University of Colorado at Boulder
The ATLAS Institute

Office of the Director
223 ATLAS Building
320 UCB
Boulder, Colorado 80309-0320
(303) 735-4577 FAX (303) 735-1605

April 14, 2010

Stein Sture
Interim Provost and Executive Vice Chancellor for Academic Affairs
40 UCB, Regent 365
Campus

Subject: Submission of Final Report of the College of Information Task Force

Dear Provost Sture:

On behalf of the College of Information Task Force, we submit for your consideration our Final Report. We appreciate the opportunity to have served the university in this capacity.

Please contact us if we can provide any additional information or materials regarding our conclusions and recommendations.

Best Regards,

John K. Bennett
Archuleta Professor and Director of the ATLAS Institute

Paul Voakes
Dean of the School of Journalism and Mass Communication

Co-Chairs, College of Information Task Force

University of Colorado at Boulder

Report of the College of Information Task Force

April 15, 2010

Table of Contents

EXECUTIVE SUMMARY 2
REPORT OF THE COLLEGE OF INFORMATION TASK FORCE 8
1. INTRODUCTION 8
1.A. The Charge to the Task Force 13
1.B. Process 15
2. THE EXISTING LANDSCAPE AT CU 16
3. HOW OTHER INSTITUTIONS HAVE RESPONDED 25
4. CONCEPTUAL FOUNDATIONS 30
4.A. Education in the College of Information 31
4.B. Research and Creative Work 35
4.C. Professional Practice 37
5. STRUCTURAL ALTERNATIVES 37
6. THE PROPOSED COLLEGE OF INFORMATION 42
6.A. Overview 42
6.B. Elements of the COI Mission and Vision 43
6.C. Proposed Structure of the College of Information 44
6.C.1. The College 44
6.C.2. Faculties 45
6.C.3. Divisions 46
6.C.4. Individual Faculty 46
6.C.5. Staff 47
6.C.6. Facilities 47
7. RECOMMENDATIONS AND DISCUSSION 47
7.A. Implementation Issues 52
7.A.1. Guiding Principles 52
7.A.2. Financial Model 53
7.A.3. Resource Impact on Other Units 53
7.A.4. External Relationships 54
7.A.5. Naming the New College 56
7.A.6. Curriculum 58
7.A.7. Timing 60
7.A.8. Faculty Governance / Promotion and Tenure 62
8. ACKNOWLEDGEMENTS 63
9. MEMBERSHIP OF THE TASK FORCE 64

Executive Summary

The networked information age, brought about by extraordinary advances in information and communication technology (ICT), has profoundly altered human society, interaction and enterprise on a global scale. This transformation has brought with it a new set of societal challenges. For example, while many traditional jobs are becoming less relevant, or even obsolete, new jobs, companies, and entire industries have emerged that did not exist a decade ago. The networked information age has also created rich new opportunities for research and scholarship, first, in the creation of technologies, and second, in the understanding of how these technologies impact human society. That impact is profound, in part because human social systems have never in history had to cope with the exponential rate of change exhibited by virtually every aspect of ICT. Our customs, laws, schools, businesses, and government - our citizens - are ill-equipped to cope with change at this pace.

These changes have also challenged the academy to keep pace. Universities have historically existed to impart special knowledge and skills, but that role is changing. Information is now ubiquitous, and anyone with Internet access can obtain a wealth of information on almost any subject. Thus, the challenge to today's students is not the acquisition of information, rather how to select, evaluate, integrate and synthesize information into usable knowledge. Citizens in the 21st century need to be technologically literate, globally aware, and prepared to employ new technologies as they emerge. What has come to be called "computational thinking" is increasingly considered one of the necessary components of a modern education. Computational thinking refers to the ability to go beyond what is physically realizable to what is computationally realizable, to employ forms of creative expression that represent a new way of thinking about what is possible, and using the computer as a tool to realize fully that vision.

A major challenge we face is how to incorporate these new ways of thinking into our teaching and scholarship. Interdisciplinary work involving ICT has led to significant advances in new directions, and in some cases has resulted in the creation of entire new disciplines. The proposed

College will create an environment that facilitates and promotes this kind of far-reaching intellectual diversity. Faculty members and students of the College will be able to readily interact across traditional disciplinary boundaries as they study and work with information from its creation to its dissemination. CU has a combination of depth and breadth upon which to build – strong research and educational programs in many areas related to computing, information and media; several new initiatives in digital humanities and digital media; and relevant pockets of exceptional expertise across the campus, in engineering, journalism, business, law, music, natural science, mathematics, arts, humanities, and the social sciences. Together, these units encompass research and educational endeavors that explore the creation, manipulation, storage, presentation, distribution and delivery of information, as well as the technologies and theoretical foundations that underlie these processes. We believe that it is crucial for CU to act quickly to capitalize on these strengths, so that we can attract and retain the best students and faculty, and provide the best education for students whose interests in ICT, and the relationship of ICT to other disciplines, are increasing rapidly.

In response to this need, the Task Force focused on creating a vision for a new academic structure that would encourage, facilitate and sustain current and future collaborations in this space, one that would promote innovation and entrepreneurship; encourage risk-taking and leadership; that would actively facilitate interdisciplinary collaborations among faculty and students from many disciplines; and whose students would be capable of computational and integrative thinking, collaboration, lifelong learning, and full participation as a globally aware citizens. As part of this process, the Task Force gathered information about cognate activities and programs in thirty-three external and fifteen internal academic units and programs.

Summary of Recommendations:

Our principal recommendation is to create a new college, named here the College of Information (COI), although the actual name of the unit may be different. The COI will serve as a focal point for campus academic activities in computing, and information and media, and will be the home for both undergraduate and graduate degree and non-degree programs. It will have a faculty, and be led by an academic dean. We propose that the COI have an internal structure that is highly

responsive to the needs of its faculty and students, and that exhibits the necessary agility and flexibility to keep pace with the rate of technological and related societal change.

Structurally and pedagogically, the proposed COI represents a departure from decades of institutional history. To be successful, it will require highly motivated and engaged faculty, staff, students and other partners. CU has a once-in-a-generation opportunity to create an exceptional and unique academic program, one that will serve a critical emerging need of faculty and students, and that will bring new energy, new resources, and new visibility to the university. We believe it imperative that CU seize this opportunity.

Specifically, we recommend:

1. *A College of Information (COI) should be created, although the actual name of the new college may be different as a result of further consideration.* Externally, the COI will exhibit all of the characteristics of other colleges and schools on campus. It will serve as the home for both undergraduate and graduate student degree and non-degree programs; for interdisciplinary research, creative work and outreach programs conducted by the faculty and students of the College; and as the tenure home for faculty rostered in the College. Like other colleges, the COI will have academic and budget autonomy, and will control university resources and faculty positions. The COI will be led by an academic dean, a member of the Dean's Council, who will have the usual administrative responsibilities related to appointments, promotions, admission requirements, curriculum, advising, development, and budget matters.

2. *The COI should have an internal structure that is highly responsive to the needs of its faculty and students, and that exhibits the necessary agility and flexibility to keep pace with the rate of technological and related societal change*. Rather than traditional departments and programs, which are often steeped in administrative inertia, we propose that the COI be structured internally into "Faculties", which represent small units of shared programmatic interests within the College; and "Divisions", which provide

additional structure, if needed, for cognate Faculties. Individual faculty members can join more than one Faculty group, and members of Faculties need not be rostered in the COI.

3. *The COI should enable, not force, collaboration.* Faculty, students, external donors and industrial partners should interact with the new College because they want to do so, not because they have been structurally led to do so. In particular, no faculty member should be required to move to or engage with the new College. Participation in the COI should require only the mutual desire of the individual faculty member, the COI, and where appropriate, depending on the type of participation envisioned, the faculty member's home unit. Further, we do not expect that the COI will include all activities in computing, information and media at CU, either at the start or in the future. Rather, the COI should provide a focal point and home for a significant portion of these activities, and for new academic programs in this space, in a manner that is accessible and visible to faculty, students, parents, funding agencies, and other constituents.

4. *The COI should operate in steady-state as a cost center, whose general budget is determined by its enrollment, research funding, technology transfer revenue, and external fundraising.* Initially, however, the COI should be allocated start-up funds sufficient to sustain operations as the new College takes shape. Temporary funding from the campus should decline over a five year period, by which time the COI should be capable of sustained operation without additional supplemental funding. The COI should receive an initial allocation of new faculty lines to enable the College to build and strengthen its core faculty. Since the COI is expected to function fully as a cost center within five years, these positions can be supported with temporary funds.

5. *Because both breadth and depth are critical to the success of the proposed College, the COI should be founded with willing faculty from certain key areas in sufficient numbers to create critical mass.* At the time of writing, likely faculty groups meeting this criterion include the vast majority of the Department of Computer Science, the Advertising and

Media Design faculty of the SJMC, ATLAS, and individual faculty from several other disciplines.

Computer Science plays an essential role in grounding the academic programs of the new College in rigor. Computer Science is also central to understanding the technological foundation of the revolutionary changes in computing, information and media worldwide, and plays a central role in academia, in research funding, and in a host of relevant industries. Computer Science currently offers BS, MS, ME and PhD degree programs. We would expect these degrees to continue to be offered in the COI, and as desired, within the College of Engineering and Applied Science, as discussed below.

Advertising and Media Design, together with the Technology, Arts and Media Program within ATLAS, address key educational needs for professional training in interaction design and general technological literacy. Degree programs in this space are likely to include bachelor's and master's degrees in Media Design, a minor (and later, a perhaps a major) in Technology, Arts and Media, and, as need emerges, information architecture.

The ATLAS PhD program facilitates interdisciplinary education and research in pursuit of a broad array of interdisciplinary topics in technology, media and society. The proposed new ATLAS MS in ICT for Development represents an exemplar for an income-producing Master's program focused upon interdisciplinary professional practice. This degree program will prepare its students for careers in the use of Information and Communication Technology (ICT) to advance people and communities in developing nations, and in underserved and impoverished areas of developed nations.

We recognize that faculty cannot simply leave their current home units without consideration of the resulting impact to that unit. Perhaps, paradoxically, this impact is less if an entire unit moves to the COI. For example, the Department of Computer Science is both an important existing component of the College of Engineering and Applied Science (CEAS) and a vital component of the proposed COI. To address this

shared need, we recommend that CU adopt a model similar to Cornell, in which Computer Science was moved to a new academic unit while remaining actively engaged with, and administratively visible within, the College of Engineering. Since the teaching and other responsibilities of Computer Science remain covered, there is no residual burden to the CEAS. In fact, at Cornell, Computer Science continued to successfully offer a BS in Computer Science within the College of Engineering, in addition to degrees offered in the new unit. Finally, while we believe Computer Science to be a necessary component of the COI, it is not, by itself, sufficient. Faculty engagement and participation from many other units is essential to the success of the new College. It is critical to the success of the new College that no single discipline dominate the academic agenda of the COI.

6. *Should the Campus decide to create a College of Information, we recommend that a Founding Committee be appointed to move forward with planning and implementation of the COI*. We recommend that the Founding Committee include representation from the faculty, students, staff and industry, be empowered to take actions and make decisions that are necessary to move forward with realizing the COI, such as bringing together the initial faculty, drafting initial bylaws and curricular objectives, developing a detailed financial model, and preparing necessary materials for review by the administration and Regents. The Founding Committee should serve until such time as a Dean of the COI is appointed, and should continue to advise the new Dean as needed until the new College establishes a formal advisory council.

Report of the College of Information Task Force

1. Introduction

Advances in information and communication technology (ICT) have resulted in a networked information age that has profoundly altered human society, interaction and enterprise on a global scale. This transformation has brought with it a new set of societal challenges. Global connectivity has created a host of new threats to privacy and security. Advances in ICT have helped support free societies, but also have given government powerful control of its citizens. Journalism, an historic pillar of democracy, faces extraordinary challenges to its economic viability. The ease of transmission of digital content poses new challenges to the interpretation of copyright law. Information ubiquity in the developed world presents itself in stark contrast to the digital exclusion prevalent in the developing world. While new jobs, companies, and entire industries have emerged that did not exist a decade ago, many traditional jobs are becoming less relevant, or even obsolete.

