The Physics of Virtual Networks, Human Culture, and Cab Sharing

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***Abstract*—This paper introduces a multi-disciplinary approach to assess the interplay between technological advancements, and society, by introducing a model for holistic systemic resilience. A new paradigm is introduced to understand human social interactions, which builds upon an interdisciplinary work from the fields of Physics, Biology, Sociology, Planning, Anthropology, Engineering, Pedagogy, and Communication. We promote a paradigm of Social Complex Adaptive Systems (SCAS) and this builds upon established ideas of Complex Adaptive Systems (CAS), from biolocial sciences, by emphasizing components of social learning and communications, and combines those concepts with theories from physics, to incorporate notions of energy transfer and trajectory. A seminal point of our argument is the multi-modal and iterative processing of data and stimuli assessments undergone by social groups (referred to as SCAS). Additionally, emphasis is placed on the need to recognize both biological and cultural constraints that limit end-user ability to cognitively analysis the overwhelming amount of data modern global citizens are expected to manage on a regular basis. We conclude with a call to address methods that examine the impacts of technological advancements, globalization, and increased data demands on human and social constraints.**

***Index Terms*—Globalization, Social Complex Adaptive Systems, Systemic Constraints, Social field theory, Technology and Social interactions, physics**

I. Introduction

Trends in globalization and technological advances have facilitated the creation and maintenance of social networks and knowledge by way of virtual experiences and communication modalities. But, as engineers and businesses have raced to capitalize on these changes through the exploration and expansion of material and structural constraints, there has been an almost concomitant willfulness to ignore human and social constraints. Yet, without acknowledging these constraints, humanity runs the risk of squandering millions of dollars and man hours on unusable technologies, in a best-case scenario; or, in a worst-case scenario, to setting in motion its own demise. Through research in Anthropology, Linguistics, Sociology, Psychology, and Neuro-Linguistics much has been learned regarding human and social constraints for communication, learning, organization and adaptation. The model presented, in this paper, to understand the human and social dynamics constraining end-user capacity is based on a Social, Complex, Adaptive-Systems (SCAS) approach. This model emerged through interdisciplinary work and processes begun by Dr. Nousala, and her team (2018) in 2014. Four key attributes to note are that societies are social, complex, adaptive, systems. This means that (1) learning and (2) adaptation take place in reaction to both internal and external constraints to system dynamics, (3) each individual system has a functional role, embedded within a larger system, which may, or may not conform to higher order functionality;and finally, (4) all adaptive systems have constraints engage in iterative processes and are subject to apparent randomness, even human ones. Moreover, the identification of complexity, within adaptive-systemic functions, means that none of these processes occur in linear fashion, but instead often happen in opposition to each other and concurrently on multiple "platforms". This paper will focus primarily on introducing the Social Complex Adaptive Systems (SCAS) model, as an holistic approach for analyzing and interpretating the complexities that arise from the introduction of advances in technology as new inputs are integrated and consumed within our social and built environments. The model presented, herein, will help others conceptualize the cultural and biological human constraints that must be considered when developing the next generation of technology and interconnectivity in order to promote social integrity. Hopefully, it will also show how increases in data processing demands for individuals and groups is adding such complexity that it is already overwhelming human capacity for adaptation.

II. PHYSICS AND COMPLEX ADAPTIVE SYSTEMS

Among the primary constraints that regulate human interaction are a tendency for heuristic thinking, a predisposition for predictable patterns and rhythms, leading to manichaeistic world views, avoidance of change, a preference for visual information, a focus on the present, and a need for social interactions. These concepts refer to human tendencies to learn and understand the world based upon past experiences, categorize knowledge and beliefs placed into dichotomous and opposing propositions, and have a temporal orientation for the present. Change or loss, especially when it is unanticipated is normally resisted, often, even, by extreme measures. Culture, which refers to all learned and shared behaviors and beliefs, can ameliorate some of these tendencies, but does not substantially change them. This means there are definite

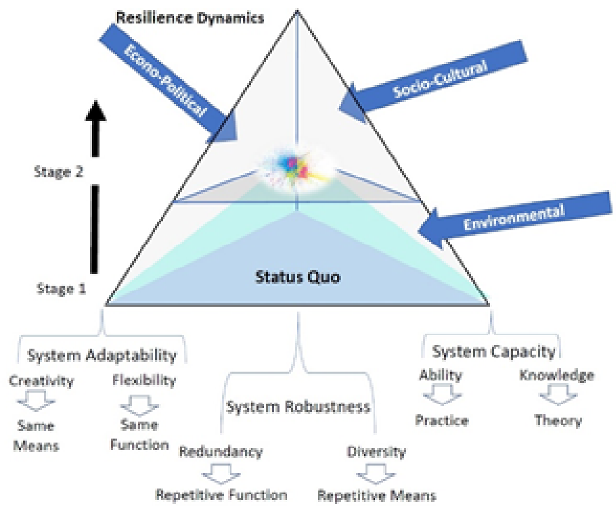

Fig. 1. SCAS Resilience Model.

