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Human Metasystem Transition (HMST) Theory

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Abstract

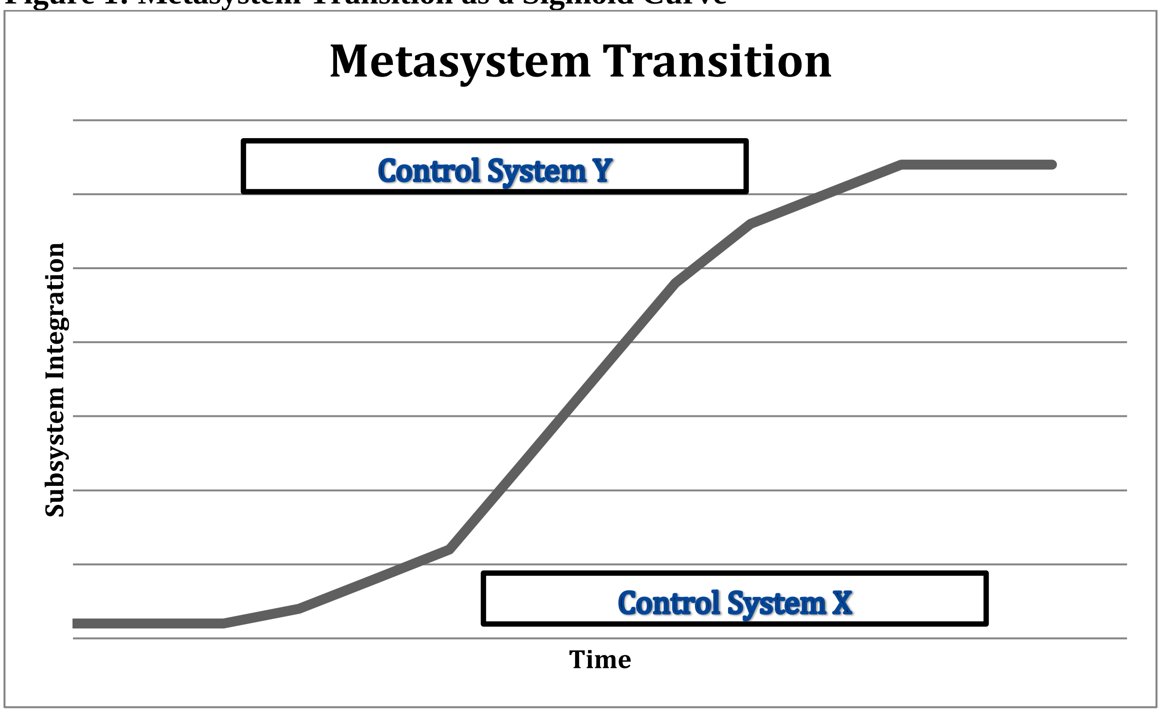
Metasystem transitions are events representing the evolutionary emergence of a higher level of organization through the integration of subsystems into a higher "metasystem" ($A_1+A_2+A_3=B$). Such events have occurred several times throughout the history of life (e.g., emergence of life, multicellular life, sexual reproduction). The emergence of new levels of organization has occurred within the human system three times, and has resulted in three broadly defined levels of higher control, producing three broadly defined levels of group selection (e.g., band/tribe, chiefdom/kingdom, nation-state/international). These are "Human Metasystem Transitions" (HMST). Throughout these HMST several common system-level patterns have manifested that are fundamental to understanding the nature and evolution of the human system, as well as our potential future development. First, HMST have been built around the control of three mostly distinct primary energy sources (e.g., hunting, agriculture, industry). Second, the control of new energy sources has always been achieved and stabilized by utilizing the evolutionary emergence of a more powerful information-processing medium (e.g., language, writing, printing press). Third, new controls emerge with the capability of organizing energy flows over larger expanses of space in shorter durations of time: bands/tribes controlled regional space and stabilized for hundreds of thousand of years, chiefdoms/kingdoms controlled semi-continental expanses of space and stabilized for thousands of years, and nation-states control continental expanses of space and have stabilized for centuries. This space-time component of hierarchical metasystem emergence can be conceptualized as the active compression of space-time-energy-matter (STEM compression) enabled by higher informational and energetic properties within the human system, which allow for more complex organization (i.e., higher subsystem integration). In this framework, increased information-energy control and feedback, and the consequent metasystem compression of

space-time, represent the theoretical pillars of HMST theory. Most importantly, HMST theory may have practical application in modeling the future of the human system and the nature of the next human metasystem.

Metasystem transitions

Metasystem transitions (MST) are major evolutionary processes that allow for the hierarchical emergence of higher organization in living systems (Turchin 1977; Joslyn et al. 1991; Heylighen 1995; Turchin 1999). According to MST theory, a metasystem (also referred to as a "major transition") (see Smith and Szathmáry 1995) occurs when living systems achieve higher system organization from the controlled coordination (i.e., control system *X*) of previously disparate subsystems (i.e., A_1+A_2+A_3=B) (Turchin 1977; Heylighen and Campbell 1995; Goertzel 2002; Last 2014a). In this framework, metasystems occur as a step function that separates two qualitatively different levels of organization (Heylighen 2014). This step function can be approximately measured as a sigmoid (S-shaped) curve (Modis 2012) (see Figure 1).

Figure 1: Metasystem Transition as a Sigmoid Curve



Metasystems separate two qualitatively different levels of organization. The new level of organization must emerge from the coordination of new controls (*X*) utilizing a new information medium for the integration of previously disparate subsystems (i.e. A_1+A_2+A_3 = *B*). The highest control can then continue to replicate ("Branching of the Penultimate Level" (Turchin 1977)), allowing for a new level of group selection, and potentially allowing for the generation of *another* metasystem transition (contingent on environmental evolutionary selection pressures for higher information processing functionality). Through metasystems, living organizations generate complexity that manifests as hierarchical and developmentally constrained cybernetic controls (Heylighen 2000).

