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A Decade of Digital Arts & Sciences at the University of Florida

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Abstract

The advent of cinematic special effects and console gaming since the late 90s suggests an increasing and sustained emphasis on combining elements from the arts and computer science. We present a ten year synopsis of a degree program created in 2000 to build an undergraduate curriculum using this emphasis as a catalyst. The degree program has resulted in steady student enrollment over the past decade as well as featuring a significantly higher female student population in computer science compared with our other three CS degree programs. We present an overview of the program, qualitative and quantitative assessments, lessons learned, and recommendations for continued improvement.

Overview

Digital Arts & Sciences (abbreviated "DAS") represents a set of programs at the University of Florida. DAS degrees were originally implemented in both the College of Fine Arts as well as the College of Engineering starting around 2000--ten years ago as of this writing. The original mission of the DAS degrees was to explore the combined influences of arts with computer science. This article briefly describes what has transpired within the DAS degree housed within the Computer and Information Sciences and Engineering (CISE) Department, while suggesting what has worked well, and what remains to be tested or retried.

The origins of the DAS degree programs can be found in an initiative of the University of Florida President in the late 1990s, where the goal was to nurture the interdisciplinary activities that seemed to emanate from the computer gaming and cinematic special effects productions, which at that time were still in a nascent stage [1]. The President of the university had met with a past graduate of the University of Florida, and through this chance encounter and discussions spanning two main colleges (Fine Arts and Engineering), the DAS degree programs were born. The question for the university, and its respective departments was how to build degree programs that related to these two topics, while simultaneously retaining the elements of the academy in terms of a liberal arts education needed to train the student for life-long learning.

Philosophy

Perhaps the most vital question when building a new degree program is to determine the purpose of that degree, to whom the degree caters, and to clearly specify the philosophy of the program. At first, it may seem clear that the goal is to create new ties across colleges, faculty, staff, and students. While this is indeed paramount, the question for the CISE department was how to build a self-sustaining program that would excite both faculty and students. The philosophy behind this type of degree program depends on whether the goal is to create a new hybrid degree program or whether to extend Computer Science into the areas inhabited by the intellectual aspects underlying computer games and cinematic special effects.

We chose the latter for several reasons: 1) CISE students needed to graduate with a degree that can be widely leveraged outside of cinema and games, 2) students needed a degree program that would be recognized by employers, and 3) degrees are conferred by Colleges, and specifically, the CISE DAS degree is a product of our CISE department whose mission is to prepare students for positions related to Computer Science. A decade later, we feel that these choices were correct. Over the past decade, students have graduated and have assumed a wide range of jobs from software and human factors engineering to special effects and games. However, students have also found positions related to media: design, advertising, and mass communications. The common thread among all of these positions is *human-centered computing*, and thus CISE DAS, while fundamentally a Computer Science degree program at the core, covers academic subjects that stress the relation of the human to media, catalyzed through digital means.

The terms *interdisciplinary* and *multidisciplinary* enter into this discussion since a truly interdisciplinary degree program would represent a new field of inquiry , much like biomedical engineering which combines elements of biology, medicine, and engineering. A multidisciplinary effort brings discipline-specific elements together with those disciplines remaining intact (e.g., fine arts and computer science). While forging a brand new discipline is tempting, it isn't clear that a conceptual, knowledge-based--as opposed to vocational--purely interdisciplinary program is possible at the undergraduate level without placing students at risk for employment in an industry that tends to rely on more traditional, and stove-piped, areas of expertise. Industry will generally seek a designer or a software engineer, not a student with hybrid knowledge. As long as employers continue to stress disciplines in their employment practices, we determined that our first step in our multi-decadal quest to create "new Leonardos" was to evolve our multidiscipline-specific program--envisioning along the way a next generation computer scientist in a world rich with human-media interaction. Thus, while the eventual goal is true interdisciplinary interaction, along with corresponding curricula, we have chosen a multidisciplinary route to get to our destination. During that process, new truly interdiscplinary courses have been created as a direct result of the

DAS program. One of them (Aesthetic Computing) is discussed at the end of this article.