These changes have challenged the academy to keep pace. Universities have historically existed to impart special knowledge and skills, but that role is changing. Information is now ubiquitous, and anyone with Internet access can obtain a wealth of information on almost any subject. Thus, the challenge to today's students is not the acquisition of information, rather how to select, evaluate, integrate and synthesize information into usable knowledge. Citizens in the 21st century need to be technologically literate, globally aware, and prepared to employ new technologies as they emerge. They need to understand networks, computing systems, and richly interactive software applications and tools. The required understanding is deeper than the ability to use a computer for day-to-day office productivity. What has come to be called "computational thinking" is increasingly considered one of the necessary components of a modern education. Computational thinking refers to the ability to create human artifacts of every kind – structures, art, music, medicine, aircraft, entertainment, entire worlds of imagination – using computing as the instrument of creation. Computational thinking frees us to go beyond what is physically realizable to what is computationally realizable. Engineers, artists, writers, pharmacologists, musicians, etc. can imagine and create artifacts that are impossible to realize by human endeavor

alone. These forms of creative expression are not represented simply by the ability to use a set of computer applications, or even the ability to write computer programs. Rather, they represent a new way of thinking about what is possible, and using the computer as a tool to realize fully that vision.

The networked information age has also created rich new opportunities for research and scholarship, first, in the creation of technologies themselves, and second, in the understanding of how these technologies interact with and impact human society. That impact is profound, in part because the pace of technological change is so fast. One of the defining characteristics of the information age is the phenomenon of exponential growth (sometimes referred to popularly as "viral" growth). Virtually every metric used to measure the performance, adoption, and capacity of computing infrastructure (CPU speed, memory size, number of World Wide Web users, number of Facebook users, capacity of Google, etc.) has grown exponentially. Human social systems have never in history had to cope with this rate of change. Our customs, laws, schools, businesses, and government - our citizens - are ill-equipped to cope with change at this pace.

The Internet, the World Wide Web, and more recently social networks such as Facebook, MySpace and Twitter are examples of the pervasive presence and impact of ICT on modern society. We do not fully understand this impact, which touches nearly every area of endeavor, and we understand even less what is yet to come. The US Bureau of Labor Statistics estimates that today's college graduates will have seven to ten different careers during their lifetime, and that as many as six of those jobs do not exist today.

How should we prepare our students for careers that do not yet exist? Universities have struggled with this question for some time, and part of the answer is known: teach students how to be life-long learners. However, in an age that will be dominated by the ubiquitous presence of information and communication technology, we believe that new skills sets, and new mind sets, also will be necessary. In addition to the ability to adopt computational ways of thinking, students will need to learn to think critically, creatively, integratively and transformatively; to embrace innovation and entrepreneurship, to analyze and synthesize vast amounts of

information; to have substantial qualitative and quantitative skills; to have both a global perspective and an eye for detail; to collaborate effectively in interdisciplinary teams; to lead when leadership is called for; in short, to be what Bill Moggridge, the co-founder of IDEO, called "T-shaped" people. A T-shaped person has basic literacy in a relatively broad domain of relevant knowledge, and a real depth of competence in a much narrower domain. The education of such students represents a key objective of the COI, one which will both distinguish the College and help chart its course. We discuss these ideas further in Section 4.A.

Challenge and Opportunity for CU

A major challenge we face is how to incorporate these new ways of thinking into our teaching and scholarship. Interdisciplinary work involving ICT has led to significant advances in new directions, and in some cases has resulted in the creation of entire new disciplines, e.g., bioinformatics, digital art and media, technology policy, digital journalism, environmental journalism, and computational science and engineering. The COI will create an environment that facilitates and promotes this kind of far-reaching intellectual diversity. Faculty members and students of the COI will be able to readily interact across traditional disciplinary boundaries as they study and work with information from its creation to its dissemination. Many of our students are already seeking this kind of integrative approach to their education. Enrollment in the ATLAS Technology Arts and Media minor continues to grow, and demand far exceeds our current ability to deliver. Our students know that digital literacy is part of a liberal education in the 21st century.

CU has a combination of depth and breadth upon which to build – strong programs in areas related to computing, information and media; outstanding research programs in computational science and engineering; several new initiatives in digital humanities and digital media; and relevant pockets of exceptional expertise across the campus, in engineering, journalism, business, law, music, natural science, mathematics, arts, humanities, and social science. Together, these activities encompass research and educational endeavors that explore the creation, manipulation, storage, presentation, distribution and delivery of information, as well as the technologies and theoretical foundations that underlie these processes. We believe that it is

crucial for CU to act quickly to capitalize on these strengths, so that we can attract and retain the best students and faculty and provide the best education for students whose interests in ICT, and the relationship of ICT to other disciplines, are increasing rapidly.

Many of the nation's leading universities have made major programmatic investment in computing and information in order to support these objectives, including the University of Washington, UC Berkeley, Carnegie Mellon University, Cornell, MIT, Georgia Tech, UT Austin, UC Irvine, Michigan, and Wisconsin. To our north, CSU has chosen to create the ISTeC (Information Science & Technology Center) in this space.

These ideas respond directly to the ambitious agenda and vision as articulated in the *Flagship 2030* strategic plan. "*The University of Colorado at Boulder will become a leading model of the 'new flagship university' of the 21st century—by redefining learning and discovery in a global context and setting new standards in education, research, scholarship, and creative work that will benefit Colorado and the world.*" The COI is responsive to all of the Central Themes articulated in that plan:

> **"First**, the university environment will be intellectually inspiring, academically challenging, welcoming, supportive, and conducive to positive personal growth.
> **Second**, CU-Boulder will become a dynamic global force for nurturing ideas and the uses of knowledge.
> **Third**, the university will be a place that exemplifies diversity, intercultural understanding, and community engagement.
> **Fourth**, CU-Boulder will help promote Colorado as a global crossroads of ideas and discovery.
> **Fifth**, the university will provide students with a foundation of knowledge that will help them reach their full potential.
> **Sixth**, CU-Boulder will be an agile organization supported by effective leadership, financial and operational models, and infrastructure."

As described below, the proposed College of Information strongly supports many of the "Flagship Initiatives" of Flagship 2030, including the following:

> "**Customized Learning**. We will launch the "Colorado Undergraduate Academy" as an ongoing incubator for innovative learning methods and customized learning experiences. The academy will provide mentoring, individualized advising, and career counseling, as well as help attract more of the nation's best-qualified students to the university."

"**Experiential Learning**. We will incorporate experiential learning programs more broadly in every student's education. These experiences may include research or creative projects with a professor, study abroad, honors or senior thesis projects, entrepreneurial initiatives, portfolios of creative work, full-time community service projects, or internships."

"**Colorado's Research Diamond**. We will initiate a "Colorado research diamond" as a collaborative enterprise among regional universities, businesses, government, and federal laboratories. The research diamond will draw upon existing strengths to develop new technologies, patents, and intellectual properties—and apply them to real-world needs in Colorado and the world."

"**Transcending Traditional Academic Boundaries**. We will build upon our excellent record in interdisciplinary research and creative work to become a global leader in ventures that span traditional academic fields. We will strengthen the university's advocacy, support, recognition, and financial incentives for faculty and students who engage and excel in interdisciplinary work.

"**Alternative Degree Tracks**. We will expand the options for earning University of Colorado at Boulder degrees, providing greater emphasis on the master's degree as a primary track, greater support for students with advanced placement credits, and concurrent bachelor's/PhD degree programs in appropriate disciplines."

External factors also support the creation of the College of Information at this time. The Boulder area has become a focal point for investment and entrepreneurship in a host of computing and information related endeavors, particularly social networking and social media. A recent article in *Fast Company* highlighted Boulder as a particularly desirable location to start a high-tech company. The local venture community is energized about the possibility of a new college on the Boulder campus focused on computing, information and media. Major established firms including Microsoft and Google have also expressed strong interest.

Impediments to Change

In his 1908 "Microcosmographia Academica," Cornford described the *Principle of the Dangerous Precedent*, in which he cynically concludes that at a university "nothing should ever be done for the first time." We understand that it has been 82 years since CU-Boulder last created a new school or college. Certainly a change as significant as creating a new college

should be undertaken with due deliberation. While recognizing that there are legitimate and important concerns that must be addressed as we move forward, we believe that there we are in a crucial window of opportunity in which to do so.

Some of the key potential concerns that have been expressed include concerns that:

- existing units might be weakened if faculty from those units join the COI;
- a faculty majority in one discipline might dominate COI decision processes;
- the COI would generally drain resources from other academic units, even under a cost center based financial model;
- the original faculty of the COI will be privileged over newcomers;
- the faculty of the COI will form new silos to replace old ones; and
- the faculty would be unable to overcome differences between academic cultures in the new College.

As detailed below, we believe that the proposed COI addresses these concerns constructively.

1.A. The Charge to the Task Force

The idea of exploring the creation of a new school or college in this space grew out of conversations between the co-chairs and then Provost DiStefano in the winter and spring of 2009. These conversations continued in the summer of 2009 with then Chancellor DiStefano and Interim Provost Sture. In September, 2009 the Task Force was created and given its charge by Interim Provost and Executive Vice Chancellor for Academic Affairs Sture. We were given the specific objective of exploring the potential benefits and opportunities associated with creating a "School of Information[1]", to characterize its likely components and constituents, to address the key issues and risks foreseen in creating such a unit, and to "explore thoroughly the unique opportunities it sees for CU to lead." We were asked to be "visionary, bold and imaginative," and, in particular, to explore how the new unit can:

[1] When the Task Force became aware of one of the key differences between schools and colleges at CU (colleges admit freshmen, schools generally do not), it began to refer to the focus of its planning as a college, rather than a school.

- attract the best faculty, leaders, practitioners and students to study and develop the enormous potential that exists at the intersection of ICT and society;
- challenge some of the world's most significant problems, unfettered by the constraints of traditional disciplinary boundaries;
- facilitate ground-breaking research to understand how ICT can transform and advance individuals, communities, economies, schools, businesses and governments;
- transform traditional models of teaching and learning with curriculum that is innovative, agile, entrepreneurial, and that responds rapidly to changing societal and educational needs; and
- empower exceptional faculty and students with the resources needed to build global leadership.

Our charge did not include proposing, planning or advocating the merger of any particular set of academic programs or units according to some vision that we might have of what interactions exist or might be of interest, or to specify the curricular or research objectives for the faculty of the new college. The Task Force believes that this distinction is critical. We are not able, nor have we attempted, to envision all of the particular interdisciplinary collaborations in this space that might be of importance or interest now, or in the future. We might imagine some of the possibilities, but we do not want to limit the intellectual breadth that might emerge from collaborations in the new college. Even if we were able to identify all of the existing possibilities with perfect accuracy, today's vision will almost certainly be out of date just a few years from now.

We therefore focused on creating a vision for a new academic structure that would encourage, facilitate and sustain current and future collaborations in this space, one that would promote innovation and entrepreneurship, encourage risk-taking and leadership, and that would actively facilitate interdisciplinary collaborations among faculty and students from many disciplines. In approaching this task, we were especially mindful of the particular challenges facing junior tenure-track faculty who seek to engage in interdisciplinary work.

1.B. Process

The Task Force began its work by gathering information about cognate activities and programs at CU and elsewhere. Thirty-three external and fifteen internal academic units or programs were examined. We recorded the unit's mission and vision; the campus structures related to information, computing, media and communication; offered graduate and undergraduate degrees and associated degree requirements; major research areas; data related to enrollment, diversity, graduation and placement; operating budget and research funding; and faculty backgrounds and research interests (not all data were available from all units). Task Force members responsible for each institution also noted particularly relevant information, and appended this information to the unit's report. In most cases the relevant dean or director was interviewed. In February 2010, one of the co-chairs (Bennett) attended the meeting of the CRA Deans[2] in Washington DC. The group discussed issues relevant to vision, curriculum, structure and implementation of the new college. The deans of the relevant units at Georgia Tech, UW Seattle, UC Irvine, Indiana, Pittsburgh, Cornell, Northeastern, Maryland, Albany, Nebraska, Rochester, Syracuse, and North Carolina participated in the discussion.

Information about programs and units at CU were gathered by Task Force members close to those disciplines. While the list of units identified is by no means exhaustive, we believe that it represents a fair cross section of CU programs working in this space. These units are discussed in Section 2.

The committee, informed by an extensive body of information regarding both internal and external programs, moved to the envisioning of the intellectual foundations, educational objectives, and supporting structure for an academic unit that would enable CU to respond effectively and competitively to the challenges and opportunities presented by the pace of

[2] The CRA Deans represent the schools and colleges if information and computing that have elected to join the Computing Research Association (CRA). The CRA is an association of more than 200 North American academic units, laboratories and centers in industry, government, and academia engaging in basic computing and allied research.

technological and societal change in computing, information and media. This report contains our conclusions and recommendations regarding that response.

