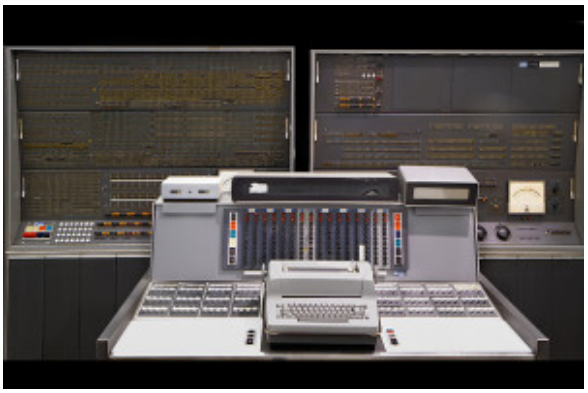
IIDE Proceedings 2014 – About IT Unemployment: Reflecting On Normative Aspects Of The 'Broken Link'



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The widespread use of information and communication technologies has given rise to some moral challenges that deserve particular attention. One such is the discrepancy between productivity growth and technological unemployment. This paper argues that if subsequent undesirable consequences of technological unemployment are to be avoided, there is a need for additional research to embed normative considerations into a scientific context, by linking technological progress with the 'Ought to Be' of the economic and societal order.

1. *Introduction*

Since the emergence of modernity and industrialism, humans have developed and introduced advanced machines to facilitate their work in various manners. Firstly, machines were created to replace human physical labor and "mechanization" became an integral element of our life. Secondly, "automatization" of human mental capabilities became an objective need to process and manipulate the vast amount of information. The introduction of various sophisticated information communication technologies (ICT) into human, social, business and industrial affairs created several kinds of effects with different degrees of predictability and desirability. For example, among positive ICT opportunities for human

development, Sartor (2012) highlights economic development, reduction of administrative costs, access to education and knowledge for everyone, elimination of distance, and moral progress. At the same time, technological development brings the risk of undesired consequences of technology use. Examples of the risks arising from the use of ICT include reduced privacy and increased control over individuals, discrimination and exclusion, ignorance and indifference, separation and loss of communication, class division, war and human distraction, and the undesired replacement of humans with ICT. Although these ICT risks can be seen as nightmares, some of them may soon become reality.

A key risk listed is when ICT replaces human labor which may potentially give rise to unwanted unemployment. Brynjolfsson and McAfee (2011; 2014) elaborate this extensively and raise an informative and provocative discussion by providing recent statistics on the effect of information technology on the level of employment, income distribution inequality, skills, wages and the economy. They identified that even if job creation in the US were to be doubled per month, it would take a few decades to fill the gap in employment opened by the last Great Recession. Moreover, although companies experience profit growth and continually invest in new technologies, the level of hiring people remains unchanged (ibid.).

Several decades ago, economic scholarship established a causal link between *IT deployment* contributing to *productivity gains* which in turn increase *market demand* and therefore *decrease unemployment* (Cesaratto et al., 2003). However, according to recent economic investigations, we are now experiencing, for the first time, early signals of a split of that correlation between productivity growth and the level of unemployment, due to technological advancement (Brynjolfsson and McAfee, 2011). It is projected that the increased use of IT and widespread automation will increase productivity and long-term structural unemployment at the same time (Brynjolfsson and McAfee, 2014). In accordance with the economic forecasts, spending on ICT will reach 5 trillion dollars by 2020 (Barnard, 2013). This is 1.7 trillion dollars more than it is today. At the same time, it is expected that GDP per capita will grow enormously in developed and developing countries. Yet, the effect of technological progress on the level of unemployment generation is anticipated to be tremendous for both developed and developing countries (The Economist, 2014, p. 7).

Although economic theories offer a set of different perspectives on the

relationship between productivity growth and technological unemployment (e.g. Postel-Vinay, 2002; Carré and Drouot, 2004; Vivarelli, 2007), it is still difficult to predict more exactly whether IT will give rise to massive unemployment or not, and in such a case how much. We know for sure that more and more job tasks previously conducted by humans are now conducted by machines. Example of such include self-checkout machines at the stores, online banking and mobile applications, automated telephone operators, self-service machines at the airports and terminals, data-driven healthcare, and software that substitutes various job tasks performed by lawyers, journalists and physicians (Autor and Dorn, 2013; Frey and Osborne, 2013). While we can clearly see that such automation reduces the number of workers needed to perform those tasks, we can also see new kind of job tasks and job profiles emerging – for example, someone is needed to design, construct and maintain the listed automations. A critical evaluation of current investigations into the risk of occupations disappearing due to technological progress reveals some challenges and questions; these in turn require more research to understand the phenomenon of IT-induced unemployment, its causes and its effects.