Throughout the evolution of life, metasystems have consistently increased living system complexity (Miller and Miller 1990; Smith and Szathmáry 1995). Common examples include the emergence of prokaryotes, eukaryotes, multicellularity, sexuality, societies, and superorganisms (Heylighen 2000; Smith and Szathmáry 1995). These metasystems have emerged in a hierarchical and developmentally constrained nature (Smart 2009), through progressive and cooperative symbioses at various levels of biological organization (Corning 2005; Margulis and Fester 1991). This simply means that previous metasystems act as structured platforms for the emergence of higher cooperation, and therefore, the potential for the generation of higher metasystems (Heylighen 2000).

However, the current study of metasystems has progressed with little detailed evolutionary analysis of the human system. This is problematic for metasystem transition theory because the human system exhibits social organization mediated by biochemistry, but also social organization mediated by culture and technology, suggesting that metasystems can occur even if driven by non-biochemical organizing properties. Furthermore, the human system, specifically because of its cultural and technological properties, gives us the most obvious appearance of a system with the capability to transition to a higher metasystem in the near-term future. Therefore, in this paper I attempt to apply MST theory to the human system specifically in order to develop "Human Metasystem Transition" (HMST) theory. This new analysis will give us a deeper framework for understanding the specific nature of human transitions, and consequently give us a better understanding of the similarities and differences between metasystems that emerge from biochemical and technocultural mechanisms, two distinct and (potentially) competing evolutionary pathways (Last 2014b).

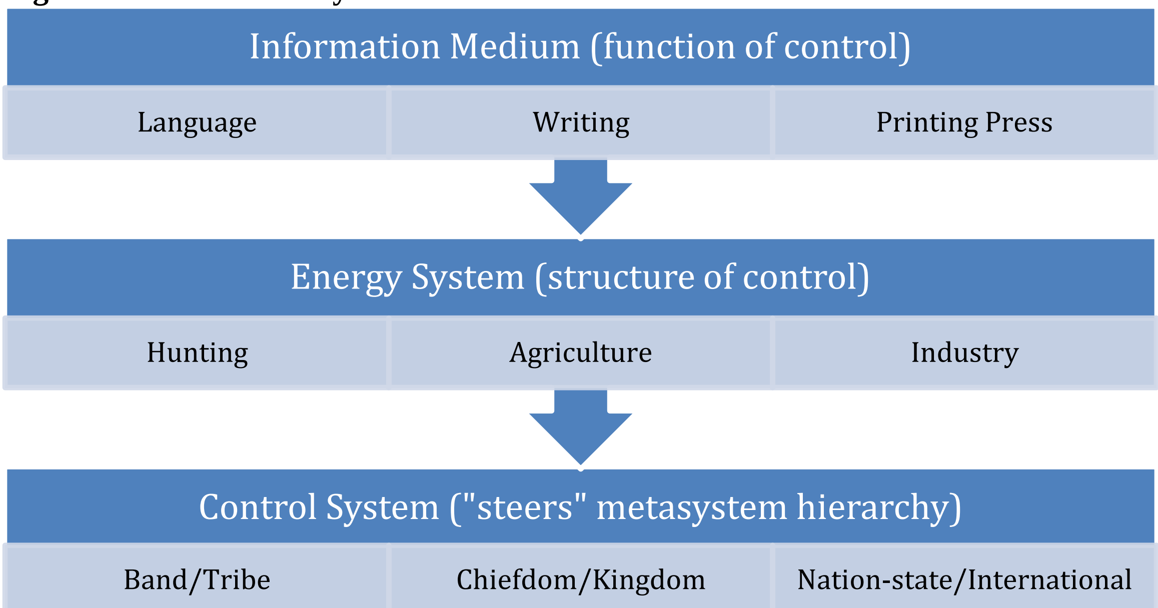
2. Human metasystem transitions

From the application of metasystem transition (MST) theory to the human system, we can identify three major system transitions throughout the evolution of our genus *Homo*. On each occasion a new level of organization has emerged, which has been stabilized by higher controls and higher group selection. These metasystems broadly include systems commonly referred to as "band/tribe," "chiefdom/kingdom," and "nation-state/international" organizations (see Figure 2). The structures of these organizations have been stabilized by the control of three mostly distinct primary energy sources: hunting, agriculture, and industry. Band/tribe organizations manifested around the control of hunted and cooked animal meat: the Pyrian Regime. Chiefdom/kingdom organizations manifested around the control of domesticated plant and animal resources: the Agrian Regime. Nation-state/international organizations manifested around the control of ancient biomass (or fossil fuels): the Carbian Regime (see Niele 2005).

The control of these energy sources was always organized through the utilization of a new information medium to connect previously disparate subsystems. During the transition to hunting organizations, modern language emerged to facilitate the formation of larger group sizes, which were capable of producing the social and technical expertise necessary for hunting to become a stable and reliable energy source (Dunbar 2003). During the transition to agricultural organizations, written language functioned to track, collect, and stabilize a coordinated large-scale economy fundamentally built on domesticated plants and animals (Cooper 2004). During the transition to industrial organizations, the printing press emerged allowing for the flourishing of scientific and technical expertise necessary for the exploitation and stabilization of fossil fuels, and consequently, the construction of the modern world (Niele 2005).

All of these human metasystem transitions (HMST) can be characterized by subsystems of lower control becoming integrated under new higher control regimes. In the hunting transitions, parties and groups became integrated into bands and tribes. In the agricultural transitions, bands and tribes became integrated or subsumed into chiefdoms and kingdoms. In the industrial transition, chiefdoms and kingdoms became integrated or subsumed into the formation of the modern nation-state. These are the most basic example of both the hierarchical and developmentally constrained nature of metasystems. Metasystems are hierarchical because they emerge from integration at lower levels and developmentally constrained because they manifest similar organizational properties at each level. In this framework of thinking about the human system, the modern nation-state sits atop an ancient evolutionary HMST control hierarchy of ever-more diversely integrated subsystems (Figure 2).

Figure 2: Human Metasystem Transitions



Human metasystems appear to be phenomena intimately dependent on information mediums, energy systems, and the synergistic feedback processes they can maintain. Information mediums tend to act as the functional tool for the organization of control system resources, capital, and people, and energy systems tend to act as structural stabilizers of control system organization. Therefore, the control of information for the purpose of acquiring and distributing energy may represent the nature of complex system control, at least in the human system.