2. The Existing Landscape at CU

The Task Force undertook to identify units on campus that are already engaged in work broadly related to computing, information, and media. Our purpose was not to try to create an exhaustive list of every unit or faculty member on campus involved in these areas. Nor was the survey intended to lead to a recommendation that any unit be included in (or excluded from) the proposed new College. A key finding of the survey is that CU has considerable research excellence in these areas, and innovative courses taught by dedicated faculty, but there are few coordinated educational offerings or programs that would guide students to take advantage of the richness of the CU environment in computing, information and media. Below we summarize the units examined.

Department of Computer Science

The Department of Computer Science is homed in the College of Engineering and Applied Science. Its research and educational programs are focused generally in four areas:

- Core Computer Science – including computer networks, architecture, programming languages and systems, theory and software engineering
- Computational Science – including basic research in numerical computation, high-performance computing, and bioinformatics
- Human Centered Computing – including human-computer interaction, educational technology, digital libraries, computer-mediated communications, and health informatics
- Intelligent Systems – including computational linguistics, computer vision, machine learning and robotics.

The department offers a BS in Computer Science that is designed to prepare students for careers as computer specialists, and for graduate study in computer science. The BS degree program culminates in a capstone course in which students carry out year-long software engineering projects for industry. Students in the program acquire the skills to communicate effectively with

users and fellow computer professionals about computing issues; to adapt techniques drawn from a large standard repertoire to new problems; and to understand, assess, and use both new and existing technologies. A minor in Computer Science, available to any student at CU, is also offered.

At the graduate level, a MSCS degree program allows graduate students to develop area-specific research and professional skills. Highly qualified undergraduates are invited to enter the BS/MS degree program. The department offers a doctorate, and a joint doctoral program with Cognitive Science. The Computer Science department also offers an MECS that is intended to meet the needs of practicing software engineers, who typically work full-time outside the University.

The Computer Science department is also home to, or closely affiliated with, the Center for Lifelong Learning and Design (L3D), the Computational Science Center, and the Center for Computational Language and Education Research (CLEAR). There are three initiatives related to Bioinformatics within the Computer Science department: the Center for Computational Pharmacology, Protein Folding by Global Optimization, and the Wellness Innovation and Interaction Lab. Finally, the Computer Science department teaches many of the courses that are required for the Computer Engineering track within Electrical and Computer Engineering.

The ATLAS Institute

The Alliance for Technology, Learning, and Society (ATLAS) Institute was established in 1997 as a campus-wide entrepreneurial catalyst and incubator for innovative interdisciplinary research, creative, educational and outreach programs that are enabled by ICT. ATLAS programs bring together students, educators, artists, writers, scholars and leaders from the academy, industry, non-profits, and government to create a multidisciplinary environment that contributes to the understanding of the interaction of ICT and human society, and to the realization of the full potential of that interaction. ATLAS is distinguished by its efforts to establish collaborative multidisciplinary partnerships and programs; by its efforts to prepare, attract and recruit a highly-qualified and diverse student population; and by its efforts to help prepare these students for lives

and leadership careers in the networked information age. ATLAS also serves as a campus and community resource in the area of educational technology.

Current ATLAS programs include a Technology, Media and Society Ph.D. and a Technology, Arts and Media (TAM) undergraduate program that is open to students from any discipline on campus. TAM seeks to prepare students for the networked age; to give them the necessary technical, theoretical and historical background to contribute to the development of new aesthetics for computer media; to facilitate the exploration of the intersection of technology and other disciplines; and to prepare them as active and critically aware producers of technology. TAM offers a 21 credit Minor and a nine-credit Certificate. ATLAS has a new interdisciplinary Master of Science in ICT for Development that is in the final stages of the approval process.

At a time when technology-related fields have very low representation of women, ATLAS programs serve as exemplars. Of students enrolled in TAM, 56% are female. The ATLAS PhD in Technology, Media, and Society has 75% female enrollment, and 40% are persons of color. The national averages for technology-related programs are about 22% women, and about 8% underrepresented minorities. By way of comparison, fewer than 24% of all computing-related occupations in the US are held by women.[3] There is considerable evidence that computing programs that take an interdisciplinary approach are far more successful in attracting women and minority students. Certainly, the ATLAS experience supports such a claim.

ATLAS is home to the Center for Media, Arts, and Performance, and hosts outreach partnerships with K-12 schools and Minority Serving Institutions. ATLAS is also home to the headquarters of the National Center for Women and Information Technology, which works nationally to increase the representation of women in all aspects of information technology. Finally, ATLAS is involved with entrepreneurship activities around campus and hosts the CU New Venture Challenge, the Entrepreneurs Unplugged series, and a vibrant speaker series.

[3] NCWIT Fact Sheet, http://ncwit.org/about.factsheet.html

The University Libraries System

The University Libraries system includes the main library, five branch libraries on campus (Business, Earth Sciences & Maps, Engineering, Mathematics & Physics, and Music) and the Glenn Miller Archive. The Libraries System is a major regional resource; it has the largest library collection in the Rocky Mountain Region, with more than 12 million physical items and an extensive online catalog. The CU libraries are a state and national leader in the digitization of resources to enhance access, having created the standard and architecture for a statewide digitization project.

There are 55 faculty members in the Libraries system, 11 of whom are tenured. Their research interests span the full range of topics that pertain to digital scholarship; digital repositories; information organization and knowledge representation; information literacy; information resources, uses, users and services; information systems; intellectual access to information; research library management and evaluation; and social, community and organizational informatics. The CU Libraries system does not confer degrees, nor does it have a core curriculum.

The School of Journalism and Mass Communication (SJMC)

The School of Journalism and Mass Communication (SJMC) has both undergraduate and graduate curriculum. Undergraduate students typically apply for admission to the SJMC at the end of their freshman year. Roughly 600 students receive a BS in Journalism, with one of the following five majors (in order of current enrollment): Advertising (217), News Editorial (186), Broadcast News/Production (184), and Media Studies (50). The SJMC also offers an MS in Journalism (with a Newsgathering track and a Mass Communication Research track), and a PhD in Communication (offered under the auspices of the Department of Communication, discussed below).

The SJMC engages in intellectual partnerships with other academic disciplines and with communities beyond the university. The SJMC was a founding sponsor (with the College of Engineering and Applied Science) of Boulder Digital Works, a 60-week certificate program

offered through Continuing Education that seeks the educational middle-space between production of creative content, application of technology, and marketing and entrepreneurship. The SJMC sponsors a "Test Kitchen" that conducts field research involving innovative software applications with journalism. Finally, the School offers two sections per semester of "The Digital Newsroom," which explores the technological frontiers of U.S. daily journalism. Many SJMC undergraduates chose to pursue the ATLAS TAM minor.

Department of Communication

The Department of Communication is within the College of Arts and Sciences. Communications faculty collaborate with CARTSS, PWR, ATLAS, CIRES, the Center for Science Policy, PACS, the Center for Humanities and the Arts, the Energy Initiative, the Center for Language and Social Policy, and the Center for the History and Philosophy of Science.

The nineteen tenured and tenure-track faculty in Communications pursue humanistic and social scientific scholarship. They investigate questions of how people use symbols to inform and influence each other in a variety of contexts. Graduate students in the program study Organizational Communication, Group Interaction, and Rhetoric. At the undergraduate level, there are approximately 1,000 Communications or pre-Communications majors. These students learn how message and interaction processes shape our experience of the social world. They learn to create, analyze, and critique the use of messages.

Faculty in the department research various ways in which technology impacts communication processes. Faculty and student research projects are generally shaped by social and cultural theory approaches towards technology that emphasize its social contingency and productivity. The department's Technology Across the Curriculum initiative was among the first on campus to programmatically use technology to support innovations in teaching and learning. The Department of Communication is well known for problem-centered, interdisciplinary, integrative work.

Institute of Cognitive Science

The Institute of Cognitive Science (ICS) conducts and facilitates interdisciplinary research programs on cognition, including topics in human-computer interaction, neuroscience, education, decision making, architecture and design, and speech/language processing. The Institute is known for theory development and the application of those theories not only to other disciplines, but also to real world problems.

ICS has eight tenured faculty, rostered in the Graduate School with tenure homes in various academic departments. ICS has seven cognate departments: Psychology, Linguistics, Education, Philosophy, Computer Science, Speech/Language/Hearing Science, and Architecture Planning & Design. It also has an additional 45 Faculty Fellows rostered in the cognate departments.

ICS offers a joint PhD in Cognitive Science through one of the following departments: Computer Science, Psychology, Philosophy, Speech Hearing and Language Sciences, Linguistics, and Education. It also offers a three-discipline joint PhD in Cognitive Science, Neuroscience and one of the above disciplines. ICS offers a Graduate Interdisciplinary Certificate in Cognitive Science, an Undergraduate Interdisciplinary Certificate in Cognitive Science, and a Graduate Certificate in Human Language Technology. Research within ICS can be roughly divided into (1) basic research into brain and cognitive processes and (2) applied research in the areas of educational technology, language processing, training, and human-computer interaction.

Digital Arts and Humanities

Faculty from many units across campus are engaged in work that falls under the very broad reach of what is often called digital arts and humanities. Faculty engaged in this work can be found in the College of Arts and Sciences, the College of Music, the School of Journalism and Mass Communication, the Digital Humanities Initiative, ATLAS (including the Center for Media, Arts and Performance, the TAM certificate and minor, and degree programs), the Center for the Humanities and the Arts (CHA), and other units. A representative sampling of some of this work is described below. We also note that a Digital Humanities Initiative, chaired by the

former chair of the CHA, and including the Head of Academic Technology Services in ITS and the Dean of Libraries, has begun building collaborations in the area of digital scholarship.

- **Art and Art History -** The Department of Art and Art History has a series of courses on media arts. It is also developing a new interdisciplinary Media Arts curriculum.
- **College of Music -** There are several members of the School of Music faculty pursuing a variety of projects in digital music and performance. Professor Michael Theodore is the Director of the Center for Media, Arts, and Performance (CMAP) in ATLAS. Professor Michelle Ellsworth of Theater and Dance is the Associate Director.
- **English -** The English Department has several faculty members who focus on digital media of various forms. There are already active collaborations between several of these faculty and the ATLAS Institute.
- **Film Studies -** The Film Studies Program is committed to film as a medium of expression and to the solo director/editor/producer model of creation. Digital video is a medium used in much of the department's teaching of production and editing. The department has different kinds of projection equipment in order to help students understand the different spectator experiences produced by the different media. It has extensive production facilities, including digital video editing and digital printing stations. It offers a series of undergraduate digital production courses and incorporates media and film theory in its advanced critical studies courses.

Interdisciplinary Telecommunications Program

The Interdisciplinary Telecommunications Program (ITP) offers a MS degree that approaches telecommunications from engineering, business and policy perspectives. To that end, ITP's curriculum is designed to develop multi-faceted professionals who are able to navigate the rapidly changing telecommunications landscape. ITP provides the opportunity for technical study in fields related to the Internet, data and computer networks, fiber optics and satellites, mobile and wireless communications, network security, and telephone systems. ITP's numerous laboratory courses give students the opportunity to explore what they have learned in the classroom in a simulated network environment. ITP's business offerings include courses on

network economics, business strategies, and industry trends. ITP's policy courses include broad legal and regulatory overviews as well as courses focusing on more specific areas, such as international telecommunications regulation and spectrum policy. Most of the faculty members in ITP have joint appointments with other departments in Engineering, the Law School, the Department of Economics, or the Business School.

In addition to the 2-year MS in Telecommunications, there are certificate programs in Computer and Network Security, and in Wireless Networks and Technologies. Also, ITP offers concurrent degrees programs: BS, Operations and Information Management and MS, Telecommunications; MS, Telecommunications and MBA; MS, Telecommunications and ME in Engineering Management; and MS, Telecommunications and JD. A proposal for an ITP doctoral degree is pending.

Department of Applied Mathematics

The Department of Applied Mathematics (APPM) conducts research and teaching in the application of mathematics to other disciplines. At the undergraduate level, APPM offers a BS and a Minor in Applied Mathematics. The undergraduate curriculum emphasizes the use of computational methods and the implementation of mathematical algorithms on computers. In addition, students completing a degree in applied mathematics acquire in-depth knowledge of an area of application (an engineering discipline, a natural science field, or one of the quantitative areas of business and economics).