Besides, in a situation when a broken link between productivity growth and technological unemployment will be consistent, we may expect a long-term structural unemployment. In these conditions, economic, political and social systems will need to adapt to the new reality. " *If handled poorly, the widespread displacement of workers by technology could result in rapidly expanding economic divergence between rich and poor, economic poverty and social unrest for growing numbers of dislocated workers, backlashes against technology and social institutions, and economic and social decline.*" (Marchant et al., 2014, p. 27). Most of the debates regarding ICT-induced unemployment focus on whether that mechanism is really establishing itself now or not, and if so what the exact consequences will be and what the exact substitution mechanism is, e.g. which job task will be substituted and which not. There is much less debate, however, as to whether IT-generated job-elimination and a resulting massive unemployment is wanted or not? In this text, some suggestions will be developed to address this *question*.**[iii]**

The paper is organized as follows. The next section reviews economic theory on the link between productivity growth and technological displacement. This will be followed by a review of current empirical studies on technological displacement.

The conclusion made there is that IT has indeed brought a fundamental new feature to the relationship between technological development and social change. The next section reviews moral theories and then discusses contemporary challenges of computer ethics to align technological features and employment opportunities. This paper ends with a discussion where we advocate for taking into account ethical considerations in a scientific context as a necessary requirement to meet future consequences of technological unemployment.

2. *Technological Unemployment: Theoretical Prerequisites and Empirical Evidence*

This section deals with the economic theories which explore the link between productivity growth and technological unemployment. The purpose of this section is, by synthesizing and evaluating the existing body of research in the domain of the relationship between productivity growth and technological unemployment, to provide the reader with a broad theoretical framework, demonstrate theoretical pluralism and difficulties in reaching one conclusive message on the "broken" link. Further, in this section, an analysis of current investigations on the probability that jobs will disappear is conducted to show a potential risk of technological substitution. A critical evaluation of these studies lays a foundation for the investigation of the normative aspects of the current information society.

2.1 *Is Economic Theory Good Enough to explain the "Broken Link" and resolve its consequences?*

Since the economic community was the first to detect the threatening tendency of technological unemployment, its opinion deserves our attention in the first place. Since the late 18th century, the concept of "technological unemployment" has been widely deliberated among economic theorists and policymakers to understand the underlying reasons and predict the effect of technological change on the level of unemployment (Postel-Vinay, 2002). According to recent statistics, an increasing level of technological unemployment is a macroeconomic problem worldwide, especially in technologically advanced countries (The Economist, 2014). Social and economic consequences of those tendencies became a reason for a number of studies and calls for conferences, congresses and discussions at global level. Therefore, this section is based on the systematic review of papers that analyze changes in the level of unemployment due to technological advancement from several leading economic journals.

Review of literature demonstrates that the current theoretical regime has a set of

different conceptions; yet, two polar perspectives such as equilibrium and disequilibrium have been formulated in economic literature (Appendix 1). Both controversial standpoints can be explained by the differences in views on the nature of the relationships between technological progress and level of employment. For example, neoclassical economists believe that IT progress is always beneficial to employment as markets can work freely and competitively. Supporters of the Ricardian view argue that since automatic compensating factors are generally absent, innovations and IT progress are harmful for employment, and are possible causes of long-term unemployment. Proponents of the Neo-Schumpeterian approach believe that technological unemployment is a transitory phenomenon and a compensation mechanism for employment through effective demand will eventually stabilize the level of employment. Finally, followers of the Keynesian tradition claim that high growth rates of output can, in principle, compensate decreasing labor requirements in the long-run.