Students create a wide variety of creative products during their stay and play different roles in teams, mirroring the sort of large-scale organizations required to build consumer games and cinematic productions. Figure 1 shows two sample products created in the first two years.

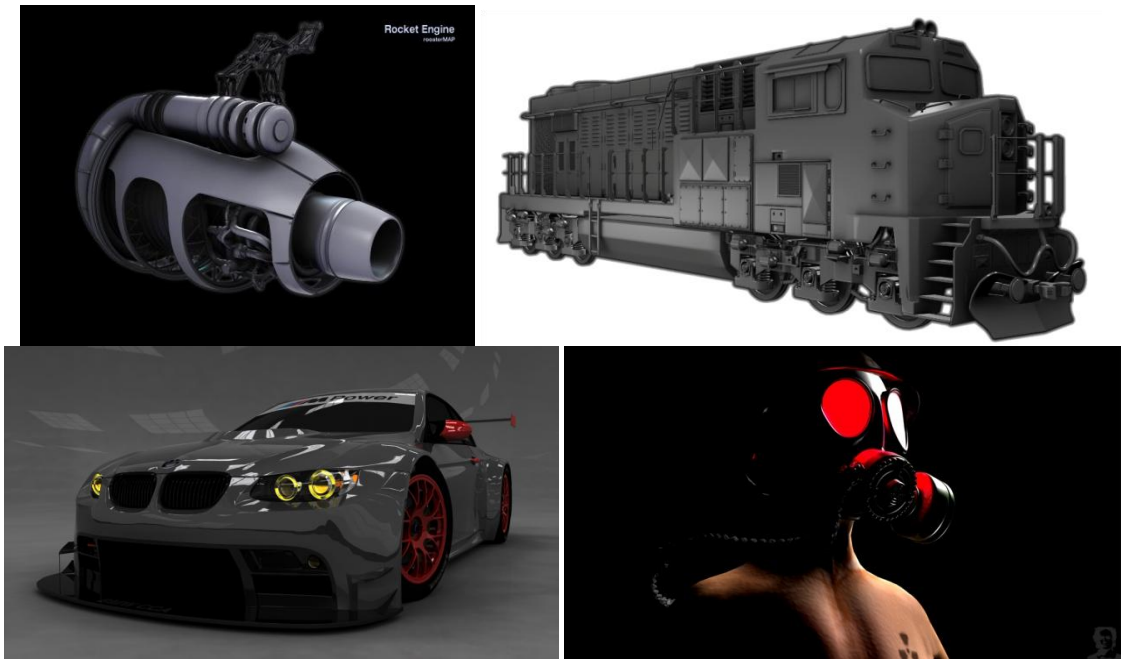

Figure 1: Maya models created by DAS students (top row images are by Timothee Yeramian (Rocket Engine and Locomotive) and the bottom images are by Howard Cortes (BMW GTR and Centaur).

Degree Components

Details on the degree are housed on the web [2], where the reader can review the philosophy of the program, along with the Counseling Sheet (i.e., a one page description of all courses) and the Tracking Sheet (i.e., a one page semester-by-semester schedule for undergraduates). The degree is a 120 hour (minimum) program. The program is described in terms of departmental broad subject area requirements, and the minimal number of hours in each category:

- General Education (15 hours): includes composition, social and behavioral sciences, art history, and international and diversity studies.
- Mathematics (18 hours): three semesters of analytic geometry and calculus, followed by differential equations, and linear algebra.
- Physics (8 hours): two semesters of physics with calculus, and lab.
- Chemistry (4 hours): one semester of chemistry with lab