At the graduate level, APPM offers an MS, a joint BS/MS, and a PhD in Applied Mathematics. There is also a combined M.S. and M.A. Program with MCD Biology, and a Computational Science and Engineering Track. The graduate curriculum is intentionally flexible to support special interest directions. APPM also coordinates the interdisciplinary computational science and engineering initiative on campus.

Silicon Flatirons Center for Law, Technology, and Entrepreneurship in the School of Law

Silicon Flatirons has a three-part mission: (1) to elevate the debate around technology policy issues; (2) to facilitate networking, the development of "human capital" and the promotion of entrepreneurship in the Colorado technology community; and (3) to inspire student interest in technology law and entrepreneurship. In furtherance of this mission, Silicon Flatirons hosts a series of conferences and sponsors an array of initiatives to spur greater understanding of the information industries, influence policymaking in the field, and support the local technology community. In terms of research, Silicon Flatirons led several important initiatives, including important research into public safety communications and developing a software regulation clearinghouse. Silicon Flatirons also supports two clinics - the Technology Policy Law Clinic and the Entrepreneurial Law Clinic - that together give students a chance to develop their own skills as technology lawyers and also support sound policy making and entrepreneurship.

In addition to the Entrepreneurial Law Clinic, Silicon Flatirons also encourages and supports entrepreneurship through a campus-wide business plan competition, the New Technology Meetup, the Entrepreneurs Unplugged series, and the Crash Course for Entrepreneurs series. Most of these efforts reflect cross-campus partnerships with the ATLAS Institute, the Interdisciplinary Telecommunications Program, and the Deming Center for Entrepreneurship.

Leeds School of Business

The Deming Center for Entrepreneurship (DCE) in the Leeds School of Business focuses on collaboration between students and the business community. It offers a rich curriculum with courses designed specifically for the entrepreneur, and access to specialty programs in "cleantech", bioscience, and natural products/organics. DCE is also an active part of the rich, cross-campus focus on entrepreneurship that includes the Office of Technology Transfer, Biosciences, Engineering, ATLAS, and the Law School. The DCE consistently ranks as one of the top programs in the country. Currently, the DCE offers an undergraduate Certificate of Excellence in Entrepreneurial Studies. There is also an Entrepreneurship Concentration within the MBA curriculum and a Ph.D. in Business Strategy and Entrepreneurship.

The Operations and Information Management (OPIM) group is composed of faculty with interests in information systems, operations management, and operations research. OPIM oversees the undergraduate, masters, and doctoral programs in operations and information systems. The group is also coordinates the joint B.S./M.S. information systems and telecommunications program, offered jointly by the Leeds School of Business and the College of Engineering. OPIM faculty members conduct research in the implementation of technology and its impact on global/local organizations, the usability of information systems, organizational modeling in sustainable resource planning, and modeling of supply chain systems.

In summary, we see that there are a host of cross-disciplinary efforts on the CU-Boulder campus. These efforts encompass many non-traditional areas of learning, research, and creative work, including: Digital Art and Media; Entrepreneurship; Human/Computer Interaction; ICT and Development; Informational and Library Science; ICT Law and Policy; ICT, Society and Culture; and ICT and the Physical and Natural Sciences. We envision the COI as an enabling and facilitating focal point for current and new interactions of this kind.

3. How Other Institutions Have Responded

Peer universities have responded to the challenges of the networked information age in different ways. More than thirty "schools/colleges of computing/information" (under varying names) have been created. These units integrate a variety of campus academic programs, including computer science, computational science, library science, telecommunications, journalism, communication, law, business and media studies. The mission statements of these schools are similarly varied. For example, UC Berkeley's School of Information (ranked number one in Computer Science) works closely with professional schools in "understanding how people seek, obtain, evaluate, share, categorize and use information." The University of Washington's Information School (ranked 4th among iSchools and 6th in Computer Science) works to "ensure information's continuity, its usability, and its accessibility." The School of Communication, Information and Library Studies at Rutgers University (ranked 6th among iSchools) studies "how people generate, exchange, find and understand information and media." The "iSchool" at

Drexel University (ranked 9th among iSchools) seeks to "connect people with information through technology, and deliver the right information at the right time to the right people in the right form, making sure our world is not inundated by information overload but instead emancipated by information success." Cornell University's Faculty of Computing and Information (ranked sixth in USNWR) describes its mission as "to integrate computing and information science—its ideas, technology, and modes of thought— into every academic field." Similarly, Carnegie Mellon University (ranked fourth in USNWR) stresses computational thinking as a "fundamental skill used by everyone in the world by the middle of the 21st Century."

The Task Force undertook to examine many of these interdisciplinary units. Our review included the top-ranked Schools/Colleges of Information/Computing, as well as several other interdisciplinary centers and programs. Over thirty programs were examined. In most cases, the Task Force supplemented the research with conversations with the relevant Dean or Program Director.

In each case, we examined the program's mission, and its relationship to the other campus structures related to information, computing, media and communication. We noted the degrees offered, degree requirements, graduation statistics, student demographics, and faculty data. The following schools and programs were examined:

- Arizona State University (ASU) School of Arts, Media and Engineering
- ASU Walter Cronkite School of Journalism and Mass Communication
- Carnegie Mellon University H. John Heinz III College
- Carnegie Mellon University School of Computer Science
- Cornell University Faculty of Computing and Information Science
- Drexel University College of Information Science and Technology
- Georgia Tech College of Computing
- Harvard University Berkman Center
- Hasso Plattner Institute of Design at Stanford University
- Indiana University School of Informatics and Computing
- Indiana University School of Journalism
- Indiana University School of Library and Information Science
- MIT Media Lab
- New School Media Studies

- New York University NYU Tisch School of the Arts
- Northwestern University
- Penn State College of Information Sciences and Technology
- Rutgers University School of Communication and Information
- Syracuse University School of Information Studies
- UC Irvine - Bren School of Information and Computer Sciences
- UCLA - Department of Information Studies
- University of California at Berkeley, School of Information
- University of California at Berkeley, School of Law
- University of Edinburgh School of Informatics
- University of Illinois Graduate School of Library and Information Science
- University of Michigan School of Information
- University of Nebraska, Omaha College of Information Science and Technology
- University of Pennsylvania - Annenberg School for Communication
- University of Pittsburgh School of Information Sciences
- University of Southern California, Annenberg School for Communication
- University of Texas College of Communication
- University of Texas School of Information
- University of Washington Information School

The result of this analysis was a snapshot of our peer institutions' responses to the emerging educational and professional landscape in computing, information and media. Successful programs have taken varying approaches to structure, curriculum, and organization. This is not surprising, given their unique history and faculties. However, we found certain common lessons, as well as some innovative ideas.

The units examined generally fall into one of two categories: (1) those rooted in Library Sciences, and (2) those with Computer Science at the core. The first category generally includes schools with strong, degree-granting Library Studies programs that have grown organically to include a broader, interdisciplinary focus. Of the schools in the top fifteen spots of the 2009 U.S. News and World Report ranking of library and information studies programs, all but two are members of the iSchools Project, which advocates the idea that "expertise in all forms of information is required for progress in science, business, education, and culture. This expertise must include understanding of the uses and users of information, the nature of information itself, as well as information technologies and their applications." We also noted an anecdotal, but reasonably strong correlation between strong iSchools and strong computing programs. Among

iSchools specifically, the University of Illinois – Urbana-Champaign shared the number one spot with the University of North Carolina – Chapel Hill. According to John Unsworth, Dean of the Graduate School of Library and Information Science at the University of Illinois, the "natural integration of library science and information science allows for opportunities to enhance and strengthen learning, teaching, and research: at GSLIS, we understand that fluency with current technologies is important to all information professionals, from librarians, archivists, and museum curators to information architects, Web developers, and data managers."

The second category includes Cornell's Faculty of Computing and Information, Georgia Tech's College of Computing, Carnegie Mellon University's School of Computer Science, UC-Irvine's Bren School of Information and Computer Sciences, and Indiana University's School of Informatics and Computing. All of the Schools/Colleges with Computer Science programs that U.S. News & World Report ranked in the top ten have significant and innovative interdisciplinary initiatives in computing, information and media. For example, Cornell University (ranked sixth) created a Faculty of Computing and Information Science (FCIS) that draws faculty members from across the entire campus -- some homed in the FCIS, and some with joint appointments. In response to its recognition "that the speed of change in the world makes it critical to explore new, more flexible and more inherently interdisciplinary structures," Cornell homed Computer Science in the FCIS, but also placed it "virtually" within the College of Engineering. We find this model well-suited to application at CU. The College of Computing at Georgia Tech (ranked ninth) is home to the School of Interactive Computing, which offers a Bachelor of Science in Computational Media (BSCM). The BSCM degree, offered jointly with the School of Literature Communication and Culture within the Ivan Allen College of Liberal Arts, was developed in response to the significant role in communication and expression played by Computer Science. Students in the BSCM program gain "significant hands-on and theoretical knowledge of computing, as well as an understanding of visual design and the history of media. Our graduates are uniquely positioned to plan, create, and critique new digital media forms for entertainment, education and business." The Entertainment Technology Center within the School of Computer Science at Carnegie Mellon University (ranked 4th in Computer Science)

focuses on “leadership in education and research that combines technology and fine arts to create new processes, tools, and vision for storytelling and entertainment.”

The Media Lab at MIT (which shares the number one Computer Science ranking with Stanford) “is a community of inventors - a community where faculty members and students from numerous, seemingly unrelated disciplines work together, ‘atelier style,’ as members of research teams, doing the things that conventional wisdom says can’t or shouldn't be done.” Media Lab professors include designers, nanotechnologists, data-visualization experts, industry researchers, and computer scientists. Its initiatives include the improved treatment of Alzheimer’s, the use of sociable robots to improve health monitoring, and smart prostheses. Stanford created a d.School (Design School) that brings together students and faculty from computer science, engineering, medicine, business, the humanities, and education.

The schools and colleges that appear best able to attract excellent students, and to prepare them for networked information age, are the schools that have been able to approach ICT broadly and comprehensively. As noted in Section 2, the Library system at CU does not confer degrees, nor does it have a core curriculum. Thus, at CU we believe that Library Science is likely not the appropriate foundation for the proposed College.

The structural models that seemed to best match our needs all incorporated Computer Science in some way, while ensuring disciplinary balance with other areas. Given CU’s institutional history, and the trajectory of existing campus units in this space, we believe Computer Science to be a necessary foundation and enabling force for the new College. A strong core of faculty and students in Computer Science will help support the rich array of interdisciplinary explorations involving ICT that will shape the educational and research agendas of the COI. At the same time, it is important that Computer Science not dominate that agenda. Achieving this balance must be a key leadership objective of the new College.

4. Conceptual Foundations

The convergence of information and communication technologies, forming the networked information age, is having a profound effect upon our nation and the world. Some observers already consider the developments of the last two decades to constitute the fourth of the "communication revolutions" that have marked the progress of mankind - following the emergence of the spoken word, the written word, and the printed word. The emergence of the networked information age already is having a fundamental set of impacts on our nation and world:

- It is the major driver behind the wave of globalization, outsourcing and off-shoring that is leading to a large and lasting transformation of the global economy.
- It is changing the nature of governmental and political control of societies by making it increasingly possible for people in all parts of the world to have access to a wide spectrum of communications and information.
- It is having profound impacts on national and global security, and on the privacy of individuals.
- It is redefining the media and entertainment industries in terms of content and delivery, and having a significant impact on literature and the arts.
- It is changing the nature and patterns of human interaction at the family level and beyond.
- It is impacting attention spans and learning modes, fundamentally affecting the design and delivery of education.

From an academic viewpoint, the networked information age is almost unprecedented in the range of disciplines that are involved in studying its impacts, and well as in the needs for multidisciplinary research that it creates. Among the disciplines that play key roles in assessing the impact of the networked information age and in constructing new approaches and knowledge for it are (alphabetically): Anthropology, Art, Business, Communication, Computer Science, Economics, Education, English, Film, the Foreign Languages, Geography, History, Journalism, Law, Music, the Physical Sciences, Political Science, Sociology, Telecommunications, Theater and Dance, and Writing and Rhetoric.