In more detail, proponents of the equilibrium perspective believe that while technological progress destroys jobs, new occupations emerge that can employ the released labor force (e.g. Kreickemeier and Nelson, 2006; Michelacci and Lopez-Salido, 2007; Barnichon, 2010). Different arguments have been provided to support the equilibrium perspective. For example, Stadler and Wapler (2004) believe that a general-equilibrium model of endogenous skilled-biased technological change provides a reduction in high-skilled unemployment through reduction of wages and the creation of new positions. The relationship between technological progress, productivity growth and technological unemployment was challenged by Barnichon (2010) and Canova et al. (2013) who emphasize that the conventional way of modeling the technological effect on unemployment does not work, because the market responds differently to neutral and investment-specific shocks. However, eventually, technological and non-technological shocks balance the link between productivity and unemployment.

Despite the seemingly simple explanation of the relationships between productivity growth and the level of employment, the economy of individual countries is more complex and depends on various macroeconomic and microeconomic adjustment mechanisms. Supporters of the disequilibrium perspective refer to statistics and emphasize that it is difficult to predict innovations, extrapolate technology from other macroeconomic effects and that IT progress can lead to a jobless world (e.g. Vivarelli, 2007; Baddeley, 2008;

Shahkooh et al., 2008; Pavisou et al., 2011). Although economic theorists develop and test different theoretical hypotheses on the relationships between technological progress, productivity growth and technological unemployment, Brynjolfsson and McAfee (2011) claim that technological innovation sped up too fast and left a lot of workers behind. By searching the reason for the high level of technological unemployment, beside cyclicality and stagnation of the economy, they highlight the threat of the "end of work". According to the study, technological displacement due to technological progress is observed in all sectors of the economy. The core implication of this displacement is the fact that fewer and fewer workers will be required to produce goods and services which will lead to "near-workerless" world.

Given the above, empirical proof of the link between technological progress and unemployment remains an open question for debate. Some researchers claim that technological progress mostly leads to restructuring of job markets (e.g. Peláez and Kyriakou, 2008; Ott, 2012). Proponents of the technological revolution believe that technological progress stimulates consumer demand through cheaper products. As a consequence, new markets will be created and people will be able to find highly-paid working places in other spheres of employment. So-called fatalists of technological advancement emphasize that while productivity growth is increasing, more and more people become jobless and their leisure is not provided as expected (Aronowitz and DeFazio, 2010; Brynjolfsson and McAfee, 2011). Given these points at the present time, and by applying different theoretical prerequisites, researchers are not able to present a single answer as to whether IT will give rise to massive unemployment or not. Therefore, there is a need to look into empirical data of technological displacement. Below, studies on how technological advancement can transform the structure of employment are reviewed and through critical analysis a set of research questions that require further clarification in order to understand the phenomenon of IT induced unemployment are identified.

2.2 *Empirical Evidence on Technological Unemployment and a Need for Further Research*

The desire of humans to create some powerful engine, an inexhaustible source of energy or labor-saving machine is understandable. Hard physical or dangerous jobs and repetitive mental work have forced humans to carry out an enormous number of studies of technological development. As computers have extensive

machine memory and perform some tasks much faster than humans; engineering, finance, insurance and accounting activities are no longer possible without electronic machines. From the point of view of any company owner, it is reasonable to spend some assets on technologies, rather than employ costly personnel. This can be explained by the fact that: "*…machines require no wages or benefits, take no sick days or vacations, provide a consistent, highly reliable quality of work for up to twenty-four hours a day, seven days a week if needed, and incur no injuries…*" (Marchant et al., 2014, p. 28). Yet, new technologies are costly and require essential expenditures on their purchase and maintenance. Employees from their side prefer to be competitive on the labor market to ensure long-term employment. Therefore, both sides need knowledge to predict which changes can bring technological progress to the labor market and which professions will be able to survive.

At this time, human society is at a new stage in world history where computer technologies change the specificity of labor and the economy in general (Autor et al., 2003; Goos and Manning, 2007; Frey and Osborne, 2013). Computers become not only complements but also fully substitute some jobs. This fact would not deserve so much attention if computers could only substitute the manual workforce. New computers become more competitive with the human brain in such areas as law, financial and banking services, wholesale, medicine and education (Rotman, 2013). Driverless cars developed by Google (Frey and Osborne, 2013), hospital robots (Bloss, 2011), powerful, intelligent robots with a learning capability and which behave in a manner similar to human beings (Peláez and Kyriakou, 2008) are only a few examples of current technological achievements we are likely to see before too long.