- Art (6 hours): Perceptual drawing and Form & Space (sculpture or ceramics)
- DAS (18 hours): Courses unique to the DAS degree, including a media-focused introduction to computing, two courses in 3D modeling and animation, two courses in multimedia computing, and a course in aesthetic computing [3].
- Computer Science (22 hours): Advanced programming, discrete structures, data and program structures, software engineering, programming language concepts or operating systems, computer organization, numerical analysis, computer graphics, and computer simulation, and human-computer interaction.
- Interdisciplinary Electives (14 hours): courses taken outside of CISE that have a strong media/arts content.
- Computer Science Electives (6 hours): additional computing courses.
- Senior Project (3 hours): capstone independent study and demonstration course.

Evaluation of Program

What was done right, what needs changing, and how do we assess ourselves over these past ten years? We divide the assessment process into two parts: qualitative and quantitative.

Qualitative Assessment

The assessment process is a tight feedback loop involving faculty, students, staff, and institutional infrastructure. We continually assess the DAS program by ensuring that the objectives of DAS are being met. Student feedback is obtained through interaction with our Student Services Center, faculty, and through student-led organizations centered on digital media and the interrelationships between computing and the arts. The department has a biannual Industrial Advisor Board (IAB) meeting so that students, staff, and faculty ensure that we are meeting the needs of industry. DAS students have been actively recruited for jobs related to human factors, media, and modeling. The following are examples of significant changes made to the program as a result of student feedback and internal assessments made by faculty:

- DAS students used to have to create a portfolio to enter the program in a way similar to Fine Arts students; however, the department determined that CISE students are less likely to have basic drawing and art skills, although their interests may be significant in DAS topics such as computer gaming, visualization, and the technical aspects of visual special effects. We abandoned the portfolio requirement but also instrumented several courses with projects that could be used by students to build portfolios. The senior project in particular, is now viewed as the key time when students can produce a substantial portfolio product. Thus, students have

ample opportunity to build portfolios**.** However, CISE does not require portfolios as a prerequisite into the program since we want to allow for students who have a strong interest in human-centered computing and whose capabilities are indicated by their academic successes in courses (i.e., grade point averages).

- In the early years of the program, DAS students did not have access to a "practicum" course where they learned significant computer animation/design program skills offered by large and complex systems such as Maya, 3D Studio Max, or Blender. We have used all three, with a six credit (2 course) sequence to allow students to obtain vocational knowledge (required by some employers) while maintaining our mission to provide a conceptually-focused and university-oriented education. There is a knowledge-based/vocational tradeoff of which we are well aware--and while we focus on a curriculum that stresses foundational knowledge, there is room for a small number of courses to teach the mechanics of the more complex modeling and animation software skills. In these courses, we emphasize the conceptual skills common to the software. This approach is similar to a traditional CS class where a programming language such as C++ or Java is taught: the goal is to teach the student about the "language/package" while not losing sight of the need to frame that package within a larger more conceptual knowledge-base.

- Four years ago, a significant pool of students wanted the opportunity to further enhance their advanced Computer Science skills as part of their elective credits, and so, we modified the program to allow for students to seek the usual media-focused interdisciplinary courses outside of the department or to choose advanced courses in Computer Science. This flexibility has resulted in increased student choice.

Quantitative Assessment

Figure 2 shows enrollment of four of the CISE Department's undergraduate degree programs, by gender, from years 2003 through 2009. The degree programs are (1) CIS, offered through the College of Business, (2) CEN, offered through the College of Engineering, (3) CSC, offered through the College of Liberal Arts and Sciences, and (4) DAS, offered through the College of Engineering. Under each degree program, the following columns are defined: "M" for Male, "F" for female, "TOTAL" for the total number of students enrolled, and "%F" for percentage of female students as a quotient of number of females divided by the number of males. For example, for a program with equal number of males and females, the quotient would be 100%. The quotient defined in this way serves an indicator of the degree of gender diversity.