There are clear opportunities for the COI to productively bring together students and faculty from a variety of disciplines to engage in interdisciplinary research, education and other scholarship centered around computing, information and media design. That reason alone would justify the creation of a new academic unit to support such work. However, we have an extraordinary opportunity to innovate, to imagine what is possible beyond traditional models, to strive for excellence, and then to realize that vision. What should a university education entail in the networked information age, and how should that education be structured? How should we prepare our students for the pace of technological change that is certain to characterize their lifetime? How can we prepare them to be engaged, globally-aware, analytic thinkers and creative innovators? How can we facilitate truly significant interdisciplinary research and creative work? How do we attract, support, reward and retain the best faculty, the best students and the most capable staff? How do we imbue our students with a spirit of entrepreneurship and the capacity for leadership? How do we create an environment in which tenure-track faculty can actively pursue interdisciplinary research, if such is their wish, without impairing their chances for advancement?

These are only some of the questions facing us. Few universities have the institutional courage and vision to commit to revolutionary changes to the fundamental ways in which they work; most simply continue to make incremental changes to old models. The Provost charged us to be "bold, visionary and imaginative." We have endeavored to do so, focusing particularly on how best to support the envisioned breadth of education and research. Below we discuss our conclusions in this regard.

4.A. Education in the College of Information

We have already described broadly what we believe should characterize the education of COI students. Elements of that characterization included computational and integrative thinking, the ability to collaborate, a commitment to lifelong learning, an entrepreneurial spirit and strong global awareness. We also believe that it is important that COI graduates be capable of creating

and representing professional work products that are of real benefit to others. To be more specific, we propose that graduates of the College of Information will:

- possess the intellectual tools to understand, critique and conduct interdisciplinary work at the interface of computing, information, media and society;
- be "T-shaped" computational thinkers who have substantial expertise in one area, and useable breadth in at least two other areas;
- demonstrate the professional skill sets necessary and appropriate to their chosen field;
- be capable of high quality work that demonstrates advanced knowledge of a variety of technologies, and the limitations of those technologies;
- bring reasoned argument, informed judgment, and a well-articulated standpoint to issues of significance in computing, information, media and society;
- exhibit a strong sense of social responsibility and civic engagement;
- be able to collaborate effectively with individuals from multiple disciplines, and have experience and expertise in several collaborative work styles;
- communicate effectively at a professional level, orally and in writing, to diverse constituencies;
- possess a set of skills that are immediately marketable in some aspect of computing, information and media;
- compete successfully for rewarding jobs in the public and private sectors; and
- compete for admission into the best graduate schools in the nation, and be well-prepared to excel, once admitted.

When employers are asked what they look for most when making hiring decisions, they describe, in addition to solid academic preparation, the ability to work in collaborative teams. They want creative "idea people," individuals who are capable of synthesizing available information into actionable alternatives; they want graduates whose education went beyond the classroom – people who have gone abroad, interned with a company (or started their own company!); they want graduates whose education involved experiential learning projects, in which students engaged in "hands-on" activities that challenged their creativity, adaptability and entrepreneurial

skills. Such people are capable of learning new skills, adapting to changing circumstances, and will be learners for the rest of their lives.

Tim Brown, the President of Ideo, also speaks of intellectual curiosity and professional empathy as critical skills:

> "Regardless of whether your goal is to innovate around a product, service, or business opportunity, you get good insights by having an observant and empathetic view of the world. You can't just stand in your own shoes; you've got to be able to stand in the shoes of others. Empathy allows you to have original insights about the world. It also enables you to build better teams.
>
> We look for people who are so inquisitive about the world that they're willing to try to do what you do. We call them "T-shaped people." They have a principal skill that describes the vertical leg of the T -- they're mechanical engineers or industrial designers. But they are so empathetic that they can branch out into other skills, such as anthropology, and do them as well. They are able to explore insights from many different perspectives and recognize patterns of behavior that point to a universal human need. That's what you're after at this point -- patterns that yield ideas."

There was general consensus among the Task Force that COI graduates should be educated broadly in the liberal arts, but we also recognize that ideas about what constitutes a liberal arts education is changing in the 21st century. There are signs that such change is needed. Humanities students seeking to strengthen their computer science background are currently advised that Computer Science is not a satisfactory science elective. Engineering and science students routinely take an incoherent assortment of humanities and social science electives with little thought given to their relevance or even interest.

The term "liberal arts" is typically applied to a curriculum that imparts general knowledge and develops a student's rational thought and intellectual capabilities, with an underlying emphasis on critical thinking and humanist values. The general knowledge deemed necessary for a well-rounded person changes historically. A select history of these changes in the American university

in the twentieth century provides also a revealing history of culture and values; Louis Menand chronicles the development of two notable general education programs - Harvard and Columbia - in *The Marketplace of Ideas: Reform and Resistance in the American University* (2010).

Liberal arts are commonly held to comprise studying literature, languages, philosophy, history, mathematics, and science. The origin of the term is ancient; referring to the education appropriate for a free man (Latin: *liberus*, "free"), in contrast to the education appropriate for a slave.

Liberal arts in the medieval Western university were divided into the *trivium* (grammar, rhetoric, logic) and the *quadrivium* (geometry, arithmetic, music, astronomy). In the United States, liberal arts colleges emphasize, not surprisingly, liberal arts, and while a survey of these colleges reveals considerable variations in the details of what comprises a liberal arts curriculum, underlying all of the programs are some assumed humanist values. So it seems appropriate that a 21st century liberal arts education would continue to thread these values through whatever particular subjects are taught. However, in the face of the technological changes that will shape the 21st century, and their incumbent issues, opportunities, challenges, and potential, it also seems important incorporate technology substantially and meaningfully into the curriculum, just as great the books courses did in the Columbia and Harvard programs discussed by Menand. One rationale for this approach is that technology in many respects now facilitates, and in some cases actually embodies, our common culture. A second rationale is that any general education would necessarily include technological literacy as a central element.

Some of us are convinced that interaction design can represent the technological literacy required of a liberal arts education in the 21st century - both for contextual or historical reasons, and because of the humanist values resident in its practice.

Computing is now a pervasive presence in our society. Computing and information technologies are increasingly more intuitive and embodied, which places a significant, possibly crucial, emphasis on interfaces and their design. Pervasive computing represents a paradigm shift, from

the design and creation of virtual worlds, to information technologies being embedded in actual worlds. The design challenge of pervasive computing is interaction design, because more interactions with more people are more possible than ever before. This relationship will only continue to expand. With increasingly ubiquitous mobile computing and pervasive networking, new possibilities - and challenges - will evolve. There will be an increasing impact on how we exchange information, develop community, and connect with the world in which we live to the people who inhabit it. So while the catalyst for change is pervasive computing, an accompanying and compelling argument exists for a 21st century vision for liberal arts shaped by the increasing need for integrative thinking and human-centered design. Such a vision informs and facilitates the creation of experiences that are connected and meaningful.

Resolving such issues is beyond the work of the Task Force, and indeed, beyond the ability of any single college or school to address. The Task Force recommends that the entire campus undertake to evaluate its general education requirements, as well their implementation. The general curricular offerings of the COI should be factored into such discussions.

Finally, the Task Force is very aware that there are cultural and generational issues that must be considered if these ambitious educational objectives are to be realized. Our students arrive profoundly conditioned by modern culture in ways not generally anticipated or well understood by the faculty. Both our curriculum and our pedagogy must be responsive to the ways in which our students best learn. Indeed, we believe that excellence in teaching must be woven into the fabric of the new college from the start, not considered later as an afterthought. We have asked the Presidential Teaching Scholars to make specific recommendations in this regard.

4.B. Research and Creative Work

The networked information age has created rich new opportunities for research and scholarship, first, in the creation of technologies themselves, and second, in the understanding of how these technologies interact with human society.

The need for greater understanding of ICT has never been more urgent. “Information overload” has become part of our vocabulary, representing the overwhelming volume of information that confronts us every day. The ability to select, evaluate and synthesize vast amounts of information into usable knowledge is a skill required not only of students, but of citizens. The same technologies that helped create a surplus of riches with respect to information can also help create information management systems and tools that can help us organize and manipulate information as we move from data, to information, to knowledge.

We see natural synergies between computational sciences, business, law, the social and natural sciences, the arts and humanities. Every discipline, every organization, every industry, every profession, has been profoundly affected by the information revolution; each of these sectors needs help in understanding and applying ICT in order to achieve their own basic mission. This is particularly true in the arenas of public communication. ICT has profoundly altered the way that people access news content; distribute information; advertise products and services; and engage with others.

The networked information age has created not only a new array of software tools; it has created a new communication culture. From global broadcast systems to personal relationships, mobile communication technology is changing the way human beings understand each other, by changing the way we communicate with each other. ICT education must address the cultural as well as the mechanical dimensions of the networked information age.

Computer science likewise needs a closer relationship with other disciplines on campus. Computational thinking is enriched by creative thinking, critical thinking, and analytical thinking. The integration of these intellectual modes will lead to considerations of how information can be gathered and distributed, for example, in the public interest.

Computational thinking has also created new opportunities for addressing large and complex research challenges in the social sciences, the physical sciences, national security, geosciences,

engineering and manufacturing, and the biological sciences and medicine. There are also important and creative opportunities for interactions between ICT and the arts and humanities.

4.C. Professional Practice

Many of the external units examined have added an emphasis on professional preparation and practice to supplement their more traditional academic foci. We believe that a critical component of the educational mission of the COI should be the training of professional practitioners. However lofty and well-intentioned our educational objectives, in the end, our students rightfully expect to be able to find gainful employment. For many disciplines, a professional masters degree represents essential preparation for a career as a practitioner. A relevant example includes the proposed new ATLAS MS in ICT for Development. We believe that critical thinking, and other traditional academic foci, can exist in tandem with professional preparation. The COI should unapologetically seek to prepare its students for careers, and should have both Bachelors and Masters degree programs with this objective.

5. Structural Alternatives

To realize these ambitious programmatic objectives, a supporting academic structure is required that will facilitate highly innovative interdisciplinary research, education, outreach and creative work. Such structure needs to provide an intellectually diverse, richly creative, and highly supportive environment in which faculty and students from many disciplines can excel. It also needs to facilitate active collaboration between people and organizations inside and outside the university, and create an inclusive and diverse environment for such collaborations to take place. Such a structure needs to allow existing programs to flourish, and encourage new programs to take root and thrive. The structure should promote innovation and entrepreneurship, and exhibit the flexibility and agility needed to quickly respond to the rapid pace of technological and social change.

In considering possible academic structures, the Task Force affirmatively rejects a structure planned as merger of any set of existing academic units. Whatever the new structure, it needs to

be enabling, not forcing. Faculty and students should engage with the new unit because they see opportunity, not coercion. While some will find a new academic home within the COI, faculty and students should be able to engage with and benefit from activities within the new College without having to leave their existing academic homes.

The Laws of the Regents of the University of Colorado recognize many kinds of academic unit that might be considered. These include Department, Center, Laboratory, Bureau, Institute, School and College. Each of these alternatives will be discussed below.

Department

Regential laws define a department as "an academic unit organized around a single academic discipline or several related academic disciplines." Departments exist within a School or College. Structuring the new unit as a department would be problematic, for at least two reasons. First, departments lack the envisioned intellectual breadth and academic flexibility. Second, a new department would have to be located within an existing school or college, which would necessarily limit the academic reach of the unit's programs.

Center

Like departments, centers lack necessary breadth and flexibility. Under Regential law, centers have one or more sponsoring departments (or other academic units), and are "characterized by less programmatic autonomy and less independence relative to the annual operating budget of the sponsoring department(s) or other academic unit(s)."

Bureau or Laboratory

The primary function of a bureau or laboratory is research and/or service. Since the new unit is envisioned as supporting both graduate and undergraduate degree programs, structuring the new unit as a bureau or laboratory is inappropriate.

Institute

Structuring the new unit as an institute would offer the necessary programmatic and budgetary autonomy, however, institutes do not in general possess the necessary breadth. At CU, institutes are primarily researched focused. All but one institute (ATLAS) fall under the purview of the Vice Chancellor for Research. Institutes work with graduate students from many departments, but they do not admit these students, or determine their degree requirements. In the typical institute structure, these functions are the domain of departments. While the institutes at CU Boulder represent a highly successful model for interdisciplinary research, institutes do not create or offer degree programs outside of this departmental purview.

The institutes are even less engaged in undergraduate education. Although the institutes have had considerable success involving undergraduates in their research programs, institutes do not recruit or admit undergraduate students, and they do not create or offer undergraduate degree programs. Again, such activities are generally conducted by departments.