Throughout this process of higher subsystem integration, the stabilization of a new HMST appears to compress spatial and temporal restrictions on human action, both within the control system and within society as a whole. The highest metasystem controls display an ever-broader extension of control over larger regions of space, and they can accomplish this spatial feat in shorter durations of time (i.e., physical space-time barriers to human action are consistently and progressively reduced). Consequently, there is a trend toward accelerated metasystem emergence, as the space-time reach of human action progressively increases. The hunting transition occurred over a period of hundreds of thousands (if not millions) of years, the agricultural transition occurred over a period of thousands of years, and the industrial transition has been occurring over a period of centuries. This metasystem process has resulted in more complex human organizations directly and coherently controlling more of the Earth’s surface, faster. For individuals, the consequence is the emergence of systems that increasingly allow for action that is global (spatial) and instant (temporal). Therefore, in regards to both space and time, higher metasystem controls appear to facilitate a culturally and technologically mediated conquest of dimensionality.

Of course, it is unknown whether the metasystem conquest of dimensionality will be further extended, but there is already evidence that a new information-energy relationship is emerging in the human system between the Internet (information medium) and renewables (energy structure). The development and stabilization of a new information-energy feedback process could provide the basic architecture for a further metasystem transition, which would mean a transition towards higher controls (i.e., global), greater systems complexity (i.e., higher subsystem integration), and further reduction of space-time restrictions on human control and action. Such a metasystem transition would likely produce a human civilization best described as a "global village" (Last 2014a) with a "global brain" (Heylighen 2014a).

2.1. Emergence of bands/tribes

The first HMST was caused by the regular exploitation of animal meat (Wrangham 2009) via coordinated hunting and complex culture and technology (Ambrose 2001). This allowed our ancestors to organize parties and groups into bands and tribes. We see evidence of a gradual but significant increase in animal meat consumption with the emergence of the genus *Homo* 2 million years ago (Braun et al. 2010; Schoeninger 2012; Steele 2010). This exploitation of animal meat accelerated with successive *Homo* species (e.g., *Homo erectus*, *Homo heidelbergensis*, *Homo neanderthalensis*) (Antón 2003; Pontzer et al. 2011; Ungar 2012) between the emergence of the genus and the emergence of modern humans approximately 200,000 years ago (McDougall et al. 2005). As human brain size increased, there was a concomitant rise in the diversity and proportion of animal meat exploited from hunting larger game, and eventually the regular exploitation of coastal resources (Wrangham 2009; Gamble et al. 2011). From an analysis of great ape and modern human hunter-gatherer meat consumption, we can see that the consumption of animal meat exploded during the transition from ~5% to ~65% (Cordian et al. 2002).

During the acceleration of hunting and cooking animal meat for energy, several evolutionary anthropological models suggest that increased communication abilities emerged as a result of the functional need to increase the faithfulness of information transfer within parties and groups (Aiello and Dunbar 1993; Dessalles 2009; Dunbar 2009). Between the emergence of the genus *Homo* and the emergence of modern humans, linguistic ability appears to have improved in three or four evolutionary "movements" from grooming to vocal language (Gamble et al. 2011). These movements can be correlated with increased brain size and group size, and increased animal meat dietary dependence (Dunbar 2003; Gamble et al. 2011). From these models we can identify that a new relationship between information and energy was becoming established. Without language our human ancestors would not have been able to achieve the coordination, faithful cultural transmission, or technical know-how to engage in an elaborate and complex hunting energy regime.

The hunting energy regime necessarily required the development of new controls for a new qualitative level of organization: bands/tribes. Bands and tribes typically consist of 100-250 individuals, but can include larger aggregations. This may seem like an inconsequential increase in the level of primate organization, but our closest great ape relatives typically operate in party sizes of 5-10 individuals (Chapman et al. 1994, 1995), and group sizes that may reach a maximum of 50 individuals (Aiello and Dunbar 1993). Therefore, tripling the number of cooperating primates required the development of sophisticated kin and social networks, as well as new complex modes of distributed decision-making and diversification of labor related to energy acquisition and utilization. This larger and more complex metasystem compressed both space and time. This was in part facilitated by the development of long-distance endurance-running capabilities, which co-evolved in the genus *Homo* with language and hunting (Bramble and Liberman 2004). Long-distance running, along with complex language, allowed bands and tribes to form organizations with the capability to migrate, colonize, and stabilize in almost any niche on the planet within a relatively short duration of time (Richerson and Boyd 2008). However, the specific spatial and temporal reach of any one band/tribe was always regional in nature. Of course, this simply means that no bands/tribes organized on large semi-continental or continental scales. But as a whole, when compared to pre-*Homo* hominid species and contemporary great ape species, the human band/tribe organization was able to control larger areas of space within shorter durations of time.

2.2. Emergence of chiefdoms/kingdoms

The second human transition was caused by the domestication of plants and animals via selective breeding (Diamond 1997; Morris 2011). We see evidence for independent agricultural developments in seven different locations between 9000 B.C.E. and 2000 B.C.E. (Diamond and Bellwood 2003). These "agricultural revolutions" shared the same system-level patterns and included the same general ordering of causal events related to the cultivation of plants, domestication of animals, and rise of sedentism (Morris 2011). The degree to which the agricultural system matured was largely dependent on the plant-animal complexes available to human populations on different continents (Bellwood and Oxenham 2008) and the ecologically influenced (but not dictated) diffusion patterns of agricultural cores over centuries and millennia (Putterman 2008). However, history gives us a clear directional trend: between the original establishment of agricultural systems 11,000 years ago and the present day, we have seen an overwhelming tendency of human populations becoming integrated (or subsumed) (willingly or unwillingly) within controls originating from the agricultural revolutions. Indeed, the human groups who adopted agricultural practices transformed the ecology of nearly every habitable region of the planet Earth (Haberl 2006).