		CIS					CEN					CSC					DAS			
		M	F	TOTAL	%F		M	F	TOTAL	%F		M	F	TOTAL	%F		M	F	TOTAL	%F
2003		193	31	224	16		532	75	607	14		183	31	214	17		77	27	104	35
2004		118	19	137	16		429	68	497	16		155	22	177	14		71	27	98	38
2005		77	10	87	13		358	45	403	13		121	7	128	6		79	28	107	35
2006		53	10	63	19		305	32	337	10		76	7	83	9		71	30	101	42
2007		32	2	34	6		256	29	285	11		60	8	68	13		60	29	89	48
2008		5	1	6	20		268	27	295	10		67	10	77	15		51	24	75	47
2009		2	0	2	0		256	29	285	11		39	3	42	8		49	26	75	53
TOTAL		480	73	553	15.2		2404	305	2709	12.7		701	88	789	12.6		458	191	649	41.7

Figure 2: Enrollment by gender for four degree programs (CIS,CEN,CSC,DAS)

Figure 3 is a trend analysis of total number of students in each of the four programs. Note how, even though DAS has a relatively small number of students each year, the enrollment is fairly steady over time compared with the other three degrees.

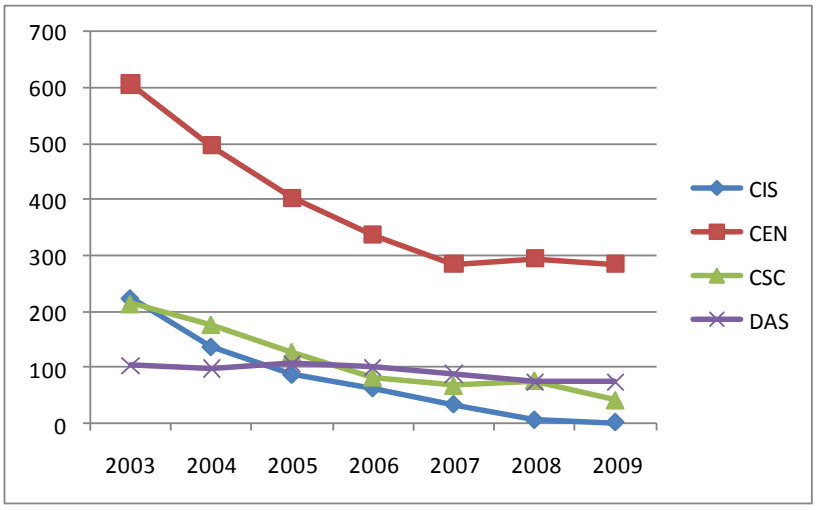

Figure 3: Trends of total enrollment from 2003 to 2009

Figure 4 displays the relative gender ratios captured in Figure 2, with four pie charts created by totaling years 2003 to 2008. Note the significantly higher percentage of female students in the DAS program. For example, in 2009, the gender ratio for DAS was 53% compared with 11% for CEN - almost a 5-fold difference.