limitations to the rate, rhythm, and capacity for adaptation among humans, at a societal level; if we continue to try to impose change in a linear, unidirectional manner. Instead, we are advocating a new paradigm, that of Social Complex Adaptive Systems (SCAS), to be used as both a method for devising and analyzing societal adaptation to technological changes. Taking inspiration from biology and physics we are proposing a new way to conceptualize the roll-out and development of 5G technologies and the next generation of innovations. This approach breaks from the traditional way of conceptualizing technological advancement as unidirectional; to one that promotes systemic resilience and adaptation, by understanding and recognizing the forces that both sustain and constrain all systems, as shown in Figure 1.

III. FROM A QUARK TO SUPERPOSITIONING

This model draws on the similarities between the social sciences and physics, by combining theories derived from various disciplines to produce a new paradigmatic way of assessing social and cultural interactions, through the lens of physics and biological systems (see figures 1 and 2). Physicists from Leo Kouwenhoven to Tim Palmer have began to explore the complex interconnections between matter and human ecosystems, which result in awareness, and process evolution. Examples of some of these types of knowing are given terms such as "intuition", "vibe", "feeling" and "awareness". These terms point to ways of knowing, which are not based on formalized logic, education, or even consciousness; but which illustrate that SCAS have multiple methods of learning and adapting to constraints, which are not well understood, conceptualized nor even acknowledged by many.
Everyone has experienced moments in which they have felt a connection or sense of something, or to something, they could not explain. This is one small instance to illustrate how biology and culture have worked to constrain human knowledge. Due to language limitations, and belief systems those moments are often regulated to epistemologies that do not intersect with daily life. This is particularly true in the West. Exemplifying the Manichaeistic tendency to divide experience and knowledge into black and white categories, the West has relegated almost all non-heuristic knowledge to the realm of "unscientific" and hence not relevant. However, recent advances in mathematics and physics has begun to provide proofs of the veracity of knowledge which cannot be experienced, replicated, or measured. The model we are advocating takes from these new concepts, to develop a paradigm for understanding how SCAS operate, and how technologies can be conceptualized to facilitate adoption by SCAS. To summarize these interactions, an ontological model was developed by Nousala, et al. (see figure 1). It is represented by three, paired relationships; each composed of binary forces, which represent those forces that sustain complex adaptive systems:

- Ability+Knowledge=**Capacity**

Increase in **A** positively correlate with **K**, where **A** is reflective of manpower or potential manpower to complete a job, and **K** of institutionally recognized education to provide those skill levels.
It is easier to increase **K** than increase **A**.
Increase in **A** negatively correlate with **EP**.
Increase in **K** negatively correlate with **EP**.

- Redundancy+Diversity=**Robustness**

Increase in **K** positively correlates with **R**, where **R** reflects the redundant ways or forms to achieve an objective.
Increase in **R** negatively correlates with **D**. In social sciences this is often referred to as the Normalcy bias (i.e. In our analogy, the path of least resistance). Efficiency gains, or energy conservation is positively correlated with **K** and **R**.
R requires less energy/resources than **D**.
Too much **R** negatively correlates with Resiliency, because it creates brittleness and prohibits adaptability.
Increases in **D** necessitate increases in **K** and **A** to retain functional cohesion.

- Flexibility+Creativity=**Adaptability**

Increases in **F** positively correlate with **D** Increases in **F** plus Increases in **D**, without Increases in **R**, negatively correlate with Robustness
Increase in **C** positively correlate with **K**.
Increase in **R** negatively correlate with **C**.
In turn, these forces are constrained by another three paired forces, leading to dynamic interactions between nested systems. To understand the transference of energy and interaction among forces, this model is supplemented with notions derived from field theory; thus, providing a more holistic image of systemic functions (see figure 2).