Agricultural organizations formed sedentary populations of varying sizes and scales, but all were ultimately stabilized by the new organization of symbolic information in the form of written language (Cooper 2004). We have evidence of recorded human symbols functioning to communicate information that predates agricultural organizations by tens, if not hundreds, of thousands of years (Hawks 2013). Therefore, the recording symbols as a practice, is likely as old, or older than the modern human species (Conkey 1997). This ability to record symbolic information facilitated the increased sociopolitical complexity necessary to organize early agricultural organizations, as the first written records are largely composed of lists related to administration and taxes (Cooper 2004). In the most intensified agricultural cores (e.g., Mesopotamia, Egypt, China, and Mesoamerica) we have the best evidence of this early record keeping (Trigger 2004). From this evidence, we find that increased population size increased the need for administration and wealth redistribution to collectively maintain the first city-states, chiefdoms, and kingdoms (Morris 2011). Without written records for the practical administration and continued maintenance of agricultural resources, large interconnected farming networks would not have been able to provide the energy surplus for the emergence of civilization (Stewart 2010). After the new information-energy relationship between writing and agriculture was established in the most productive agricultural cores, more individuals could dedicate their time and energy toward non-food related tasks (Morris 2011). This eventually culminated in writing as a medium for recorded narrative, bringing spoken language and written language closer together (Stewart 2010). Therefore, the cultural and technological capabilities of agricultural groups vastly expanded.

Controls facilitating the metasystem transition toward the most intensified agricultural systems represented a new qualitative level of organization exhibiting increased functional specialization. The smallest of these controls reached sizes of 1,000 to 10,000 individuals (Gabriel 2007), but in the most intensified agricultural regions, controls managed to organize empires as large as 10 to 100 million individuals (Taagepera 1979; Taagepera 1997). These organizations were highly centralized in their nature and manifest in cultural kin-based institutional structures often referred to as chiefdoms and kingdoms. However, our conceptual framework to discuss ancient agricultural political organizations, especially within an evolutionary perspective, needs to be improved (see Graeber 2004). But like their hunting predecessor, agricultural systems allowed for the compression of both space and time in comparison to lower metasystems. Spatially, many agricultural systems began organizing vast empires across large expanses of continents (e.g., Inca Empire), and sometimes even inter-continental regions (e.g., Roman Empire). Temporally, agricultural systems achieved and maintained this larger spatial conquest in shorter durations of time (e.g., millennia, centuries) (Stanish 2002; Taagepera 1979; Taaepera 1997). The mechanisms to facilitate this compression included domesticated horses for more efficient intracontinental travel and constructed sailing ships for the beginnings of early intercontinental travel.

2.3. Emergence of the nation-state

The third transition was enabled by the exploitation of fossil fuels (e.g., coal, petroleum, natural gas) (Landes 1969; Allen 2009). This transition happened so quickly that it required only one diffusion center (i.e., England) (Allen 2009). Therefore, the diffusion of the new energy economy was largely dependent on the European sociopolitical context into which it was unleashed. European colonial and neo-colonial entities started exploiting fossil fuels well before any other sociopolitical entity was able to develop a post-agricultural economy (excluding Japan) (Robertson 2003). This gave most western European and European neo-colonial entities a tremendous energetic advantage over non-European peoples and territories. But global industrialization has been developing and accelerating in “non-Western” countries between 1945 and the present (i.e., the post-colonial era) (Weiss 2003). In particular, in the twenty-first century, it is impossible to now talk about globalization as a purely “Western phenomenon”, as many of the most developed countries exist throughout Asia. Similar to the initial diffusion of fossil fuel use, the modern period of industrialization is dependent on sociopolitical context (i.e., sociopolitical groups’ ability to control the resources and development of their territory). But unlike the first diffusion, most modern industrializing nations throughout Asia, Latin America, and Africa are emerging in a far more competitive and quickly evolving energy landscape, within which alternative fuel sources may start to play an increasingly important role.

In the same way that earlier human metasystems were dependent on the organization of higher information mediums, modern structures were constructed utilizing an emergent information medium: the development of mass-produced recorded symbolic information (i.e., the printing press). The first experiments with paper (105 C.E.), printing (713 C.E.), and moveable type (1041 C.E.) started in East Asia over the course of several centuries (Gunaratne 2001). These developments predated the famed Gutenberg printing press, which was developed in mid-fifteenth century Germany (Harnard 1991), but the system-level pattern of significance is that similar moveable type technologies were developed in the two most intensified agricultural cores: Western and Eastern Eurasia (Morris 2011). This suggests that, like previous information mediums (e.g., language, writing), the printing press as a medium emerged and adapted in response to increased population size and sociopolitical complexity. However, the effects and diffusion of the printing press in Europe were far more profound than those in East Asia: between 1500-1700, European cultures, technology, and society were forever changed by the proliferation of “ancient” knowledge, as well as the ability to diffuse philosophical, scientific, artistic, and technical literature to ever-broader audiences (Eisenstein 1980; Dittmar 2011). This medium fully matured with “industrial scale” printing press technology in the nineteenth century, allowing for the organization and maintenance of the modern nation-state, as well as intercontinental empires and eventually the beginnings of international governance (Eisenstein 1980; Mazower 2012). From the new information-energy feedback between the printing press and fossil fuels, the modern world (i.e., third human metasystem) emerged: the printing press enabled the flourishing of knowledge for the exploitation of fossil fuels, and then fossil fuel energy distribution in turn increased the percentage of humans who could engage with the knowledge generated by the printing press.

Controls in the first industrial metasystem manifest in the establishment of the nation-state. Nation-states, like the agricultural organizations that preceded them, had a proclivity for colonial and neo-colonial empire building (e.g., British Empire, American Empire) (Mann 2012). However, industrial organizations represent the largest controls in human history, with the largest entities (e.g., China, India) encompassing as many as 1-1.5 billion humans (Winters and Yusuf 2007). Throughout the industrial era, various forms of the nation-state have emerged, but these control systems are typically more decentralized and driven and/or influenced by significantly higher citizen input than is typical of the largest agricultural organizations. Once again, the industrial metasystem compressed space-time when compared to previous metasystems, as humans began to aggregate spatially on larger scales (i.e., expansion and consolidation of integrated territory e.g., United States of America, Canada, Russia, China, India, Brazil) over shorter temporal periods (i.e., centuries, even decades). The primary intracontinental mechanisms to facilitate these industrial advances included the development of the steam engine (nineteenth century) and automobiles (twentieth century), and for intercontinental travel the steam ship (nineteenth century) and airplane (twentieth century) (Crafts 2004)

3. Future human metasystem transition

As demonstrated (see 2.0-2.3), throughout the evolution of the human system increasingly complex control systems have emerged from the development of new information-energy systems (Figure 2). Within this framework of thinking about human evolution, nation-states currently represent the highest control systems, and thus, the highest human metasystems. However, it is unlikely that these organizational structures represent the pinnacle of human evolution, or cosmic evolution for that matter, as cultural and technological processes could allow for the production of higher complexity in the future (see Smart 2009; Heylighen 2014a): a fourth human metasystem.