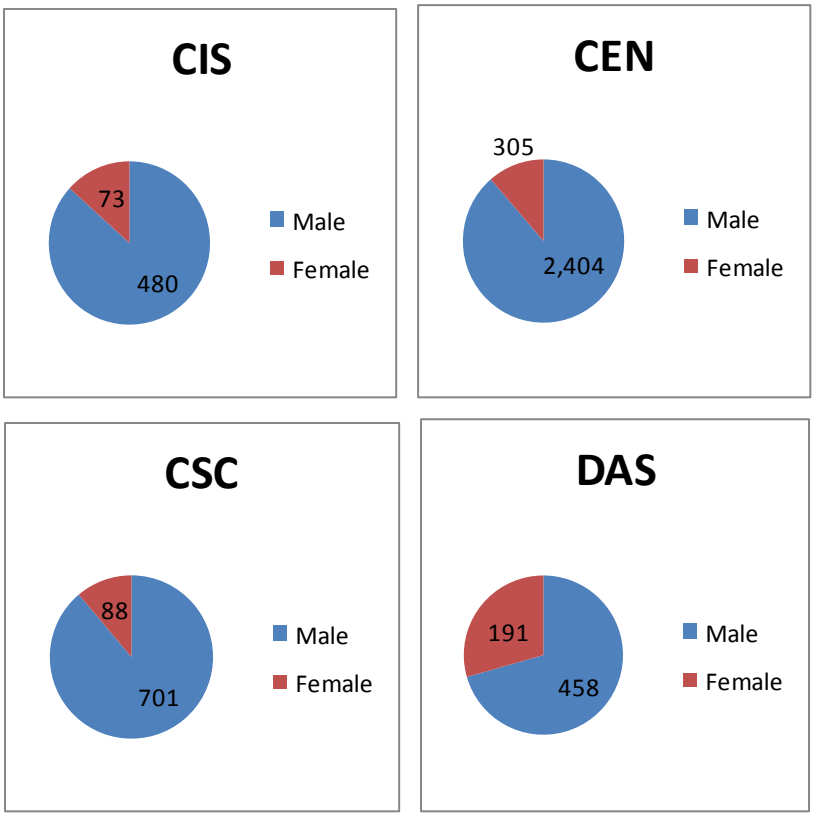

Figure 4: Gender ratios for each of the four CISE degrees using 2003 to 2008

Program's Achievements and Impediments

Achievements:

1. Development of an academically strong and stable program (ref. Figure 3) that involves a high quality undergraduate computer science curriculum and the required mathematics, science, and computer science electives.
2. An integration with the remainder of the university at the student and faculty level with regard to blending the arts and sciences
3. A significantly higher percentage of females in a computer science degree, as compared with other undergraduate CISE programs
4. Production of students who are adequately educated and trained to take on a *broad array* of occupations from digital entertainment, film, visualization, human-computer interaction, vision-based analysis, simulation, and computer aided design and manufacturing.

Impediments:

1. Lack of sufficient faculty to cover required DAS courses with lecturers or tenure-track faculty. This problem is in both the raw number of faculty required to teach the courses as well as a lack of breadth. With regard to

the latter, we lack coverage in advanced areas of animation, gaming, and audio/music related courses. For music, the UF Music department has electroacoustic composition courses so students are encouraged to take these classes. For games, specific classes incorporate games into class projects.

2. Lack of integration at the senior year with other parts of the university to provide our students with an opportunity to team with other non-CISE students. One solution would be an agreement among a small number of departments to offer simultaneous credit for a team-based, cross-college, senior project.

Comparison with Other Programs

Even though our purpose with this article is a ten year status report on the DAS program and not to perform a broad survey, we recognize that there are numerous programs that relate the arts to computing. Undergraduate programs that connect computer science with the arts seem to fall into three broad categories by the nature of their curricula: (1) Computer science-centric, (2) Arts-centric, and (3) Hybrid of 1 and 2. The CISE DAS program falls into category 1, where our effort has been to produce computer scientists first and foremost, with a strong interdisciplinary arts and design knowledge and skills. The Digital Arts & Sciences (DA&S) program at Clarkson University [4] is similar in its curricular approach, while the Digital Arts/New Media program at UC Santa Cruz [5], for example, focuses on category 2. The University of Florida hosts a BFA program in Digital Media [6] and the Digital Worlds Institute is renewing the undergraduate BA program [7]. Many arts schools such as Savannah School of Art and Design [8], Ringling College of Art and Design [9], and Full Sail University [10] offer curricula spanning categories 2 and 3. Georgia Tech's [11] seems to fit category 3. The University of Pennsylvania's Digital Media Design [12] program is similar to DAS in its curricular structure. Nationwide, the number of institutions hosting category 2 and 3 degree programs appears to be significantly higher than for category 1. There are many programs that are missing from this list, since there are hundreds, and many more outside of the U.S. that are not listed. A properly instrumented survey would also be most useful for the bridge spanning arts and computing, however, that task lies outside of the scope of this article, which is a progress report on the DAS program.

