Nurturing Next-Generation Computer Scientists

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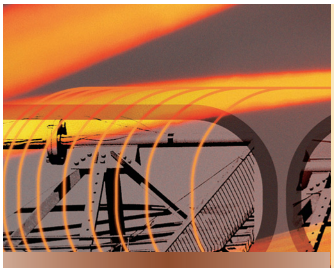
The origin of the University of Florida's Digital Arts and Sciences (DAS) curriculum is steeped in myth and adventure.

Anecdotal evidence indicates that DAS's story began on a transcontinental airliner, with UF's president seated across the aisle from a special-effects industry expert. After some mutually critical chitchat, these two visionaries decided the university should invest in bridging at least some of the gaps between the fine arts and computer science. This chance encounter resulted in an academic program designed to nurture students who have *both* sides of their brain functioning fully: the left brain doing logical thinking while the right brain focuses on aesthetics and the arts.

The DAS origin story not only sounds good, it has more than a grain of truth to it. In the six years since that fateful meeting, we have established a unique set of curricula and developed strong ties between the College of Fine Arts (www.arts.ufl.edu) and the College of Engineering's Department of Computer and Information Science Engineering (CISE, www.cise.ufl.edu/), with the potential to forge much stronger bonds. Both colleges already support cross-disciplinary baccalaureate and masters programs.

Through DAS, CISE seeks to produce the next-generation computer scientist. To justify this statement, we need look no further than recent computing history and, specifically, this column. Entertainment Computing has consistently chronicled the amazing possibilities inherent in inexpensive graphics hardware.



Can merging fine arts and computer science create modern-day successors to Leonardo da Vinci?

Indeed, we may well be on a roller coaster powered by improving the scope of human-computer interaction, from graphics and audio to sensors and actuators. Meanwhile, the fierce and ongoing graphics-processor-unit wars produce ever-faster consumer-targeted graphics rendering rates for games and simulations.

THE BURNING QUESTION

All this leads to a seminal question: How will this technology change computer science as a discipline? Although imagining the future state of computer graphics, vision, and sound can itself be rewarding, a more important question concerns how this trend in fast hardware and immersive environments will transform foundational computer science in areas such as program and data structures, software engineering, machine organization, database methodology, and discrete mathematical structures.

We are experiencing a fundamental branching of computer science into areas that more closely examine the relationship between humans and their computing hardware. While human-computer interaction has always focused on these areas, a plethora of new areas have opened to us: Ubiquitous, tangible, pervasive, and human-centered computing add new dimensions to virtual and augmented reality.

Even though speed ultimately got us where we are today, we now find that computing must be as focused on quality and sensation as it traditionally has been on quantity and speed.

We must pay closer attention to experiential effects in our discipline.

HUMAN-CENTRIC FOCUS

A human-centered focus on experience, presence, interaction, and representation forms the core of the arts. Perhaps, then, the arts can lead computer science in new directions. Imagine a set of programs that build upon a rigorous mathematical and computer science core—but do so with an outer shell of intense arts-based practice and knowledge—to generate future Leonardos who will become our next-generation computer scientists. DAS attempts to build such a set of programs.

The core DAS and CS undergraduate degree programs draw identically from a curriculum saturated with a computer science program's typical fare: core science studies such as chemistry and a two-phase physics sequence combined with a mathematics focus that includes three calculus courses, differential equations, and numerical analysis.

The DAS undergraduate program (www.cise.ufl.edu/student_services/undergrad/das/) differs from the CS version only in that DAS students also must take arts classes, including drawing, sculpture, digital montage, and time-based media. This shell extends somewhat more broadly than traditional fine arts classes in that it encourages students to choose from an interdisciplinary list of DAS-related areas that include theatre, architecture, new media, electro-acoustic music, and hypermedia narrative composition.

The DAS graduate program (www.cise.ufl.edu/student_services/grad/das/) pursues a different goal, assuming that some graduate students enroll with an academic history that may not be true-blue CS. The program requires an undergraduate core-CS equivalency, however. The graduate DAS core consists of modeling for geometry and dynamics and combines disciplinary electives such as vision, AI, visual modeling, aesthetic computing, and virtual environments with interdisciplinary electives like those found in the undergraduate DAS program. Students can choose either a master's thesis or a project and performance focus.

EVOLVING NEW COURSES

Aside from gluing existing courses together across colleges and curricula, we have found that DAS offers the opportunity to create and evolve new course types.

For example, two years ago I worked with Tim Davis and Jane Douglas to create a course in aesthetic computing (www.cise.ufl.edu/~fishwick/aescomputing; www.dagstuhl.de/02291). Funded by the National Science Foundation, this course let students create virtual and physical models of formal structures found in mathematics and computing. We reasoned that combining artistic aesthetics with CISE modeling and representation to explore new interface modalities would offer students the opportunity to uncover innovative modeling and programming methods.