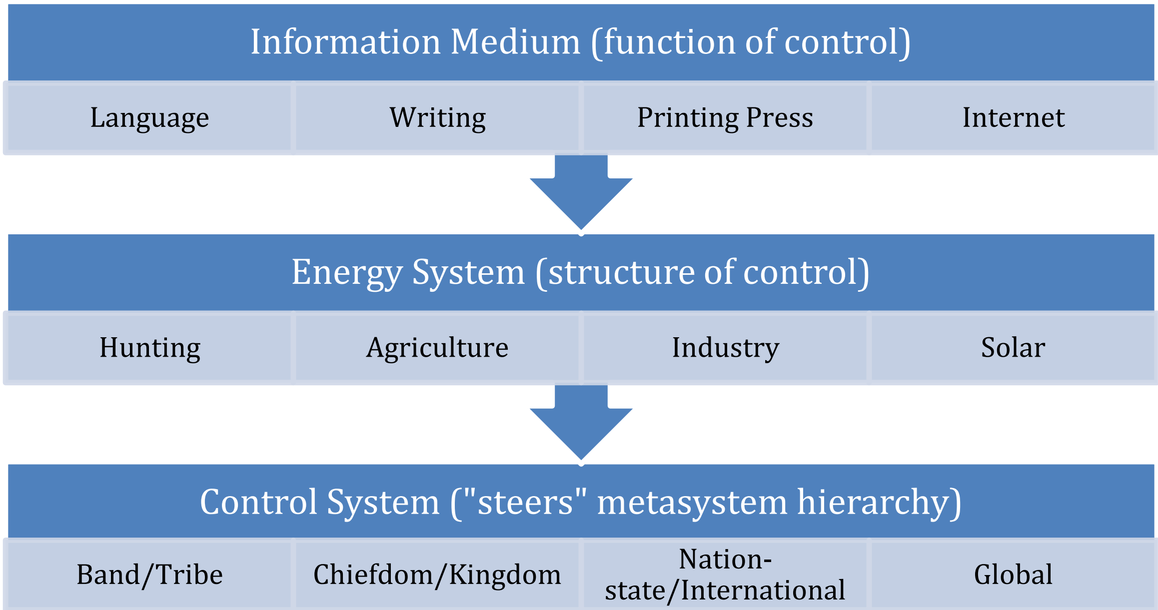
Human Metasystem Transition (HMST) theory offers a way to understand the future emergence of a new level of human complexity through the development of emergent information-energy systems, and consequent integration of the highest control subsystems. If accurate, this next metasystem may not be too far from fundamentally disrupting modern control structures, as radically new energy and information systems are developing and could form higher collective synergies than current information-energy systems (Rifkin 2014). The possibilities of a new energy system to stabilize a fourth metasystem could be based on the full exploitation of solar energy (Bradford 2006). Many energy experts have recognized that there is a strong pressure for a new carbon-neutral energy economy that can provide more energy to a greater number of people (e.g., Lewis and Nocera 2006; Şen 2004). Such experts have also realized that solar provides us with the best opportunity to achieve this next energy system (e.g., Bradford 2006; Goetzberger et al. 2002; Lewis 2009; Liang et al. 2010; Morton 2006). Of course, other energy sources, such as wind and geothermal power, could (and likely will) complement solar (Carrasco et al. 2006, Haralambopoulos and Polatidis 2003). Therefore, we could exist in a world primarily powered by distributed solar energy complimented by a wide variety of “alternative renewables” (Singer et al. 2011). But also, we should not underestimate the potential future of nuclear energy, either the fission or fusion variety (Niele 2005). Nuclear energy has had a problematic history, but if developed and controlled properly, this fuel source could offer humanity practically infinite energy for the remainder of Earth's life history. However, whether our next energy system is primarily based on solar radiation or nuclear fusion, we can consider both energy systems "solar", in that nuclear fusion mimics the properties of stellar bodies (Niele 2005).

The information medium that could stabilize the establishment of a higher level of systems-organization is far more advanced than emergent alternative energy: the Internet. If the Internet acts as the medium enabling higher human organization, the fact that it precedes the maturation of new alternative energy would be consistent with previous human metasystems (see: 2.0-2.3), as new higher information mediums have always preceded the stabilization of a new energy source. But that is not to say that the Internet is fully mature, in both quantitative and qualitative terms. Quantitatively, most humans still do not have Internet access (Kende 2012) (although access is increasing quickly, and the selection pressures for truly global access are strong). Qualitatively, Internet experience itself is likely to change dramatically, as advances in artificial intelligence, virtual reality, and semantic web technologies will likely alter the way humans interact with each other, and with computers (Goertzel 2002). These quantitative and qualitative developments combined could result in an Internet at full maturity that acts as a self-organizing "planetary nervous system" (Giannotti et al. 2012) or "global brain" (Heylighen 2014b), facilitating *all* intelligent agent interaction *all* the time (Goertzel 2002; Heylighen 2008). Such a communication medium would emerge from increasing Internet use, increasing access to the Internet, and the development of the "Internet of Things" (IoT) (Atzori et al. 2010; Kopetz 2011; Kortuem et al. 2010; Rifkin 2014; Sahel & Simmons 2011).