Hybrid curricula traditionally work best at the graduate level since the student will have achieved a discipline-specific foundation at the Bachelors level. For example, at UF we have the Master of Science in DAS (CISE) and a Master of Arts in DAS (DW). Carnegie Mellon University has their Entertainment Technology Center (ETC) with a Masters in Entertainment Technology [13]. The MIT Media Lab [14] is degree-granting at the Master and Doctoral levels with a program in Media Arts and Sciences.

Summary

The sort of program desired depends very much on the skill set range at the end of four years. In all cases, there will be tradeoffs. Do we skip a semester of calculus, or take on more interdisciplinary media credits? Do we focus on games, cinematic effects, or web-based media? We've chosen a path that is rooted in computer science fundamentals, but that provides a clear direction for computing into the human interface through foundational courses in media and the arts. As a result, students have graduated with a wide range of career choices centered on computing technologies based on how humans connect to information. The range of jobs includes: (1) software engineer, (2) game designer, (3) HCI, and (4) simulation engineer.

There is little question that the fields of art, design, and computing have considerable cross-flow and offer each other many benefits. The fields of design and art provide conceptual, publicly relevant, and creative products, and computing provides the information-rich, technical foundation on which modern society is based. The academy may move eventually toward a recognized discipline, but this will require the usual formation of institutes, centers, archival journals centered around this concept. The other approach, which we have taken in DAS, is to recognize the importance of the arts to computing and even change our own discipline as a result. One example of this within the CISE Department is the Aesthetic Computing class [3] where the goal is to produce design and artistically-motivated representations of information--the inverse of "computer art". Figure 5 shows an immersive representation of a System Dynamics model representing relationships between metabolism, food intake, weight loss, exercise, and nutrition.