The role of institutes is also limited with respect to faculty. Institutes do not serve as the tenure home for any tenured or tenure-track faculty. Departments, schools or colleges serve as the tenure home, define the standards for promotion and tenure, and evaluate faculty performance with respect to those standards. The institutes may have input into these processes, but ultimately cannot make a tenure decision. The nature of the interaction between institutes and the tenure homes of the faculty represents a limiting constraint to interdisciplinary scholarship. However interdisciplinary an institute's vision and mission, it can only hire tenured/tenure track faculty that can succeed academically within a single existing discipline. Thus institutes face special challenges when seeking to hire faculty whose scholarship falls across several disciplinary boundaries.

Consider bioinformatics as an example. At CU, faculty working in this area might be found in Computer Science; Molecular, Cellular, and Developmental Biology; Philosophy (ethics); Law; Chemical and Biological Engineering; Business; and Medicine. A number of successful interdisciplinary research collaborations exist in this area, most notably as part of the new

Biotechnology Initiative. However, any faculty member or student seeking to work in this area must align her/his activities with respect to advancement along dimensions defined by their home department. While this is not necessarily bad, it makes it difficult to build strength at the center of the field, and represents a particular challenge for new tenure-track faculty who must focus their research efforts largely in areas that will contribute to a successful tenure dossier within their home department.

Finally, although institutes possess programmatic and budgetary autonomy, they do not participate directly in campus decision processes critical to their success.

ATLAS

ATLAS is unique among the institutes at CU in that it offers undergraduate and graduate degree programs, supports interdisciplinary research, education, creative work and outreach, and falls under the purview of the Provost's office. It has the structural authority to hire and tenure faculty, although it has not yet done so. ATLAS is the only degree-granting unit on campus not represented on the Deans Council or on the Budget Advisory Committee. Despite these apparent limitations, it is reasonable to ask whether a suitable enhanced ATLAS might be able to serve as the home for the envisioned academic endeavors. The answer is "not easily", for three reasons:

- First, ATLAS has its own unique mission and focus that is congruent, but not identical, to the envisioned unit. For example, ATLAS has substantial programmatic focus on increasing the representation of women and persons of color in all aspects of information and communication technology. ATLAS also has a strong commitment to its Center for Media, Arts and Performance. It would be highly undesirable to dilute these current foci of ATLAS programs by moving the intellectual center of gravity of the institute in another direction.
- Second, the steps necessary for ATLAS to undertake this leadership would transform ATLAS into a school or college in all but name.
- Finally, there is a critical need for a clear and understandable external identity for the new academic unit. Students recruited into the program (and in many cases their parents)

need to be able to understand what they are being recruited for. "I'm going to major in ATLAS" is unlikely to be an acceptable representation for new undergraduate students. Placement of graduates requires a similarly clear articulation. Potential employers (and program graduates) need to have a clear and concise understanding of what the program's graduates are trained to do. This begins with a program name that helps convey that understanding.

A New Institute Similar to ATLAS

It is also possible to imagine the creation of a new institute that is similar to ATLAS with respect to reporting relationship and the ability to home faculty and degree programs. This alternative also fails critical analysis. Like ATLAS, a new similarly structured institute would require effective transformation into a school or college in order to carry out its mission, and would suffer the same identity issues described above. In addition, the presence of two institutes on the Boulder campus whose missions have substantial overlap would be at best inefficient, and potentially problematic as the two institutes attempted to articulate and distinguish their respective missions.

School

The Task Force was originally charged with considering the formation of a school. However, Schools in general to do not admit freshmen directly. The Leeds School is a notable exception that required special Regent approval. The envisioned unit is likely to want to admit freshmen directly, and to shape new curricular opportunities that span four years. In addition, schools generally lack the disciplinary breadth envisioned for the new unit.

College

Under Regential law, a college supports the necessary curricular and budgetary autonomy, intellectual breadth, and academic flexibility. A college also connotes disciplinary breadth and anticipates the direct recruiting and admission of students. It is likely that a new college would work actively to develop its own applicant pool by offering outreach programs to high school,

and even middle school, students. A college naturally represents an entity that participates fully in campus decision processes.

A college provides stability, but it can also impose inertia. While being structured as a college appears to represent the best model for accomplishing the external objectives of the new unit, the common internal structure of a college (departments and programs) is not sufficiently flexible to support the desired agility. Fortunately, there are other models that suggest how to support this agility within the college framework. Such an internal structure is the subject of Section 6.

Some Other Structure

It is certainly possible that an entirely new structure could be conceived and implemented. Such a structure would require appropriate approvals, and would likely suffer from an unclear interface to the campus hierarchy and other campus academic units. Given that an existing structure was suitable, the Task Force did not consider this alternative further.

6. The Proposed College of Information

6.A. Overview

To summarize the preceding section, we propose that with respect to the rest of campus, the new unit be structured as a college. To the campus administration, and to other academic units on campus, the new unit will look and act like a college. Internally, however, the new college will be structured to facilitate the rich interdisciplinarity and agility necessary to support its programmatic objectives. Our principal recommendation in this regard is that the COI faculty self-organize into flexible units called "Faculties," which represent centers of shared research and educational interests among its faculty. Faculties are formed from a critical mass of faculty, who can be members of more than one Faculty group, and need not be rostered in the college. "Divisions" represent groups of related Faculties. Faculties need not be part of a Division, and in fact, individual faculty of the College need not be part of any Faculty. Such faculty members might be seeking to form a Faculty group, or they may have a personal research model that is less collaborative. We discuss these ideas further in the remainder of this section.

6.B. Elements of the COI Mission and Vision

The Task Force was reticent to craft the final mission statement of the COI, believing that this task rightfully belongs to the faculty and leadership of the new College. We did, however, identify what we believe to be some of the essential elements of that mission, as follows:

1. The COI will prepare its graduates to employ computational thinking, creative entrepreneurial strategies and innovative interdisciplinary approaches to solving challenging and socially relevant problems involving ICT.
2. Graduates of the COI will:
    - have a thorough understanding of modern communication processes and technologies, and will possess a deep sense of professional integrity;
    - be engaged and informed citizens of Colorado, the United States and the world;
    - will be capable of using visual, verbal and computational tools to communicate effectively;
    - will have global awareness, understand the digital divide, and be committed to a world characterized by equitable access to reliable information; and
    - will be prepared to both collaborate and lead as they take on complex problems.

In realizing its mission, the COI will seek to employ the following strategies:

1. The COI will seek to attract the best faculty, leaders, practitioners and students.
2. The COI will develop a curriculum that maximizes student's freedom to learn across traditional academic boundaries.
3. The COI will offer an agile, entrepreneurial and responsive curriculum, and will keep this curriculum fresh and up-to-date in response to technical and social changes.
4. The COI will build close ties to the professions and industry.
5. The COI will develop and use new models of teaching and learning. Teaching excellence will represent a core value of the College.

6. The COI will create a collaborative research and educational environment unfettered by traditional disciplinary boundaries. Innovative research excellence will be a core value of the College.
7. The COI will exhibit programmatic boldness in its research, educational and other scholarly endeavors.
8. The COI will operate as an "incubator" that encourages the creation of agile, flexible and innovative research clusters among faculty and students.

The Task Force endeavored to imagine an academic structure that could support a vision and mission of this breadth and agility. That proposed structure is described in the next section.

6.C. Proposed Structure of the College of Information

6.C.1. The College

The primary role of College in the proposed structure is to provide an intellectually diverse, richly creative and highly supportive environment in which faculty and students in the various Faculties and Divisions can thrive and excel. From an external viewpoint, the COI will look like any other campus college or school. Like other colleges, the COI will have academic and budget autonomy, and will control university resources and faculty positions. The COI will be led by an academic dean, a member of the Dean's Council, who will have the usual administrative responsibilities related to appointments, promotions, admission requirements, curriculum, advising, development, and budget matters. The COI, and its faculty and students, will therefore be represented fully in campus decision processes.

The College of Information will serve as the tenure home for faculty rostered in the college, and as the degree home for graduate and undergraduate degrees offered within the College. The COI will provide necessary infrastructure for faculty hiring, promotion and tenure; and degree programs for students. As described below, this arrangement gives the internal units of the COI great flexibility and freedom of action.

6.C.2. Faculties

Faculties represent a unit of shared programmatic interest within the COI. Faculties provide undergraduate educational programs, graduate education and research (as used here, "research" specifically includes creative forms of scholarship found in the arts and humanities) programs, or both. The principal requirement to create a Faculty within the COI is a critical mass of faculty (perhaps on the order of six) who wish to do so. Examples of Faculties might include "Digital Humanities," "Bioinformatics," "Digital Culture," "Human Centered Computing," "Advertising and Media Design," "Natural Language Processing," "Telecommunications," "Digital Art and Music," "Networked Devices and Systems," "Computational Science," and "Software Engineering," to name just some of the possibilities.

This model for faculty interaction focuses on engagement and participation, rather than forced migration. Faculty need not move from their existing tenure/roster home in order to participate fully in the educational and research programs of the COI. Additionally, individual faculty may be members of more than one Faculty group, and need not be rostered in the COI in order to be members of a particular Faculty.

Educational programs offered by Faculties may consist of graduate degrees; undergraduate majors and minors; "tracks" within the major degree programs of other degree-offering academic units (provided, of course, that those units support the offering of such programs), either within the COI, or elsewhere; or certificates.

Administrative support for Faculties is provided by the College. A Faculty need take on only that organizational overhead needed to accomplish its function. For example, Faculties focused solely on undergraduate educational programs likely need a curriculum committee and little else. Faculties with broader focus can create such organizational structure as needed, and these structures can change over time according to developing needs.

One of the significant benefits of the proposed Faculty structure is that it allows a group of faculty members from several existing disciplines from across the campus to come together to

work in (or even create) an interdisciplinary area. The Faculty thus created might wish to hire a new faculty member whose research interests are at the center of that interdisciplinary area, instead of on its periphery. The new faculty member could have her tenure home in the COI, and build a highly successful career working with faculty from many different academic units. This flexibility is in contrast with a traditional departmental structure, where a junior faculty member is usually ill-advised to engage in interdisciplinary work, because such work may adversely impact his tenure picture.

Another important distinction between Faculties and departments is that Faculties need not be permanent. Faculties can cease to exist with the same ease with which they come into being. This is not a concern, because individual faculty can belong to more than one Faculty, tenure homes (for faculty rostered in the College) are in the college, and degrees are granted at the College level. In its efforts to design the COI to continue to be vibrant and relevant, the Task Force recommends that Faculties should, absent affirmative renewal by the members of the Faculty, terminate automatically after some period of time (on the order of 5 years).

6.C.3. Divisions

Divisions may be formed when cognate Faculties perceive benefit in creating a larger administrative grouping (for example, to offer a set of related coherent tracks within a common undergraduate major). Divisions may offer a variety of undergraduate educational programs, graduate education and research programs, or both. Divisions will likely have more substantial administrative structure than Faculties, allowing them to provide first level of review for faculty hiring, promotion and tenure. Divisions are also likely to have faculty governance (Division Head, Bylaws, relevant internal committees, etc.), but only as needed. Administrative support not specifically needed to operate the Division will still be provided largely by the College.

6.C.4. Individual Faculty

Individual faculty may be rostered in the COI without currently being a member of a particular Faculty group. They may be in the process of creating a Faculty, or may simply prefer to conduct their research, teaching or creative work solely with their students.

All members of the College faculty will participate fully in faculty governance in accordance with campus, system and Regential policies

6.C.5. Staff

A capable and supportive staff is essential to the successful operation of any academic unit. This is particularly true of units seeking to innovate. The staff of the COI will be regularly challenged with finding ways to accomplish potentially unfamiliar objectives while adhering to existing guidelines and policies. COI staff will face regularly new and unanticipated challenges, and they will have many cross-cutting responsibilities. The COI will need staff who find such an environment exciting and rewarding.

Staff form the backbone of any university organization. Just as they need to be supportive, the staff also needs to be supported. Administrators, faculty and students need to understand and appreciate the pivotal role of staff, and actively endeavor to support that role. Staff of the COI will need ready access to all of the technological tools that can aid their work, and these tools must be kept up to date.

6.C.6. Facilities

The new College will necessarily begin its existence distributed across several campus buildings. Technology will help ameliorate some the impact of this discontinuity, but a near-term priority of the new College must be finding ways to co-locate its faculty and staff.

7. Recommendations and Discussion

Our principal recommendation is to create a new college, named here the College of Information, although the actual name of the unit may be different. The proposed College should be a focal point for campus academic activities in computing, and information and media, and should have resources to seed and nurture the development of both existing areas and emerging activities. The COI should serve the broad and strong faculty and student interest in computing,

information and media across the university and should incubate new concentrations, degree programs, majors, minors, and research and creative initiatives as appropriate.