IV. THE ROLE OF ALGORITHM IN CAPACITY BUILDING FOR RESILIENCE AND CHANGE DYNAMICS

Combined, these two models challenge human capacity for learning and understanding, since they do not provide simple

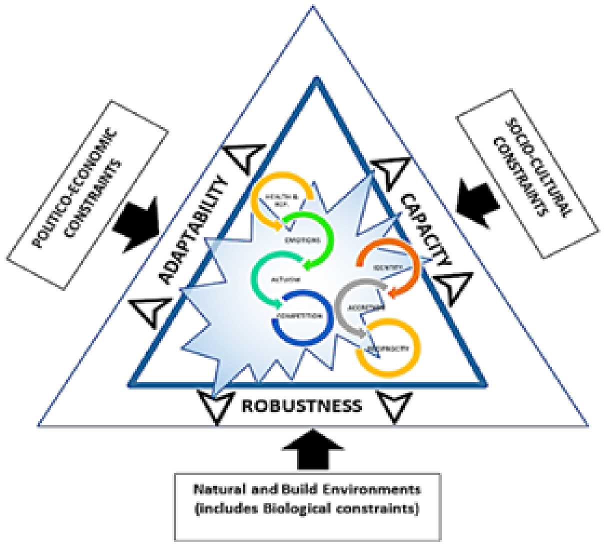

Fig. 2. The Forces.

heuristic or linear relationships between systemic functions. The complexities created by embedded systems and stochastic interaction require the use of algorithms and complex mathematics to model higher order systemic adjustments; in essence, computations which run counter to human SCAS tendencies. Much of the work currently done in Artificial Intelligence (AI), Internet of Thing (IOT), Machine Learning (ML), or Computational Linguistics (CL) requires these types of algorithmic computations which go counter to human tendencies and many cultural norms for learning and understanding. While these new computational modalities allow for enormous leaps of connectivity among processes and materials, their seemingly magical ways clash with human social norms and biological tendencies for learning (Nousala, S., 2014).

Because most people do not understand how data is computed, know how data is acquired, or how it is organized, it falls beyond their experience, and may be something that cannot be trusted, or known to be real. Legitimacy and veracity are qualities given to knowledge and learning based upon only a small number of processes: replicability, experience, reference, and/or authority (O?conner and Weatherall, 2019; Tosey, P., 2006). Younger generations learn the functional applicability of technology by replicating experiences, and they trust it intuitively, since they have not known things differently. Older generations of technology users have more constraints and more to risk when changing or adjusting to new technological innovations, and they need additional ways of having new technologies exposed to them, by relying multiple different formats and methods of learning how to conceive and use new technologies, so legitimacy, and ultimately trust, will be conveyed upon them. Hence, it is important to find, incremental, repetitive, referential and authoritative mechanism to reinforce new technological adoptions. These new mechanisms could form part of the social structures that constrain different nested systems.

Using another analogy from physics, such social structures function to create the pressure around embedded social systems, so that the energy within those systems can be released as work (i.e. free energy). If we want a system to work, in this case, by adopting new technologies, then the more structures presented to promote technological adoption, the more likely a system will be to work and find ways to adjust to the new technology. Not only do these ideas relate to how new products are introduced, but also the rate at which they are introduced. To continuously introducing new technologies, but not provide a framework or structure for those concepts, is to increase systemic energy levels, which leads to greater chaos, but not develop the constraints that produce work.

V. MAXWELL, EINSTEIN, NEWTON AND EMBEDDED SYSTEMS

The SCAS models presented, herein, are based upon relativistic and quantum research in Physics, and supplemented with notions derived from field theory, to provide a more holistic image of energy transfer (see figure 2). The fields proposed for SCAS mirror those of quantum physics, and add two, additional, molecular fields which are not discussed within the discipline of Physics. The premise of this paper is that our universe is governed by sets of laws and relationships that affect all matter, including biological beings and systems. Biology is unique because of its ability to propagate and auto-adapt to external stimuli, but it is not exempt from the laws of physics. Therefore, the social world, derived and constructed by humans (i.e. biological beings), is also confined to the laws of physics, and mirrors the physical world. Social constructs, including language and culture, are products of physical and biological entities; thus, the same laws and relationships found in the physical world constrain and support them, including the forces described in field theory. The major differene is an ability for social learning and culture, which implies a cognitive and willful trajectory in how and when adaptation occurs.

