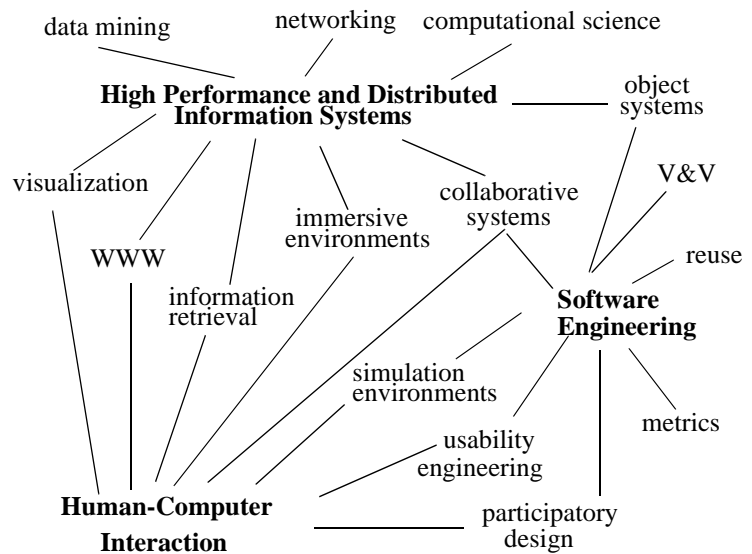


At Virginia Tech, the Department of Computer Science is focused on how people, software, and information and their interactions are viewed from the perspective of a computing discipline. This triad is reflected in the department’s teaching and research agendas. These three key elements are also the points at which the department builds collaborative linkages with other researchers, departments, and colleges. For example, a concern for information provides a connection between Computer Science and departments in the College of Business as well as the library; each views information and people from different, but complementary

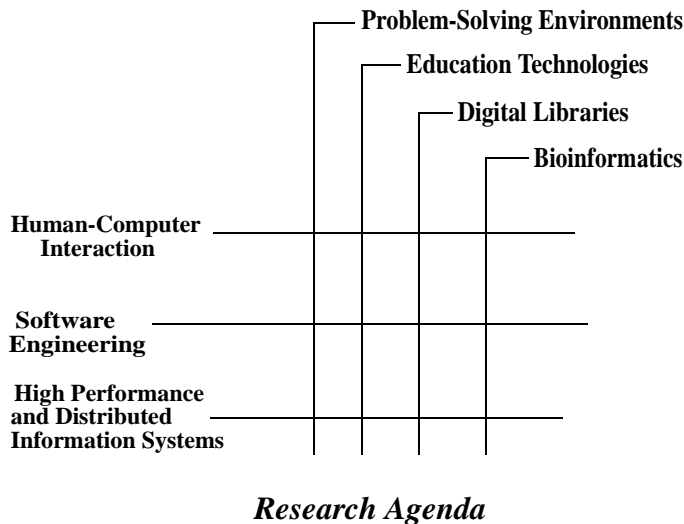
perspectives. In a similar way, the focus in Computer Science on the fundamental properties and processes associated with software are complemented by the discipline-centered application of software systems in departments in the College of Engineering and the College of Business.

*Research Expertise*

The Computer Science faculty possesses rich expertise in a broad variety of specialized research areas that are broadly connected to human-computer interaction, software engineering, and high performance and distributed information systems. Research in some of these topics is related to more than one of the three areas. For example, the work in visualization involves both human-computer interaction and high performance systems, and collaboration involves all three of the areas. This sampling of research specialities is not a complete list of the expertise held by the faculty, but represents a substantive part of the department’s research expertise.



## Cross-Cutting Research Programs



The research agenda of the department applies its core technical expertise to creating computer-based systems that have impact on the lives of scientists, engineers, students, and the general public. Cutting across the three main lines of research expertise are major projects that focus on people with different needs different ways of accessing and manipulating information. In the problem-solving environments project the people are scientists and engineers

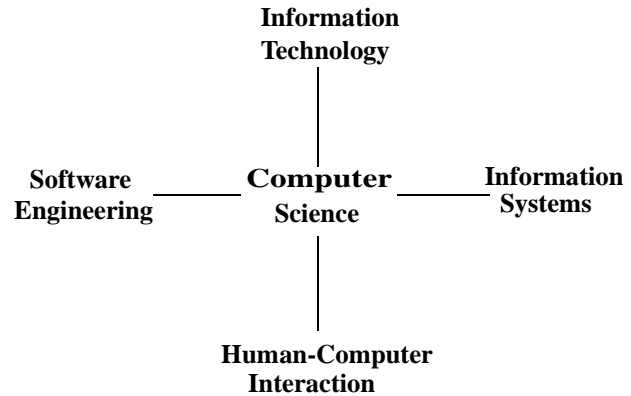
using parallel and networked computing resources to manipulate problem artifacts in their disciplinary areas. Educational technology focuses on people acquiring new knowledge or learning new skills through the support of computer-mediated forms. A digital library actively assists its users in accessing information in a structured repository. Bioinformatics concerns the way in which information about biological systems can be processed and visualized to lead to new understanding in the life sciences. These projects provide interesting research problems in human-computer interaction because of the intertwining of software systems and people working alone or in collaborative groups. The construction of these systems relies on the application of sound principles of software engineering and creates opportunities for the invention of new software technologies to support the development of these innovative systems. Underlying these systems is the use of high performance computing devices and the access to both computing resources and people who are geographically distributed.

By cutting across the technology areas, these projects draw the faculty together in diverse groups that combine their expertise in creative and innovative ways. These groups also reach out beyond the departmental boundaries to involve researchers in other departments and colleges. The hallmark of research in computer science at Virginia Tech is reflected in the collaborative, multi-disciplinary nature of these projects.

## ***Teaching Programs***

The prominence of people, software, and information centered in a computing discipline is reflected in the degree programs offered by the department. The Bachelor, Master, and Doctoral degrees in Computer Science provide in-depth exposure to the core body of knowledge in the computing discipline.

Surrounding and intersecting with these degrees are specialized graduate degrees emphasizing one of the three elements of information, people, and software. A proposed Master of Human-Computer Interaction degree is concerned with how computer-based system can be designed so that they best meet the needs of their human users. Ultimately, computing serves the needs of people, facilitating their work, providing entertainment, and enriching their lives. The principles and technologies related to software are embodied in the proposed Master of Software Engineering degree. This degree focuses on how high-quality software can be produced in an efficient and predictable manner. An information-centered degree is the existing Master of Information Systems, a collaboration with the College of Business that blends together core material in computer science with a study of the uses and effects of information in management settings.



### ***Graduate Degree Programs***

Our teaching agenda also encompasses the development of interdisciplinary tracks, areas of study, and specializations. The innovations provide undergraduate students with a greater opportunity to match their skills and career goals with an appropriate combination of educational experiences combining the science of computing with complementary knowledge and skills from cognate departments in the information technology arena.