Academic Vision for a New Gallo School

We envision a new transdisciplinary Gallo School that supports and promotes the integrated research, teaching, and service missions of social and natural scientists, engineers, and practitioners in broad areas related to (1) the management and science of complex coupled human-technological and human-environmental systems; and (2) the behavior, management, and governance of individuals, firms, institutions, and economies in a world of rapidly evolving technologies, populations, and global environment. For instance, faced with the need to achieve a sustainable society in a time when humans have profound impacts on climate and the environment, a key to a sustainable, vibrant, and caring civilization lies in an integrated understanding and management of individual and collective human behavior, the natural environment, and socio-technological innovation, considering physical, cognitive, economic, and social processes, and accounting for complex interactions and dynamics in private, public, and non-governmental contexts. This critical need for interdisciplinarity to focus on hard problems is why UC Merced is uniquely positioned to achieve distinction and excellence in cross-cutting areas of management, cognitive science, and economics.

Three existing departments have collaboratively articulated this new shared vision and mission: Management of Complex Systems (MCS) in the School and Engineering (SoE) and Cognitive and Information Sciences (CIS) and Economics in the School of Social Sciences, Humanities, and Arts (SSHA). The three groups propose to collectively meet challenges for research, teaching and learning, including gaps in knowledge related to (1) understanding complex human behavior and decision-making in individual, interactive, organizational, institutional, technological, and natural settings; (2) understanding complex interactions between natural processes and human-designed or human-influenced systems; (3) designing complex systems that sustainably and efficiently couple people, technologies, and natural processes; and (4) managing complex real-world systems to put theory into practice and improve human and natural conditions locally and globally. All three groups rely on similar methods, including observation, experimentation, large-scale data analytics, and computational modeling and simulation. The perspective created by aligning these departments represents the seeds of an innovative integration of perspectives that can incorporate others that focus on and integrate theories, methods, and applications related to management, information, cognition, economics, and coupled-human natural systems, as well as other related areas, and may also lead to cross-campus collaborations and cross-school appointments.

MCS. The MCS faculty focus on adaptive management of complex human and complex coupled human-technological and human-environmental systems, including for-profit and not-for-profit organizations and public and private enterprises. MCS is aligned with the graduate group in Management of Innovation, Sustainability, and Technology (MIST). MCS has one minor program, Management Analytics and Decision Making (MAD), and expects to propose an undergraduate major program within a few years. MIST is offering the campus' first professional master's program, Master of Management (MM). It also has two planned academic graduate programs (MS and PhD in Management of Complex Systems) that are pending UC system approval. The MCS department has 10 core faculty members, with one open search. Arrangements of people, organizations, information, technology, and the natural world, operating together for common purposes, constitute the sort of complex adaptive systems that MCS/MIST faculty aim to understand and shape.

CIS. The CIS faculty focus on the interdisciplinary study of human behavior and cognition. In its short history, CIS has established an international reputation as a world leader in studies at the intersection of communication, dynamics, and complex systems, as well as in the computational modeling of cognitive processes. The CIS Unit currently houses 12 faculty members with expertise in artificial intelligence, experimental psychology, communication, neuroscience, and philosophy. There are currently 4 open searches. This group oversees six educational programs: a world-class PhD program in Cognitive and Information Sciences (currently 27 students), both BS and BA programs in Cognitive Science (179 majors in Fall 2017), an undergraduate minor in Cognitive Science (52

students), a (new) BA in Philosophy (starting Fall 2018), and a minor in Philosophy (32 students). Cognitive Science majors have gone on to top graduate programs and excellent jobs at leading technology companies. CIS postdocs and PhD graduates have been offered tenure-track faculty positions and top postdoctoral positions, as well as positions at companies that work at the intersection of human cognition, data science, and technology.