However, all metasystem transitions are fundamentally dependent (and defined) around the formation of new control systems. Currently, international control mechanisms exist, but the nation-state has not been socioeconomically superseded. Despite this, modern nation-states appear to represent an insufficient level of organization to manage socioeconomic issues in the twenty-first century (e.g., Piketty 2014). Furthermore, data suggest that individual opinion of modern governments is at an all-time low globally (see Glenn et al. 2014). Therefore, it is possible that these control structures will be superseded in the twenty-first century (Stewart 2014); but understanding the future nature of human controls is still in its infancy (see Graeber 2004), and perhaps inevitably an active ongoing process. Will the next system be a transition towards global governance through socioeconomic regulation by a political body like the United Nations? Will the next system be a transition to higher levels of state cooperation, similar to what is currently occurring in the European Union? Will the next system experience fragmentation to stronger local governance? Or will the next system develop a wholly new type of control structure utilizing emergent information technology related to artificial intelligence and collective intelligence? In other words: what will be the nature of subsystem integration and higher organization?

I have my own speculations, but I must admit that here there are more questions than answers, although I hope human metasystem transition theory will provide a helpful framework to begin a serious inquiry into the future of human control.

Figure 3: Human Metasystem Transitions (Possible Future)



The emergence of a fundamentally new information medium and energy structure could suggest the beginnings of a metasystem transition towards a higher level of control. If true the first half of the twenty-first century could be characterized by a fundamental disruption to the operations of the nation-state and the stabilization of new higher forms of human organization.

What we can learn from previous human metasystem transitions is that new controls will likely be organized utilizing the highest emergent information medium (in this case, the Internet as medium should play a crucial organizing role). And indeed, there has been a recent flourishing of studies suggesting that some form of transition to "e-democracy" merits more serious consideration (e.g., Chadwick 2009; Fountain et al. 2011; Lathrop and Ruma 2010; Noveck 2009). Furthermore, if past human metasystem transitions are any indication, and new digitally based controls emerge to stabilize feedback between emerging global information-energy systems, we should expect a continuation of the trend toward space-time compression. This would likely result in a global human network composed of 8 to 12 billion individuals who can seamlessly interact with few global restrictions on travel and communication. Such a system would require the emergence of more efficient intracontinental and intercontinental travel mechanisms, but also, controls facilitating a more fluid dynamic between individuals and societal boundaries. Is our world truly a small world after all?

Although this world may be difficult to imagine given current global conflicts, its description is consistent with current trends toward higher international cooperation during the later stages of the industrial transition (Karns and Mingst 2004; Krahmann 2003), current projections of global population for the middle of the twenty-first century (Boongaarts 2009; Cohen 2003), as well as the trends characteristic of previous human metasystem transitions (Hanson 1998; Hanson, 2008). The fourth human metasystem would allow us to enter a world as different from the industrial world as the industrial world is from the agricultural world, or as different from the agricultural world as the latter was from the hunting world. But to enter such a world would be to challenge and successfully replace, fundamentally, the current structure of our world. Such a transition would be unprecedented, although the idea of higher global integration has a long and complex history. In the metasystem framework, we would tend to view this transition as humanity in the process of birthing a global biocultural superorganism (see Turchin 1977). Considering that no such entity has ever existed, the concept and foundations of the metasystem, should receive far more of our attention.

4. Conclusion

I have tried to describe a complex systems theory of the human evolution – human metasystem transition (HMST) theory – based around the emergence of higher control organization through the stabilization of feedback between emergent information-energy systems. Both energy and information as phenomena appear to fundamentally influence human system structure and also appear to build on previously established processes, allowing higher controls to stabilize new organization and complexity. If this theory accurately maps the territory of human evolution, the emergence and establishment of new information and energy systems should present us with a signal that our current control structures will be challenged and potentially superseded this century.

From an evolutionary cybernetic perspective, this theory has the potential to better integrate unique human species processes within a systems-level evolutionary model of all life. Previous biochemical metasystem transitions have followed very predictable patterns related to organization and complexity, and it appears as though the human system is not distinct in this respect even though a new and unique pathway (that of technocultural evolution) has emerged and continues to dominate change within our lineage. If simple fundamental mechanisms increase the probability of the establishment of higher-level organization within the human system, this may make our systems behavior easier to understand in relation to other complex systems.

References

Aiello, L.C. and R. Dunbar. 1993. Neocortex size, group size, and the evolution of language. *Current Anthropology* 34: 184–193.

Allen, R.C. 2009. *The British industrial revolution in global perspective*. Cambridge: Cambridge Books.

Ambrose, S.H. 2001. Paleolithic technology and human evolution. *Science* 291: 1748–1753.

Antón, S.C. 2003. Natural history of *Homo erectus*. *Yearbook of Physical Anthropology* 122: 126–170.

Atzori, L., A. Iera, A. and G. Morabito. 2010. The Internet of Things: A survey. *Computer Networks* 54: 2787–2805.

Bellwood, P. and M. Oxenham. 2008. The expansions of farming societies and the role of the demographic transition. In *The Neolithic demographic transition and its consequences*, ed. J-P. Bocquet-Appel. 13–34. New York: Springer.

Boongaarts, J. 2009. Human population growth and the demographic transition. *Philosophical Transactions of the Royal Society* 364: 2985–2990.

Bradford, T. 2006. *Solar revolution*. Cambridge, MA: MIT Press.

Bramble, D.M. and D.E. Liberman. 2004. Endurance running and the evolution of *Homo*. *Nature* 432: 345–352.

Braun, D.R., J. Harris, N.E. Levin, J.T. McCoy, A.I.R. Herries, M.K. Bamford, L.C. Bishop, B.G. Richmond, and M. Kibunjia. 2010. Early hominin diet included diverse terrestrial and aquatic animals 1.95 Ma in East Turkana, Kenya. *Proceedings of the National Academy of Sciences* 107: 10002–10007.

Carrasco, J.M., L.G. Franquelo, J.T. Bialasiewicz, E. Galván, R.P. Guisado, M.A. Prats, and N. Moreno-Alfonso. 2006. Power-electronic systems for the grid integration of renewable energy sources: A survey. *Industrial Electronics, IEEE Transactions* 53: 1002–1016.

Chadwick, A. 2009. Web 2.0: New challenges for the study of E-democracy in an era of informational exuberance. *Journal of Law and Policy for Information Society* 5: 9–42.

Cohen, J.E. 2003. Human population: The next half century. *Science* 302: 1172–1175.