Social constructs are embedded within complex adaptive systems, and replicate physical laws, though through different modalities. The patterns that emerge, therefore, replicate those of the natural world, though they have been studied and described by different disciplines. What has been handed down is akin to the parable of the three blind men describing an elephant, where each person believed the animal to be an extension of only that portion that he was touching. The social sciences have done likewise, each discipline imposing its own terminology and paradigm to describe the phenomenon being studied. For example, in Sociology, what is termed the "normalcy bias" is similar to Newtons?s first law of motion: "things will stay the same, unless acted upon to induce change". If we take a step back, we can see that the patterns and processes being described replicate those in physics, just at different scales. There is a tacit recognition of this reality as evidenced by common lexicon describing thematic areas of social science research: e.g. power, force, efficiency, leverage, decay, etc. However, there is a general cultural negation of the complexities embedded within the phenomena being described and studied, which are supported by Western cultural normsthat emphasize linear rationalities and heuristic learning, and are reinforced through both scientific and economic measurements and systems.

The paradigm for energy transfer we are proposing is derived from quantum theory and embraces the idea that our universe is woven together by fields. Field theory essentially proposes that there are at least five fields that compromise the most basic forces upon which the universe is built, and they lay the basic foundational principles for relationships between all quantum interaction (Carroll 2013). We believe the same realities exists within the social-organizational schemes of human-cultural expression. These realities have been identified through parallel functional equivalences, and their respective "bosons" [in brackets]: hence, (1) Strong field= **Social identity/bonding** [synchronicity], (2) Weak field= **emotions** [positive/ negative /neutral sentiments], (3) Electromagnetism= **Communication** [reciprocity], (4) Gravity= **Accretion** [yearning], (5) Higgs= **substance** or **Matter** [attention]. Two additional MOLECULAR fields have been added to the classic physics analogy because of the dynamic interplay created through higher order complex adaptive systems; these are (6) **Autopoiesis** [organization and fertility] and (7) **Competition** [parity and dominance]. These seven fields permit the transfer of energy, power, and resources between institutions, individuals and our environment. They have driven human, social history and our relationship with the physical and built environments. We propose the processes and functions, listed above, are social constructs, which express underlying quantum fields; but they have been called something else and never recognized as fields. The strong force is used to bind the qaurks inside hadrons, as well as othersubatomic particles, in the nucleus of an atom. Humans also feel this strong force, but we recognize it as a need for social identity and bonding. It is this force that drives us to connect to other individuals or social groups and create a shared group identity. The weak force is instrumental in atomic decay and the creation of electrons, which are essential for electromagnetism. Emotions are the human equivalent of bosons engaging with the weak field. They are central to the human experience and instrumental in determining one?s cohesion to one?s reference group, or separation from them (those groups to whom one feels connected). However, as happens within quantum theory, if a quark is displaced, it may recombine with other quantum particles and engage with the weak field or electromagnetic field. So, it is with humans, if one experiences an incident that disengages the individual from his/her social group, that person may seek to bond with another entity. Such bonding may occur on an individual basis, or may replicate the dynamics of covalent bonds and join different groups together. Just as electromagnetism allows atoms to bond and form molecules by sharing or exchanging electrons; such actions allow individuals (or sometimes groups) to fulfill the role of electrons and build the requisite quantum symmetries that allow mass to amalgamate.

When individuals take on this role, the "boson" engaging with the electromagnetic field is communication. As with physics, the greater the distance between molecules, the weaker the electro-magnetic connections. If we hold with this analogy, new communication platforms have seemingly negated the constraints of distance, and broken the natural laws governing this field, since we can communicate with people over great distances. Yet, we propose that when conceptualizing "communication", people are only referring to a small portion of actual data exchange and processing between individuals and groups. There are layers upon layers of communication happening among and between SCAS, only a small portion of which is accessible as conscience speech or "communication". A well-known example of this is the synchronization of female menstrual cycles, when fertile women spend much time together. Thus, truly, the physics metaphor holds up; and, as with matter, the greater the distance between entities, the weaker the connection, and no amount of speech can bridge the lack of data exchange. Although, as befalls human constraints, because we are unaware of much (if not all) of the non-verbal data exchanged when communicating. We are notcognizant of these processes, and hence discount their existence and importance. By discounting the unconscientious levels of communication, we discount much of that data processing in which our bodies engage. The over emphasis on only verbal and visual modalities of communication, mean that we are trying to funnel all normal data processing functions between human and environment through a very small percentage of our human capacity. Moreover, we are additionally overwhelming these same modalities (vision and hearing) with constantly new, and innovative forms and kinds of data, due to globalization and new technologies. These "data-dumps" overload the limited cognitive capacity our brains have for real-time data processing. The result is SCAS drop-out, tune-out, turn-off technology, or continue, but with highten stress levels from lack of confidence.