Economics. The Economics faculty focuses on research, teaching and learning in order to understand and inform behavior and management of individuals, organizations and institutions in the economy, considering broad social objectives to advance economic welfare, sustainable environments and improved health. SSM currently encompasses 12 ladder research faculty (11 Economics, 1 Management), 4 Senate lecturers (LSOE), and 4 Unit-18 lecturers (3.3 FTE). The ladder-rank faculty have published in top general and field journals of the Economics profession, already placing the nascent department in the top 10 percent of world economics departments (RePEc). SSM has developed two undergraduate programs. Between the two, SSM delivers the third largest undergraduate program on campus (by numbers of graduates), graduating roughly one-seventh of UCM's undergraduates (a higher proportion than at most major universities) and serving roughly 700 majors. The two undergraduate programs are Economics (BA) and Management & Business Economics (BS); the latter the largest (roughly 600 majors). An economics Ph.D. program has been approved and is on track to be launched within the next two to three years. The unit has one open search at the Associate or Full Professor level.

The proposed new Gallo School is centered on the study of human cognition, decision-making, complex human, complex coupled human-natural systems, sustainability, and management of individuals, organizations and institutions in the economy. By combining scholarship and teaching in science and engineering that addresses deep and complex processes of individual human and natural systems with scholarship and teaching in understanding behavior, design, and performance of integrated political-economic systems and implications for practices of businesses, groups, and governments in markets and society, work in the new School builds upon knowledge of underpinning complex physical, cognitive, and natural systems, the design and use of incentives, and the functioning and failures of markets, all in view of economic outcomes broadly defined to include human satisfaction, diversity, and inequality in health and wealth, health of natural environments, and their relationship to both human progress and ecosystem function.

For example, issues in *technological innovation* in particular require expertise in existing areas of faculty and campus strength, including services, analytics, cognition, environment, and technology. Business and big data analytics address the challenges associated with making decisions based on an ever increasing amount of collected data. Being able to make decisions using large amounts of data, perhaps in real-time, opens opportunities ranging from eradicating diseases to understanding and identifying fraud. This requires deep knowledge and research in four broad strategic areas of research and education: analytics (e.g., spatial analytics, smart infrastructure, econometrics), networks for value creation (e.g., network security, logistics and supply chains), technology management (e.g., services, innovation, and leadership), resource management (e.g., protected lands, renewable energy, sustainable land use).Issues of *economic sustainability* in particular require expertise in areas of existing campus strength, including health economics (e.g., providing cost-effective health care and alleviating health disparities), environmental economics (e.g., effectively managing our global resources and managing pollution), development (e.g., alleviating poverty and providing access to resources that empower individuals), international trade (e.g., coordinating the production and marketing of goods globally), and regional growth (e.g., equipping cities and regions with policies to grow sustainably).

Integrating research on complex physical, cognitive, human and natural processes with economics modeling and research on behavior and outcomes in firms, markets, politics and the economy at large promises unique and innovative research opportunities for both individual disciplines and across disciplines. Some work focuses principally on the "upstream" (fundamentals of physical, cognitive and

natural processes, including properties of brain function, communication, and natural systems) whereas other work focuses principally on the "downstream" (behavior of individuals, groups, firms, and governments in economic and natural worlds). A unique feature of the Gallo School vision is the combination of these in one School that promises intellectual and learning synergies for advancing knowledge and teaching at the intersection of upstream science and downstream research and practice.

There are many promising synergies for advancing new paradigms and approaches to related research and teaching, for example:

1) **Environment and health**. Environmental and health economists study behavioral, regulatory and systemic mechanisms that drive the enhancement and/or degradation of the natural environment, health outcomes, the demand and supply of health care and healthy activities, and links between environmental and human health. Central to many of these mechanisms are complex environmental, ecological, biological, physical and cognitive human systems. Examples include the study of species preservation, ecosystem protection, and climate change. Integrating economic study of environmental phenomena with complex system underpinnings and methodology can be cultivated within the Gallo School.

2) **Cognitive processes and economic behavior of individuals, organizations and society**. Increasingly, economics focuses on psychological and physical mechanisms driving behavior and norms of individuals and groups and how these mechanisms affect economic outcomes in firms, political processes, governmental policy and economic welfare. Foundations for studying these links and phenomena can be found in cognitive and decision science, motivating the interdisciplinary collaboration that the new Gallo School can advance.