We believe that the new College should operate in many ways as a "start-up," and should be guided by entrepreneurial principles that lead to successful ventures: mission focus, leadership integrity, agility in response to changing circumstances, close attention to the needs of customers and excellent relationships with investors and partners. In this case, the customers are represented by students, faculty, and alumni, and the investors are the university, external donors, and the same students, faculty, and alumni.

CU has a once-in-a-generation opportunity to create an exceptional and unique academic program, one that will serve a critical emerging need of faculty and students, and that will bring new energy, new resources, and new visibility to the university. We believe it imperative that CU seize this opportunity.

Specifically, we recommend:

1. *A College of Information (COI) should be created, although the actual name of the new college may be different as a result of further consideration.* Externally, the COI will exhibit all of the characteristics of other colleges and schools on campus. It will serve as the home for both undergraduate and graduate student degree and non-degree programs; for interdisciplinary research, creative work and outreach programs conducted by the faculty and students of the College; and as the tenure home for faculty rostered in the College. Like other colleges, the COI will have academic and budget autonomy, and will control university resources and faculty positions. The COI will be led by an academic dean, a member of the Dean's Council, who will have the usual administrative responsibilities related to appointments, promotions, admission requirements, curriculum, advising, development, and budget matters.

2. *The COI should have an internal structure that is highly responsive to the needs of its faculty and students, and that exhibits the necessary agility and flexibility to keep pace*

with the rate of technological and related societal change. Rather than traditional departments and programs, which are often steeped in administrative inertia, we propose that the COI be structured internally into "Faculties", which represent small units of shared programmatic interests within the College; and "Divisions", which provide additional structure, if needed, for cognate Faculties. Individual faculty members can join more than one Faculty group, and members of Faculties need not be rostered in the COI.

3. *The COI should enable, not force, collaboration.* Faculty, students, external donors and industrial partners should interact with the new College because they want to do so, not because they have been structurally led to do so. In particular, no faculty member should be required to move to or engage with the new College. Participation in the COI should require only the mutual desire of the individual faculty member, the COI, and where appropriate, depending on the type of participation envisioned, the faculty member's home unit. Further, we do not expect that the COI will include all activities in computing, information and media at CU, either at the start or in the future. Rather, the COI should provide a focal point and home for a significant portion of these activities, and for new academic programs in this space, in a manner that is accessible and visible to faculty, students, parents, funding agencies, and other constituents.

4. *The COI should operate in steady-state as a cost center, whose general budget is determined by its enrollment, research funding, technology transfer revenue, and external fundraising.* Initially, however, the COI should be allocated start-up funds sufficient to sustain operations as the new College takes shape. Temporary funding from the campus should decline over a five year period, by which time the COI should be capable of sustained operation without additional supplemental funding. The COI should receive an initial allocation of new faculty lines to enable the College to build and strengthen its core faculty. Since the COI is expected to function fully as a cost center within five years, these positions can be supported with temporary funds.

5. *Because both breadth and depth are critical to the success of the proposed College, the COI should be founded with willing faculty from certain key areas in sufficient numbers to create critical mass.* At the time of writing, likely faculty groups meeting this criterion include the vast majority of the Department of Computer Science, the Advertising and Media Design faculty of the SJMC, ATLAS, and individual faculty from several other disciplines.

   Computer Science plays an essential role in grounding the academic programs of the new College in rigor. Computer Science is also central to understanding the technological foundation of the revolutionary changes in computing, information and media worldwide, and plays a central role in academia, in research funding, and in a host of relevant industries. Computer Science currently offers BS, MS, ME and PhD degree programs. We would expect these degrees to continue to be offered in the COI, and as desired, within the College of Engineering and Applied Science, as discussed below.

   Advertising and Media Design, together with the Technology, Arts and Media Program within ATLAS, address key educational needs for professional training in interaction design and general technological literacy. Degree programs in this space are likely to include bachelor's and master's degrees in Media Design, a minor (and later, a perhaps a major) in Technology, Arts and Media, and, as need emerges, information architecture.

   The ATLAS PhD program facilitates interdisciplinary education and research in pursuit of a broad array of interdisciplinary topics in technology, media and society. The proposed new ATLAS MS in ICT for Development represents an exemplar for an income-producing Master's program focused upon interdisciplinary professional practice. This degree program will prepare its students for careers in the use of Information and Communication Technology (ICT) to advance people and communities in developing nations, and in underserved and impoverished areas of developed nations.

We recognize that faculty cannot simply leave their current home units without consideration of the resulting impact to that unit. Perhaps, paradoxically, this impact is less if an entire unit moves to the COI. For example, the Department of Computer Science is both an important existing component of the College of Engineering and Applied Science (CEAS) and a vital component of the proposed COI. To address this shared need, we recommend that CU adopt a model similar to Cornell, in which Computer Science was moved to a new academic unit while remaining actively engaged with, and administratively visible within, the College of Engineering. Since the teaching and other responsibilities of Computer Science remain covered, there is no residual burden to the CEAS. In fact, at Cornell, Computer Science continued to successfully offer a BS in Computer Science within the College of Engineering, in addition to degrees offered in the new unit. Finally, while we believe Computer Science to be a necessary component of the COI, it is not, by itself, sufficient. Faculty engagement and participation from many other units is essential to the success of the new College. It is critical to the success of the new College that no single discipline dominate the academic agenda of the COI.

6. *Should the Campus decide to create a College of Information, we recommend that a Founding Committee be appointed to move forward with planning and implementation of the COI.* We recommend that the Founding Committee include representation from the faculty, students, staff and industry, be empowered to take actions and make decisions that are necessary to move forward with realizing the COI, such as bringing together the initial faculty, drafting initial bylaws and curricular objectives, developing a detailed financial model, and preparing necessary materials for review by the administration and Regents. The Founding Committee should serve until such time as a Dean of the COI is appointed, and should continue to advise the new Dean as needed until the new College establishes a formal advisory council.

7.A. Implementation Issues

While we believe that the implementation of the COI is properly the task of the Founding Committee and initial COI leadership, we necessarily gave considerable thought to that implementation. Here we summarize that thinking in the hope that it will serve as a guide.

7.A.1. Guiding Principles

Discussed in more detail in the body of the report, here we summarize the key visioning ideas from Task Force discussions. With respect to structure, administration and finance, the new College:

- should operate with a "start-up," entrepreneurial, highly adaptive approach;
- after start-up, should be self-supporting financially;
- should not draw resources from other colleges and schools;
- is not planned as a merger of any set of academic units;
- should be enabling, not forcing
- should create an inclusive and diverse (in every way) environment;
- should actively measure and evaluate; learn from mistakes; and
- make corrective changes based upon feedback from all constituencies.

With respect to faculty, students and curriculum, the new College should:

- facilitate highly innovative interdisciplinary research, education, outreach and creative work, and provide an intellectually diverse, richly creative and highly supportive environment in which faculty and students from many disciplines can excel (especially junior faculty);
- produce "T" – shaped" graduates (depth in a least one area, breadth in several), who are capable of leadership, critical and computational thinking in the 21st century;
- offer a rigorous curriculum, including a core that prepares students for leadership and successful careers in the networked information age;
- in appropriate curricular areas, prepare students for advanced professional practice;
- allow existing programs to flourish, and new programs to take root and thrive;

- actively promote innovation and entrepreneurship, and encourage risk-taking and innovation;
- be flexible, agile and malleable;
- provide structure that facilitates active collaboration between people and organizations inside and outside of the University;
- actively promote excellence in teaching as a foundational value;
- create opportunities for lifelong learning for its graduates, and others; and
- develop a global perspective in its graduates.

7.A.2. Financial Model

To ensure its long-term sustainability in austere fiscal times, the new College should operate as a cost center after an initial start-up period. By cost center, we mean a unit whose general budget is determined by its enrollment, program fees, research funding, technology transfer revenue and external fundraising (gifts and endowments), rather than by a centrally determined allocation. During the start-up period, the COI should be allocated funds sufficient to sustain operations; this start-up funding should be expected to decline to zero over a time period of no more than five years. In addition to start-up funding, the COI will need an initial allocation of new faculty lines to invigorate its intellectual core.

7.A.3. Resource Impact on Other Units

The new College should come into being in a way that does not have significant negative financial impact on other campus schools and colleges. General funds designated for existing units should not be diverted to the COI. The new College should not employ a retention-based (bidding) model to compete for faculty (or students); programmatic choices should guide participation.

There should be clearly articulated principles and policies for faculty engagement from units outside the COI so that the chairs, directors and deans of those units can plan accurately. There are several kinds of engagement envisioned:

1. A faculty member, alone or in concert with a group of colleagues may wish to move their tenure home to the new college. There are existing policies in place for effecting such transfers. These policies require the joint agreement of the current tenure home, the new tenure home, and the faculty member involved. Thus, under existing policy, a home unit would be able to block a colleague's movement of tenure home to the new college. While possible, doing so over the strong preference of the faculty member is unlikely. For this reason, we believe that the initial transfer of faculty to the new college can be effected without needing to modify current policies governing such transfers.
2. A faculty member from an external unit may wish to be involved with the educational and/or research activities of the COI, and therefore seek to join an existing (or perhaps create a new) COI Faculty. In this case, no transfer of tenure home is contemplated or required. However, the Task Force believes strongly that joining a COI Faculty should not be a self-elective process entirely. Instead, a faculty member should be required to express their interest formally through a simple application process in which the faculty member is asked to demonstrate a genuine interest and ability to contribute, and to characterize how their teaching, research, creative work or other scholarly activities intersect with the COI.
3. A faculty member from an external unit may simply wish to teach a course, or to collaborate on a research project, within the COI. As is the case with existing units, no formal process is required to enable this kind of participation. In the case of teaching, the COI may execute a buy out with the faculty member's home unit, depending upon the particular circumstances. In the case of research collaboration, existing procedures for negotiating ICR splits are adequate.

7.A.4. External Relationships

As an academic unit focused on computing, information and media related activities, the new College needs to actively engage with the industries that create the technological foundations of these endeavors, as well as the professionals who practice them on a daily basis. The existing model at CU for engaging with industry divides this engagement into (at least) four components. Research collaboration falls with the province of the faculty, working with the Office of

Contracts and Grants. Corporate philanthropy is managed by the CU Foundation. Potential employment and internships are managed by the Career Services Office within the Division of Student Affairs. Finally, the Office of Technology Transfer manages interactions with industries seeking to employ technologies created at CU.

When the pace of change is fast, and the need for responsive interaction a key programmatic objective, this division of responsibilities is highly problematic. Within industry, interactions with universities are typically centralized in order to ensure that the company's engagement with various universities is well managed in a manner consistent with corporate mission objectives. The new College needs to manage its interactions with industry in a way that mirrors this organization. Without over-specifying, the Task Force recommends that the COI establish an Office of Corporate Relations (OCR). In general, we believe that efforts to secure funding for the COI should be coordinated and integrated with efforts to engage in other forms of collaboration. A strong OCR would understand the students of the COI, their skills, and the value they offer to companies and society as a whole; *and* the nature and needs of the industries with whom the College engages. The OCR would provide a single point of contact for industry to interact with the new College, with respect to internships, employment, research collaboration and philanthropy. The idea is not to duplicate functions provided elsewhere, rather to integrate their interaction with industry in a way that benefits all concerned. The OCR would be responsible for having close relationships with entrepreneurs, venture capitalists, local businesses and national corporations. It would integrate elements of corporate giving and career services to effectively address the needs of companies, students, and the University as a whole.

The OCR model would build on the existing approach taken with respect to entrepreneurship initiatives. There is already a strong entrepreneurial community on campus, with leadership and support from the ATLAS Institute, the Deming Center for Entrepreneurship, the eShip Program in Engineering, and the Silicon Flatirons Center in the Law School. Strong relationships exit between these units on campus and the entrepreneurial and venture capital communities of the greater Boulder/Denver/Colorado/Rocky Mountain region. The Entrepreneurs Unplugged Series is one example of how this arrangement can benefit both CU and the business communities.

Each month, a local venture capitalist and a CU representative interview a successful entrepreneur. The Series' attendance has grown to an average of 125 people at each event. The audience is typically 50% students (from ATLAS, Business, Engineering, ITP, and Law), and 50% community members (including early-stage entrepreneurs, venture capitalists, and retired CEOs). These events, combined with networking receptions, have resulted in student internships and jobs.