In his book, *Nye* (2006) reflects upon current changes in the labor market, caused by technology implementation and their consequences on working conditions, technological efficiency and production system. Drawing the line from factor production through Taylorism, Ford's assembly line, lean and just-in-time production, the author summarizes some principal characteristics of widespread computerization which are similar to the industrialization effect. Among these are unemployment of skilled artisans, monotonous low-wage work for others, high wages for a few mechanics, some new jobs in the hierarchy and the shift to white-collar work. Among those changes due to technology implementation a high level of job elimination is observed. Thus, the question: "*…will all the jobs disappear*

due to computer substitution?" (p. 118), as pointed out by Nye, sounds quite rational.

There is a growing concern among the research community on how the structure of employment will be changed due to computerization. For example, (Goos and Manning, 2007) noticed that there is a growing labor market polarization between high-income cognitive jobs and low-income manual professions. Frey and Osborne (2013) reached a conclusion that among 702 occupations in the US, 47% of current occupations are at risk of disappearing. It is projected that occupations such as transportation and logistics, office and administrative work, production occupations are at great risk of vanishing. By studying the structural shift in the labor market, Autor and Dorn (2013) noticed that by 2050, 80% of activities in the automotive sector, 70% in oil, chemicals, coal, rubber, metal and plastic products, shoe and textile sectors, 60% in security, surveillance and defense sector, 45% in the health care sector and 30% in tourism will be substituted by computers. Brussels European and Global Economic Laboratory identified that over the coming decades, almost 50% of occupations in Sweden, the UK, the Netherlands, France and Denmark will be fully automated. Under the highest risk are such countries as Romania, Portugal, Croatia and Bulgaria, where almost 60% of occupations are expected to be substituted by new technologies.

The statistics on technological displacement developed by current studies are frightening. However, what we have today is only an occupation's probability of computerization. What we are experiencing now is a lack of knowledge on the dynamics of killing and creating jobs. A set of questions is still unanswered. Namely, we lack precise knowledge about:

* What kinds of jobs have been killed by technological advancement?
* What is the rationale and dynamics of killing jobs?
* What kinds of jobs currently exist?
* What kinds of jobs are subject to being fully or partly substituted by computers and why?
* What kinds of jobs are most probably not subject to substitution by automation in the near future and why?
* What kinds of jobs are created and what are the conditions for their creation?
* Will there be sufficient work opportunities on the labor market for all citizens in the future?

What is clear is that technological progress leads to vast changes in the nature of work, leisure time and the way we consider social issues (Aronowitz and DeFazio, 2010). Therefore, there is a need for an increased understanding of the ongoing trend and underlying mechanisms of technological displacement.

All the above-mentioned studies support the idea that occupations which require involvement of creative and social intelligence, have a chance of surviving on the labor market. Currently, companies more and more seek inventors and creative employees, rather than simple technicians. One of the core ideas widely discussed among policymakers is to equip the next generation of employees with special knowledge and skills to fill in a skill gap in non-routine task performance. Yet, little attention is paid to that fact that humans have different mental abilities. New educational programs exclude some humans from workplaces where high creativity and education are preliminary requirements. Moreover, there are no recommendations where those people can be employed to at least provide their basic needs. Hence, the problem of the effect of technological advancement on the level of employment is complex and requires comprehensive insights. It is not enough to conduct economic and operational research, we also need to include social, political and ethical characteristics into our investigations.

It is well known that the economy cannot function effectively when social tension increases. Undoubtedly, it is impossible to reduce social tension without solving economic problems, especially unemployment. Nowadays, it is widely applicable to introduce employment protection reforms and active labor market programs (Sianesi, 2008). However, these attempts demonstrate that although economists and politicians are aware of the problem they are not well-prepared to respond in a timely fashion to current complex problems of technological unemployment (The Economist, 2014).

The technological paradise has not brought the joy and relief of work as expected, but instead a lot of troubles and worries. When we consider research into technological development, increasing investments in new technologies, efficient use of those technologies, we unconsciously expect higher living standards. However, access to the benefits of technological progress is limited and people are faced with the negative consequences of technological unemployment (Nilsson and Agell, 2003; De Witte, 2005; Eliason and Storrie, 2009). Job instability and wage inequality are constant companions in our life. Some researchers emphasize that the race between technological progress and

employment is a never-ending challenge (Pianta, 2005), yet must be acknowledged and addressed as one of the most important factors of social stability. Hence, the question of what recent technological advancement has brought to the labor market, humans and society as a whole is under investigation and requires detailed consideration by different research communities if they are to be able to react to turbulent changes in a timely manner.