3) **Local challenges in the San Joaquin Valley**. Many of the grand challenges and goals seen locally and in our society at large include: reduced poverty, food security, good jobs, efficient use of scarce water, better air quality, clean water, access to clean energy, access to good healthcare, high quality education, regional development and growth, use of technology to improve efficiency and economic well-being, and reduced socio-economic disparities. For example, studying how policies and incentives can increase technological innovation and its diffusion, advance efficient health delivery systems, reduce health disparities, and improve environmental conditions may be done effectively through broad interdisciplinary collaborations in the new Gallo School.

There are several benefits to aligning these three departments in a new School, including:

1. A common theoretical perspective on complexity, complex systems, and human behavior underlies modern approaches to management, cognitive science, economics, and the environment. This follows because even seemingly basic dependencies or interactions among parts or between systems and environments can give rise to complex "emergent" behavior – that is, non-linear responses to even small external perturbations. Examples include the global climate system, the human brain, markets, social and business organizations, and natural ecosystems. There is a growing set of general tools for investigating complex systems, offering innovative new concepts, mathematical modeling formalisms, computational methods, and approaches to data analytics.

2. Deep research problems lie at the intersection of management, cognitive science, economics, and the natural environment. As the relationships between humans and environments grow increasingly complex, and as ever more information about such relationships is generated, there is a need for more awareness, skills, and systems-oriented thinking to manage the coupling of data, information, people, and the environment in a sustainable and ethical manner, using for instance, incentives and appropriate institutional arrangements. Understanding people, the environment, data, analytics, communication, and ethics, among other concerns, falls squarely at the nexus of MCS, CIS, Economics, and related fields.

3. Management, cognitive science, and economics apply results of scholarship to the design of practical and productive systems that leverage the strengths of human cognition and human institutions while guarding against weaknesses of the same, for instance in the context of environmental sustainability and the future of work and automation. Applied work can range from cognitive engineering of user experiences with computers to crafting of organizational structures and policies to adaptively manage natural resources or to implement incentive systems for positive human outcomes. Whereas applications benefit from experimental work and theory, management, cognitive science, economics, and environmental sciences share a deep respect for case studies of real systems to guide fundamental research. This common interest in designing real-world applications leads to a common need for infrastructure to support partnerships with companies, government agencies, and other institutions. Such partnerships both facilitate research and offer valuable opportunities for education and professional training.
4. There are a variety of points of intersection in the educational curricula of management, cognitive science, economics, and environmental sciences. There are common concepts and skills – such as the mathematics of complexity, big data analytics, computational modeling of complex dynamical systems, and applied ethics, among other areas – that could be taught effectively in a coordinated fashion, giving rise to efficiencies in teaching and unique interdisciplinary educational experiences. For instance, management students will benefit from easy access to coursework on the scientific study of human cognition, and as many cognitive science graduates pursue careers involving leadership positions outside of the academy, management skills will likely be seen as useful augmentations to their scientific training. Related teaching priorities include the education of business and intellectual leaders for the future with a preeminent objective to advance under-represented groups of California and the Central Valley in private and public sectors of the economy.
5. The fields have common needs for institutional support at the school level. For example, there are similar needs for staff expertise surrounding the pursuit of extramural research funding. All areas require strong instructional and research computer systems support. The common focus on application domains at the nexus of technology, coordinated human activity, and environmental impact offers a number of benefits, including opportunities for synergies in educational programs, substantially overlapping targets for graduate placement, similar research collaboration arrangements with non-academic institutions, and shared potential sources for school level financial development. Beyond research alignment, the large and successful undergraduate program in Economics (particularly the MBE program) affords critical mass in base funding resources for School infrastructure and offers prospects school-level financial development.

Given a shared vision and the many benefits of establishing close ties between the three academic groups joining in this initiative, we believe there is now the opportunity to establish a new Gallo School at UC Merced to advance both the campus' aspirations for preeminence in research and its interdisciplinary mission and identity, particularly in the intersecting domains of management, economics, cognitive science, economic and environmental sustainability, and human health. The new Gallo School envisioned here does so by sculpting an institution that embraces the complexities of real world interactions among people, technologies, and the natural environment.