We believe this approach should be extended and further refined in the COI. An effective OCR could also help inform curriculum development within the College. With a better understanding of the job skills most needed in industry, the College can keep its curriculum relevant. The COI can also stay abreast of opportunities for evening classes and certificate programs targeted at working professionals – a revenue stream that is currently underdeveloped.

Finally, the COI should work to ensure that its encouragement of entrepreneurship extends to faculty. Currently, a tenure-track faculty member who wants to start a company faces a difficult choice between remaining an academic and becoming an entrepreneur. The COI needs to actively encourage entrepreneurial activity among its faculty, and reward this activity in its consideration of other, more traditional measures of faculty performance. There are excellent models among our peer institutions that suggest how this can be done without adversely impacting other programmatic objectives. Many universities have been the beneficiary of substantial gifts from their entrepreneurial faculty. We should support, not discourage activities that could contribute to that result at CU. Thus, the COI should work to ensure that entrepreneurial faculty members are encouraged to, and able to, remain active members of the campus community.

7.A.5. Naming the New College

We expect that the actual name of the new College will be the subject of considerable discussion. We have chosen the name "College of Information," not because we believe it to be a particularly compelling name, but because it is less likely to spark premature debate. There are many issues that need to be considered in choosing the new College's ultimate name. These

include name recognition for prospective students, donors, collaborators and faculty; a desire to not privilege or diminish the relative importance of any particular discipline; and the need for the name to accurately represent the foci of the COI.

Some of the names in use in this space include “Information Technology”; “Information and Communication Technology”; “Information”; “Informatics”; “Computing”; “Computational <name>”, where <name> is one or more of science, engineering, medicine, pharmacology, biology, mathematics, etc.; “Computer Science”; “Computer Science and Engineering”; “Computer Engineering”; “Digital <name>”, where <name> is one or more of art, humanities, design, culture, journalism, music, etc.; “Media Design”; “Information Systems”; “Telecommunications”; “Interdisciplinary Telecommunications”; “Communications”; “Datology”; and many more. An all-inclusive enumeration of every relevant discipline in the name would be prohibitively cumbersome, and would likely be incomplete before the new College was a year old.

In the US, “Computing and Information” is increasingly used to name schools and colleges that capture much of what is contemplated. In Europe, “Information” or “Informatics” is more common, and often used interchangeably with Computer Science. Despite significant name differences, most of these units have a significant interaction with core Computer Science domains, in areas such as databases and information systems, web and social networks, human computer interaction and bioinformatics, and many others. There are also several trends that are common to many of these units:

- An emphasis on information: information systems, information organization, information management, information analysis, information retrieval, knowledge representation, etc.
- An emphasis on the human in the loop: human-computer interaction, social computing, information policies, information economics, community informatics, etc.
- A strong interest in the use of information in various application domains: bioinformatics, health informatics, social informatics, e-science, digital art, etc.

We suggest leaving the final naming of the new College to its initial faculty and leadership, perhaps after consulting a professional brand strategist.

7.A.6. Curriculum

The COI will offer a diverse set of degree programs, some in partnership with existing Colleges and Schools, designed to provide the experiences necessary to produce the outcomes outlined earlier. While curriculum decisions will necessarily be within the purview of the COI faculty, there was a general consensus on the Task Force that there was a need for a set of fundamental core requirements across these distinct degree programs. This common core will serve as the basis for "crossing the T" for the "T-shaped" computational thinkers produced by the COI. Here we suggest possible elements of that curriculum, based upon successful innovations at peer institutions.

Computational Thinking – A single semester course required across all undergraduate degrees in the COI. This course will be based on case studies of the various ways that computational thinking is transforming a broad range of human endeavors (entertainment, politics, science, design, etc.) The focus will be on the transformative nature of modern computational systems, rather than on the detailed design of such systems. In addition to being part of the COI core, such a course could be part of broader computational thinking requirement in other schools and colleges.

Beyond the first course in Computational Thinking, the emphasis is on the analytic and design methods that our students will need to bring to bear as they move out into the workplace.

Media Design – A projects-based course focused on the computational creation and manipulation of audio and video content, programming for interactivity and multimedia integration, interactive multimedia design and production, animation, streaming media for web devices, and interactive media implementation.

Information Systems – A two-semester sequence on the design and analysis of computational systems. The focus here is on the design of software systems with an emphasis on Web-based and other media-rich systems. This requirement may be satisfied by a variety of sequences based on students' backgrounds. For example, The ATLAS introductory Technology, Arts and Media course, the Meaning of Information Technology, followed one of several other TAM courses, could fulfill this requirement. Successful models of such sequences can also be readily adopted from leading schools.

Cognitive Systems – A two course requirement that focuses on individual human interaction with computer systems. Exemplars of such courses include existing courses in user-interaction design in Computer Science, and introduction to Cognitive Science from ICS. The focus of this requirement should be on the interaction between the constraints/abilities of human cognitive system (memory, perception, attention, language, etc.) and the design of human-computer interfaces.

Social Systems – A two course requirement that focuses on computational systems in broader social contexts. Examples would include the impact of computational resources on the educational system, the role of computational social networks in political systems during periods of political unrest, and the impact of networked communication systems and social media on the practice of journalism.

Statistical Methods – A single course requirement on statistical methods. While a diverse set of existing courses on campus might satisfy this requirement, the particular selection would be based on the students intended specialization. Ideally, the course should provide the skills needed to support the analysis of computational systems and to permit the kind of computational inference methods that are employed both in data mining and the social sciences.

Capstone Experience – All the degree programs in the COI would include a final project-oriented experience in the senior year.

These proposed core requirements are orthogonal to the traditional degree core requirements that will still exist for each of the additional degree programs (e.g., natural science requirements for an engineering BS in Computer Science, or the critical thinking and writing requirements in A&S and other programs).

The Task Force recommends that the faculty of the COI actively strive to keep the curriculum fresh. Ideas for accomplishing this challenging task included significant rotation of teaching assignments so that different faculty are contributing to core curriculum on a regular basis.

The Task Force also recognizes the particular importance of advising to highly interdisciplinary educational programs. The COI faculty and staff will need to take an active role in advising to ensure that students receive necessary support for all of their advising circumstances: (1) what course to take next semester, (2) what courses to take to ensure graduation, and (3) what to study in order to succeed in a chosen career.

7.A.7. Timing

We recommend that a Founding Committee be appointed if and when a decision is made at the campus level to move forward with the formation of a College of Information. This will allow planning and implementation of the College to proceed sufficiently to facilitate review and approval by the President and Regents. The Founding Committee should be empowered to take actions and make decisions that are necessary to move forward with realizing the COI, such as bringing together the initial faculty, drafting initial bylaws and curricular objectives, developing a detailed financial model, and preparing necessary materials for review by the President and Regents. A Dean of the new College, selected after a national search, should be appointed as soon as practical after the COI is approved by the Regents. Once the Dean is in place, the College can move forward with actual implementation, faculty selection, and curriculum development. Part of the planning process will be to determine the mechanisms by which current students can transfer to the new College.

Some of the early campus discussion related to the proposed College elicited comments along the lines of:

> "This is not the right time for any proposal that calls for an infusion of start-up capital from the campus."
>
> "We should take an incremental approach and do things a little bit at a time; we should experiment first with a proof of concept."

Such positions are common and often justified in austere times. However, we argue that in this case, rather than assuming a risk-averse posture in the face of austerity, there is no better time for boldness. The proposed College of Information offers a unique and time-sensitive opportunity for CU to lead in an area that is of great interest and relevance to students, faculty and potential employers; which has captured the excitement of an entire generation, and which has enormous potential for external investment. The window of opportunity that we now enjoy is not permanent; if we do not lead now we will find it difficult to catch up. In addition, it is a fundamental obligation of the academy to meet student need, and the need for interdisciplinary educational offerings in computing, information and media could not be more clear. The success of and demand for the programmatic initiatives of the ATLAS Institute have already demonstrated proof of concept. The rapid growth of innovative programs like Boulder Digital Works has demonstrated significant external interest and demand. Finally, the success of a venture of this nature requires a certain level of commitment on the part of the university in order to receive a comparable commitment from students. Students, and their parents, are unlikely to willing to gamble their academic career on an "experiment".

While we argue for commitment on the part of the university, we also acknowledge the need for exceptionally close program scrutiny during start-up. The new COI should carefully monitor all relevant metrics during program growth, and use these data to help guide programmatic decisions. Examples of such metrics include:

Students

- undergraduate and graduate enrollment
- gender, ethnic and socioeconomic diversity

- percentage resident/non-resident and international
- number of applicants
- overall quality of applicants as measured by GPA and standardized test scores
- overall success and creativity of applicants and students based upon quality of work
- retention and graduation rates
- when available, placement information, including starting salaries
- satisfaction of students and graduates

Faculty

- research awards and expenditures
- publication record
- external visibility
- internal and external service
- strength of applicant pool
- hiring success
- gender and ethnic diversity
- early career productivity
- FCQs and other measures of teaching excellence
- faculty satisfaction and retention

Program

- gifts from individuals, corporation and foundations
- number of internships, fellowships, etc.
- relationship with other units, as perceived by the leadership of those units
- local, national and international visibility
- staff satisfaction and retention

7.A.8. Faculty Governance / Promotion and Tenure

One of the recurring themes in conversations with deans at other universities was that traditional departments can impose unwanted inertia to interdisciplinary endeavors. This view was almost universally held by the approximately twenty deans with whom this issue was discussed. Indeed,

several institutions have eliminated, or are in the process of eliminating, departments within their respective schools and colleges. At the same time, there was clear recognition that departments provided a degree of organizational stability, particularly with respect to faculty promotion and tenure. Faculty are understandably reluctant to put decisions about their performance and future in the hands of colleagues who may not be knowledgeable in their field. Several institutions have addressed this issue inventively. For example, the Bren School at UC Irvine allows faculty to choose whether they wish to be evaluated by the entire college faculty, or only by the faculty of a single department. The interesting twist to this approach is that the faculty member's choice also constrains their opportunity to vote with regard to other faculty, i.e., only faculty who have elected to have their performance considered by the entire faculty can vote in tenure and promotion matters pertaining to faculty outside of their department.

8. Acknowledgements

The Task Force would like to thank our many colleagues, at CU and elsewhere, who have helped guide our thinking. We also want to acknowledge the vision and courage of our campus leadership, who started us down this path.

9. Membership of the Task Force

John Bennett, Co-Chair
ATLAS Faculty Director
Professor, Department of Computer Science
jkb@colorado.edu

Paul Voakes, Co-Chair
Dean and Professor
School of Journalism and Mass Communication
paul.voakes@colorado.edu

Andrew Calabrese
Professor and Associate Dean
School of Journalism and Mass Communication
andrew.calabrese@colorado.edu

Herb Fenster
Senior Partner, McKenna Long & Aldridge
hfenster@mckennalong.com

Oliver Gerland
Assoc. Professor & Director of Graduate Studies
Gerland@Colorado.EDU

David Getches
Dean and Professor, School of Law
lawdean@colorado.edu

Dick Green
Former CEO, Cable Television Labs
r.green@cablelabs.com

Dirk Grunwald
Professor, Department of Computer Science
grunwald@cs.colorado.edu

William Kaempfer
Vice Provost/Associate Vice Chancellor
Professor, Department of Economics
Office of the Provost
william.kaempfer@colorado.edu

James H. Martin
Professor, Department of Computer Science and
Institute of Cognitive Science
martin@colorado.edu

Ramiro Montealegre
Associate Professor, Leeds School of Business
Director, International Management Program
ramiro.montealegre@colorado.edu

Paul Ohm
Associate Professor, School of Law
paul.ohm@colorado.edu

Lucy Sanders
Exec. Director, National Ctr. for Women and IT
lucinda.sanders@colorado.edu

David Slayden
Associate Professor, School of Journalism and Mass Communication
david.slayden@colorado.edu

John Stevenson
Interim Dean of the Graduate School
Professor, Department of English
john.stevenson@colorado.edu

Bryan Taylor
Chair & Professor, Dept. of Communication
bryan.taylor@colorado.edu

Jill Van Matre
Associate Director, ATLAS Institute
jill.vanmatre@colorado.edu

Mario Vidalon
Director. Center for Advanced Engineering & Technology Education (CAETE)
Mario.Vidalon@Colorado.EDU

James Williams
Dean and Professor
University Libraries
james.williams@colorado.edu

John Winsor
General Partner, Winsor Communications, LLP
johnbwinsor@gmail.com