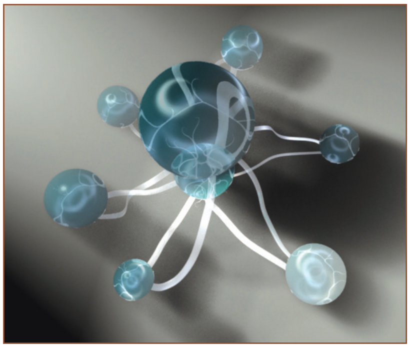


Figure 1. Virtual model of a dataflow network. The banded waveguide physical sound model can simulate a variety of sounds ranging from strings to bells.

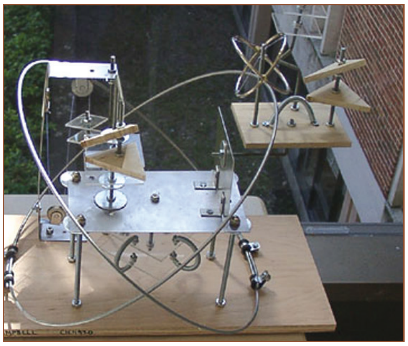


Figure 2. Physical model of the Taylor Series. A metal, plexiglass, and wood representation models the topology normally hidden in the text of mathematics and computing.

Figures 1 and 2 display two sample results from these classes. Figure 1 shows a banded waveguide physical sound model—a dataflow network—I created in collaboration with graduate art student Joella Walz and computational sound faculty colleague Georg Essl. The structure replaces rectangles and arrows with organic spheres and connectors in an engaging and immersive scenario. The scene can be simulated to produce a variety of sounds ranging from strings to bells.

While Figure 1 represents a virtual model, the model in Figure 2 is a physical model that captures the topology inherent within the Taylor series—a series expansion of a function about a point—through a custom physical model notation developed by computer science student John Campbell. His model provided part of an open-house gallery display in which all aesthetic computing students participate at midsemester. Aesthetic computing customizes what is normally hidden in the text or diagrammatic languages of mathematics and computing and places it in an immersive and engaging environment.

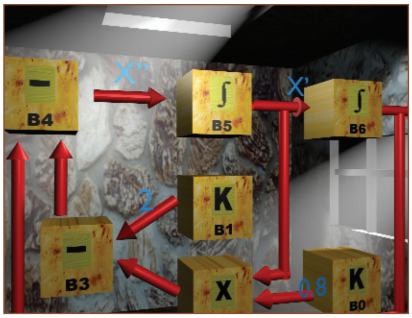


Figure 3. Second-order, dynamic-control-system model. Through its 3D environment and customized notation, the model simulates the dynamics of physical systems.

Figure 3 shows a second-order, differential-equation-based control system created by PhD student Minho Park. With the model, computer simulations can create a 3D environment and customized notation that replicate the dynamics of physical systems in a more immersive and engaging way. With the relatively new human-computer-interaction focus on modeling emotions, altering and personalizing notations for such systems will become more common.

We constructed this model using our rube (after Rube Goldberg) software framework, supported by the Air Force Research Laboratory. Rube focuses on a modeler's ability to construct dynamic models in 3D, using an XML-based foundation that formally specifies the models.

THE FINE ART PERSPECTIVE

The College of Fine Arts has its own substantial program in Digital Arts and Sciences (www.arts.ufl.edu/ART/DAS/index.htm). Its students meet with ours in several DAS core classes, in team projects they create within noncore Fine Arts and CISE classes, and in the two-semester senior-year project. Moreover, Digital Worlds Institute (www.digitalworlds.ufl.edu) provides infrastructural equipment, space, and facilities for DAS students and faculty.

We have recently created several new classes to explicitly support DAS's fine arts perspective. For example, a two-semester Interactive Modeling and Animation sequence teaches students the elements of 2D and 3D modeling and animation. A new discrete math class with explicit artistic products and elements is also under way, and we have created a few package courses to assist students in learning complex software programs such as Blender, Maya, and 3D Studio Max.

We have accumulated six years' experience working with the College of Fine Arts and related areas such as architectural design and new media. Further, DAS has already released its first class of BS recipients into the workplace. DAS students have found themselves well prepared for human-centered computer science jobs in fields ranging from entertainment technology, special effects, and digital media to pervasive computing, augmented and virtual reality, simulation, computer graphics, and visualization.

We have learned many hard lessons about how to collaborate and connect across different cultures and about how to create lasting and meaningful bridges between CISE and the College of Fine Arts.

Moving forward, we have begun extending the DAS curriculum to the doctoral level. Technically speaking, although the existing CISE PhD program can accommodate DAS-related dissertation topics, we must determine if DAS needs fine-tuning to accommodate a doctoral program structure. ■

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