Conkey, M.W. 1997. *Beyond art: Pleistocene image and symbol*. San Francisco: University of California Press.

Cooper, J.S. 2004. Babylonian beginnings: The origin of the cuneiform writing system in comparative perspective. In *The first writing: Script invention as history and process*, ed. S.D. Houston, 71–99. Cambridge: Cambridge University Press.

Corning, P. 2005. *Holistic Darwinism: Synergy, cybernetics, and the bioeconomics of evolution.* Chicago: University of Chicago Press.

Crafts, N. 2004. Steam as a general purpose technology: A growth accounting perspective. *The Economic Journal* 114: 338–351.

Dessalles, J-L. 2009. *Why we talk: The evolutionary origins of language*. Oxford: Oxford University Press.

Diamond, J. 1997. *Guns, germs, and steel: The fates of human societies*. New York: W.W. Norton & Company.

Diamond, J. and P. Bellwood. 2003. Farmers and their languages: The first expansions. *Science* 300: 597–603.

Dittmar, J.E. 2011. Information technology and economic change: the impact of the printing press. *The Quarterly Journal of Economics* 126: 1133–1172.

Dunbar, R. 2003. The social brain: Mind, language, and society in evolutionary Perspective. *Annual Review of Anthropology* 32: 163–181.

Dunbar, R. 2009. Why only humans have language. In *The prehistory of language*, ed. R. Botha and C. Knight, 12–35. Oxford: Oxford University Press.

Eisenstein, E.L. 1980. *The printing press as an agent of change*. Cambridge: Cambridge University Press.

Fountain, J.E., G. Bertucci, G.G. Curtin, Y.E. Hohlov, K. Holkeri, Y. Jarrar, J. Kang, et al. 2011. The future of government: Lessons learned from around the world. *World Economic Forum*. Geneva: World Economic Forum.

Gamble, C., J. Gowlett, and R. Dunbar. 2011. The social brain and the shape of the Paleolithic. *Cambridge Archaeological Journal* 21: 115–136.

Giannotti, F., A. Pedreschi, A. Pentland, P. Lukowicz, D. Kossmann, J. Crowley, and D. Helbing, D. 2012. A planetary nervous system for social mining and collective awareness. *The European Physical Journal Special Topics* 214: 49-75.

Glenn, J.C., T.J. Gordon, and E. Florescu. 2014. State of the future 2013–14. *The Millennium Project*.

Goertzel, B. 2002. *Creating internet intelligence: Wild computing, distributed digital consciousness, and the emerging global brain*. Dordrecht: Kluwer Academic Publishers.

Goetzberger, A., J. Luther, and G. Willeke, G. 2002. Solar cells: Past, present, future. *Solar Energy Materials and Solar Cells* 74: 1–11.

Graeber, D. 2004. *Fragments of an anarchist anthropology*. Chicago: Prickly Paradigm Press.

Gunaratne, S.A. 2001. Paper, printing, and the printing press: A horizontally integrative macrohistory analysis. *International Communication Gazette* 63: 459–479.

Haberl, H. 2006. The global socioeconomic energetic metabolism as a sustainability problem. *Energy* 31: 87–99.

Haralambopoulos, D.A. and H. Polatidis. 2003. Renewable energy projects: Structuring a multi-criteria group decision-making framework. *Renewable Energy* 28: 961–973.

Hanson, R. 1998. Long-term growth as a sequence of exponential modes. George Mason University. http://hanson.gmu.edu/longgrow.pdf (accessed: January 2, 2015).

Hanson, R. 2008. Economics of the singularity. *Spectrum, IEEE* 45: 45–60.

Heylighen, F. 1995. (Meta)systems as constraints on variation: A classification of natural history of metasystem transitions. *World Futures: the Journal of General Evolution* 45: 59-85.

Heylighen, F. 2000. Evolutionary transitions: How do levels of complexity emerge? *Complexity* 6: 53–57.

Heylighen, F. 2002. The global superorganism: An evolutionary-cybernetic model of the emerging network society. *Journal of Social and Evolutionary Systems* 6: 57–117.

Heylighen, F. 2008. Accelerating socio-technological evolution: From ephemeralization and stigmergy to the global brain. In *Globalization as evolutionary process*, ed. G. Modelsky, T. Devezas, T. and W.R. Thompson, 284–309. New York: Routledge.

Heylighen, F. 2011. Conceptions of a global brain: An historical review. In *Evolution: Cosmic, biological, and social*, ed. L.E. Grinin., R.L. Carneiro, A.V. Korotayev, and F. Spier, 274–289. Volgograd: Uchitel Publishing.

Heylighen, F. 2014a. Return to Eden? Promises and perils on the road to superintelligence. Forthcoming in B. Goertzel and T. Goertzel ed. *The end of the beginning: Society and economy on the brink of the Singularity*. Available on line at http://pespmc1.vub.ac.be/papers/brinkofsingularity.pdf (accessed: January 6, 2014).

Heylighen, F. 2014b. Challenge Propagation: Towards a theory of distributed intelligence and the global brain. *Spanda Journal* V: 1-18.

Heylighen, F. and D. Campbell. 1995. Selection of organization at the social level: Obstacles and facilitators of metasystem transitions. *World Futures: The Journal of General Evolution* 45: 181–212.

Joslyn, C., Heylighen, F. and Turchin, V. 1991. A short introduction to the Principia Cybernetica project. *Journal of Ideas* 1: 26–29.

Karns, M.P. and K.A. Mingst. 2004. *International organizations: The politics and processes of global governance*. London: Lynne Rienner Publishers.

Kende, M. 2012. *Internet global growth: Lessons for the future*. London: Analsys Mason Limited.

Kopetz, H. 2011. Internet of Things. *Real-Time Systems* 307–323.

Kortuem, G., F. Kawsar, D. Fitton, and V. Sundramoorthy. 2010. Smart objects as building blocks for the Internet of Things. *Internet Computing, IEEE* 14: 44–51.

Krahmann, E. 2003. National, regional, and global governance: One phenomenon or many? *Global Governance* 9: 323–346.

Landes, D.S. 1969. *The unbound Prometheus: Technological change and industrial development in Western Europe from 1750 to the present*. Cambridge: Cambridge University Press.