The world we are currently constructing is one akin to a nuclear fallout. We are being bombarded by bits and pieces of data, quantum communication particles from all sides. All these pieces of data are energy packets that have the potential to create new "photons", resulting in free electrons, with nothing left to bond to. Those electrons farthest from the nucleus are often sheared off, and what we are experiencing is the atomization of societies. This isn?t to say that technology is bad, or wrong, but instead to highlight the need of providing a better paradigm and metaphor to recognize and acknowledge human and systemic constraints. By first acknowledging the importance of non-heuristic and unconscious processes and the parallel constructions of matter across all scales of analysis, we can begin to understand the need to design more human-centric technologies, and the introduction of those technologies in ways that support social cohesion and true, multi-layered, multi-modal communication as occur between individuals at close proximity.

In addition to Strong, Weak, and Electromagnetic forces, human social groups also react and engage with the gravitational and Higgs fields. In physics, gravity is often explained as matter attracting more matter; the bigger the matter, the more power of attraction it has. Humans also exhibit a propensity for accumulation; instead of calling it gravity, we call it accretion. This propensity is expressed beyond the obvious examples of greed, and wealth commonly pointed out. It is expressed through a range of daily interactions: from when we satiate needs, to when people obtain or take more than they need or can consume. And, as happens with heavenly bodies, the more matter one has, the greater the individual?s power of attracting more matter to itself. Finally, in physics, the Higgs field gives quantum particles mass or substance, and makes possible the expressions of the natural world we perceive. For humans, attention bestows matter or gives substance to something. Like the Higgs boson, attention requires high energy levels, which is achieved through concerted and focused energy, derived from multiple embedded systems within the individual and/or group. Language allows us to transfer those ideas and information that we have identified as mattering, and it makes possible the ability to develop shared realities and give substance to our experiences (O'Conner and Weatherall, 2019). However, at this level, communication is being restricted to only those bits and pieces of quantum material that have engaged with the Higgs field, and all else is lost. Thus, once again, underscoring the importance of proximity for deeper levels, and more integral communication that surpasses cognition.

VI. QUANTUM FIELDS, RELATIVE FIELDS, AND MECHANICAL FORCES

One of the greatest, and possible most frustrating, finding of the past century was the realization that basic mathematical techniques and assumptions are not universally applicable. Similar constraints and dynamics are evident within and among SCAS. Thus, when trying to define, analyze, or interpret systemic dynamics, the importance of precision cannot be overstated, especially as relates to scale, level of analysis and vocabulary.

The issue of vocabulary, in particular, becomes fraught with problems, as different levels of systemic engagement often occupy the same space, but may give different meaning to the same or similar terms. For example, the word ”power” has a clearly defined meaning in physics, but a much more amorphous one in everyday speech, and still a different connotation within Sociology. This simplistic example points to the importance of context within the formation of meaning, or matter, to something; as one attunes his/her attention. When there is a shared context, communication is facilitated, but often that context is embedded within one?s immediate surroundings. Trying to transfer all that information becomes an impossibility, and information is lost and often misconstrued without an understanding of the context within which it is being used.

Engineers and scientists have attempted to devise ways of addressing increases in societal complexities by creating efficiencies. Butin creating efficacies, the primary approach has been to teardown constraints, leading to greater systemic chaos, andactually contributed to the multiplicity of energies invading SCAS. Innovations and improvements in communication technologies have greatly contributed to human creativity, and learning, but have, ultimately, added higher levels of complexity into human societal units. This mismatch exemplifies and exacerbates human tendencies towards heuristic and manichaeistic thinking, which when propagated through multiple iterative, systemic interactions often result in ideas and actions that obliviate nuances, safe spaces and opportunities for shared experiences. These are some of the basic conditions needed to create social cohesion and trust. As economic and academic interests continuously focus on technological capacity-building, there needs to be a simultaneous focus on the constraints of the ultimate end-users.

VII. CONCLUSION

This is not a call to stop or slow down technological advancements, but instead expand the analogy introduced above, to other fields of science. Then take inspiration for how organic systems have adjusted to additional complexities to develop resilience. By doing this, we?ve taken concepts of free energy from physics and juxtaposed them with a broad understanding of biological structures to provide a holistic image of the importance of internal structures and systemic interaction in maintaining organism resilience and integrity. To date, technologies, policies, and economic pressures have all pushed towards isolating systemic functions, and social groups, in the name of efficiencies; while actually eliminating internal structures and decreasing systemic abilities for work.

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