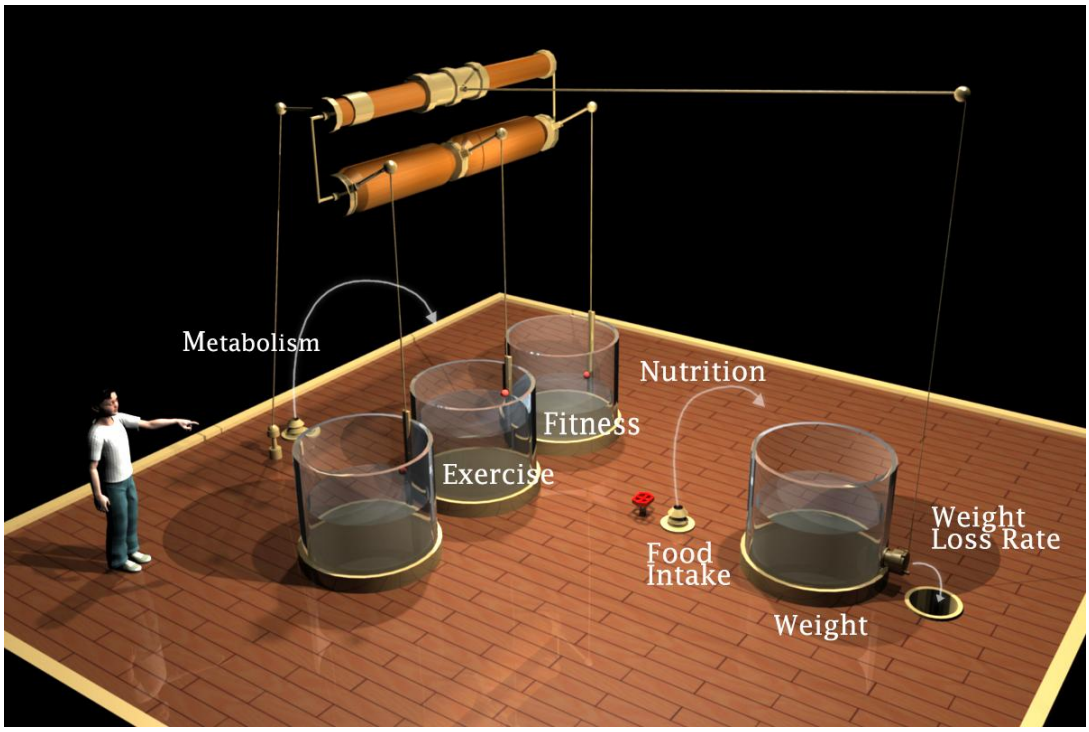

Figure 5: The Metabolism Machine (created by Zachary Ezzell)

This "metabolism machine" is an immersive 3D encoding of a more typical 2D diagram defining a set of first-order differential equations relating the system variables. This machine is isomorphic to a System Dynamics model with four levels (i.e., glass cylinders) and rates (i.e., valves). The aesthetic computing class takes concepts in design and art and uses these concepts to widen the potential audience (e.g., general public) for information artifacts normally expressed in equations or flat diagrams. Thus, bridge connecting the arts and computing becomes bidirectional. The movement of computing devices into the public sphere (e.g., smartphones, mixed reality, ubiquitous and tangible computing) ushers basic questions about human-centered design into the computing discipline.

The course Aesthetic Computing may indicate one possible future for programs that span arts and computing: a growing understanding of how our respective disciplines interconnect at the micro-curricular level. For example, can the arts inform and shape how an example computer science topic (e.g., database systems) is taught? Too often, we may think of the connection between arts and computing as unidirectional with a computing capability supporting an artistic outcome. However, a more significant and longer term challenge, with the possibility of a truly interdisciplinary state of affairs, is to continue to challenge the unidirectional assumption. The way that database systems is taught in the future, for example, may contain socio-cultural sub-topics and concerns typically addressed in the arts. An example of this cross-fertilization would be in covering new methods of personalized, or public, data representation in database systems courses rather than assuming a more limited user (e.g., technical expert)

demographic. In an age of increased human-centered emphasis within computer science, our field will evolve and be nurtured through the arts.

Acknowledgments

There are a number of people who need to be acknowledged for the development of this academic program. Gerhard Ritter was Department Chair at the DAS program inception, and Sartaj Sahni is currently Chair. They have both actively supported DAS in their administrative roles. I would also like to thank Associate CISE Chair, Stephen Thebaut for his advice and continued role within the program. James Ogles from the College of Engineering took considerable time in providing the raw statistics and MS-Access queries needed to create Figures 2-4. Individual faculty who have influenced the program include Georg Essl and current members of the Graphics, Modeling, and Art (GMA) faculty group, Benjamin Lok, Jorg Peters, and Alireza Entezari. Several faculty inside of CISE have actively taught and supported DAS-specific classes: Pete Dobbins, David Small, Mark Schmalz, and Rong Zhang.I have had numerous and long and frequent discussions with several faculty outside of CISE, including faculty in Music (James Paul Sain), Art (Jack Stenner, Maria Rogal, Katerie Gladdys, Brian Slawson), English (Gregory Ulmer, Terry Harpold), Business (Jane Douglas), Theatre and Dance (Ric Rose) and faculty at the Digital Worlds Institute (James Oliverio, Arturo Sinclair, Patrick Pagano). The CISE Student Advising Center has been at the heart of the day-to-day counseling of DAS students, and many thanks go to the past and current CISE staff based on their tireless counseling efforts, including Denise Atteberry, Todd Best, and Paul Rocha for undergraduates and John Bowers and Joan Crisman at the graduate level.

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Glossary

Computer Science, Digital Arts, Aesthetic Computing, Program Assessment, Hybrid Degrees, Interdisciplinary, Multidisciplinary, Human-Centered Computing