Last, C. 2014a. Global brain and the future of human society. *World Future Society*, 1–8. DOI: 10.1177/1946756714533207.

Last, C. 2014b. Human evolution, life history theory, and the end of biological reproduction. *Current Aging Science*, 7: 17–24.

Lathrop, D. and L. Ruma. 2010. *Open government: Collaboration, transparency, and participation in practice*. Sebastopol: O'Reilly Media, Inc.

Lewis, D. 2009. Solar grid parity. *Engineering & Technology* 4: 50–53.

Lewis, N.S. and D.G. Nocera. 2006. Power the planet: Chemical challenges in solar energy utilization. *Proceedings of the National Academy of Sciences* 103: 15729–15735.

Liang, T., X. Zheng, X. Jiangbin, T. Szu-Ting, W. Yue, L. Gang, R. Clair, and Y. Luping. 2010. For the bright future – bulk heterojunction polymer solar cells with power conversion efficiency of 7.4%. *Advanced Materials* 22: E135–E138.

Mann, M. 2012. *The sources of social power: Volume 3, Global empires and revolution, 1890-1945*. Cambridge: Cambridge University Press.

Margulis, L. and R. Fester, R. eds. 1991. *Symbiosis as a source of evolutionary innovation: Speciation and morphogenesis*. Massachusetts: MIT Press.

Mazower, M. 2012. *Governing the world: The history of an idea, 1815 to the present*. New York: Penguin.

McDougall, I., F.H. Brown, and J.G. Fleagle. 2005. Stratigraphic placement and age of modern humans from Kibish, Ethiopia. *Nature* 433: 733–736.

Miller, J.G. and J.L. Miller. 1990. The nature of living systems. *Behavioral Science*, 35: 157–163.

Modis, T. 2012. Why the Singularity cannot happen. In A.H. Eden, J.H. Moor, H. Soraker, and E. Steinhart ed. *Singularity hypotheses*, 101–126. Berlin: Springer.

Morris, I. 2011. *Why the West rules – for now: The patterns of history and what they reveal about the future*. Toronto: McClelland & Stewart.

Morton, O. 2006. Solar energy: A new day dawning?: Silicon Valley sunrise. *Nature* 443: 19–22.

Noveck, B. 2009. *Wiki Government: How technology can make government better, democracy stronger, and citizens more powerful*. Washington, DC: Brookings Institution Press.

Piketty, T. 2014. *Capital in the twenty-first century*. Cambridge, MA: The Belknap Press of Harvard University Press.

Pontzer, H., J. Scott, D. Lordkipanidze, and P. Ungar. 2011. Dental microwear texture analysis and diet in the Dmanisi hominins. *Journal of Human Evolution* 61: 683–687.

Putterman, L. 2008. Agriculture, diffusion, and development: Ripple effects of the Neolithic Revolution. *Economica* 75: 729–748.

Richerson, P.J. and R. Boyd, R. 2008. *Not by genes alone: How culture transformed human evolution*. Chicago: University of Chicago Press.

Rifkin, J. 2014. *The Zero Marginal Cost Society: The Internet of Things, The Collaborative Commons, and the Eclipse of Capitalism*. New York: Palgrave Macmillan.

Robertson, R. 2003. *The three waves of globalization: A history of a developing global consciousness*. London: Zed Books.

Sahel, A. and J.M. Simmons. 2011. Technology and architecture to enable the explosive growth of the Internet. *Communications Magazine, IEEE* 49: 126–132.

Schoeninger, M.J. 2012. Paleoanthropology: The ancestral dinner table. *Nature* 487: 42–43.

Şen, Z. 2004. Solar energy in progress and future research trends. *Progress in Energy and Combustion Science* 30: 367–416.

Singer, S., J. Denruyter, B. Jeffries. 2011. *The energy report: 100% renewable energy by 2050.* Gland: WWF International.

Smart, J. 2009. Evo devo universe? A framework for speculations on cosmic culture. In *Cosmos and culture: Cultural evolution in a cosmic context*, ed. S.J. Dick and M.L. Lupisella, pp. 201–296. Washington DC: NASA.

Smith, J.M. and E. Szathmáry. 1995. *The major transitions in evolution*. Oxford: Oxford University Press.

Stanish, C. 2002. *Ancient Titicaca: The evolution of complex society in southern Peru and northern Bolivia*. Berkeley: University of California Press.

Steele, T.E. 2010. A unique hominin menu dated to 1.95 million years ago. *Proceedings of the National Academy of Sciences* 107: 10771–10772.

Stewart, J. 2010. Foundational issues in enaction as a paradigm for cognitive science: From the origin of life to consciousness and writing. In *Enaction: Towards a new paradigm for cognitive science*, ed. J. Stewart, O. Gapenne, and E.A. Di Paolo, 1–32. Cambridge, MA: MIT Press.

Taagepera, R. 1979. Size and duration of empires: Growth-decline curves, 600 B.C.E. to 600 A.D. *Social Science History* 3: 115–138.

Taagepera, R. 1997. Expansion and contraction patterns of large polities: Context for Russia. *International Studies Quarterly* 41: 475–504.

Trigger, B.G. 2004. Writing systems: A case study in cultural evolution. In *The first writing: Script invention as history and process*, ed. S.D. Houston, 39–70. Cambridge: Cambridge University Press.

Turchin, V. 1977. *The phenomenon of science. A cybernetic approach to human evolution*. New York: Columbia University Press.

Turchin, V. 1999. A dialogue on metasystem transition. http://pespmc1.vub.ac.be/papers/turchin/dialog.pdf (accessed: October 6, 2014).

Ungar, P. 2012. Dental evidence for the reconstruction of diet in African early *Homo*. *Current Anthropology* 53: S318–S329.

Weiss, J. 2003. *Industrialization and globalization: Theory and evidence from developing countries*. New York: Routledge.

Winters, A.L. and Yusuf, S. eds. 2007. *Dancing with giants: China, India, and the global economy*. Washington DC: World Bank Publications.

Wrangham, R.W. 2009. *Catching fire: How cooking made us human*. New York: Basic Books.