3. *Questioning Traditional Moral Principles towards the Alignment of New Features and Employment Opportunities of Technological Advancement*

The existence of human labor can simply be explained by the provision of basic needs such as food, clothes and accommodation. With the development of living standards and satisfaction of basic needs new motivators such as self-realization and self-actualization have come into play. After some point, the idea that everyone has to be employed became an axiom and is still valid today. New features of the information age, such as easy access to information, the Internet, the digitization of working places, cheap storage, processing and transmission capacity of modern ICT (Schienstock et al., 1999) made their own impact on the nature of labor in general and on the employment structure in particular. Although these features brought new opportunities, they also created challenges to rely on traditional moral concepts (Johnson, 2001). While the shift to the information society has already occurred, social and ethical implications of ICT are still not well established (Bynum and Rogerson, 2004). Therefore, we will discuss in this section theoretical prerequisites of moral principles on human beings and labor, how technological advancement has challenged them and possible ways to modify and re-interpret them in relation to the current situation of technological unemployment.

Have computers brought special moral issues that require development of a new and independent branch of moral philosophy? This question has been addressed by many scientists of both computer science and philosophy. For example Tavani (2001, 2002), taking a middle ground position, mentioned the spectrum of opinions regarding computer ethics. On one side of this spectrum are the so-called traditionalists who believe that the shift to the information age did not bring any new issues about moral norms and rules, and that traditional ethical principles are quite applicable (Adam, 2001). On the other side we find the scientists who claim that computers have brought special and unique aspects that require a new field of research in philosophy (Johnson, 2001; Bynum and

Rogerson, 2004; Gorniak-Kocikowska, 2007). Unlike those polar standpoints, Floridi and Sanders (2002) came to the conclusion that although computer ethics issues are not incredibly unique, they challenge standard macro-ethics. Eventually, Bynum (2001) highlights that when computer technologies are widely implemented in our life, computer ethics will be dissolved into ordinary ethics.

Yet, the intention of this paper is not to discuss whether computer ethics have the right to be an independent field of moral philosophy. Its aim is to challenge general moral attitudes in relation to an increasing rate of technological unemployment. Although for some social classes computerization has brought new opportunities and increased income, for others the effect of computerization is the opposite. Which ethics will help us avoid policy and economic vacuums and formulate new social policies in responsible ways to new technological features? It becomes more accepted that new features of technological advancement and new opportunities cannot be supported by a common moral system (Bynum and Rogerson, 2004). Therefore, current moral landscape and the broken link between productivity growth and technological unemployment is exactly an issue that deserves particular attention from the economic, philosophical and IS communities.

The Association of Computing Machinery, the Information Technology Association of America, the Data Processing Management Association, and International Federation on Information Processing are organizations that develop and reconsider codes on computer ethics. Privacy, accuracy, security, reliability, intellectual property are core issues which form the basis of codes of computer ethics with regard to the micro level (Johnson, 2001). The main postulate of these codes from a macro-perspective is that computer technologies are not supposed to produce side effects that harm humans and society. However, current data demonstrates that widespread use of computers has led to technological unemployment. Job insecurity has a set of negative effects on health and well-being (De Witte, 2005). Job losses increase the rate of suicide, alcohol-related mortality (Eliason and Storrie, 2009) and crime (Nilsson and Agell, 2003). Thus, the most negative effect of unemployment is on psychological well-being of humans when people cannot meet their financial obligations; their social position becomes worse, people are insecure in their future. Hence, the question arises: why should people experience such emotional traumas in a society where productivity is growing and living standards are improving?

The EU's core principles of sustainable peace, social freedom, consensual democracy, associative human rights, and supranational rule of law, inclusive equality, social solidarity, sustainable development and good governance are all based on the pluralist approach of normative moral principles (Manners, 2008). All those traditional norms and laws had been functioning for a long time before the emergence of computers. The computer age brought new entities, features and ways of doing things. The high speed of development and the implementation of new technologies led to a situation where society cannot appropriately react to changing conditions. Moreover, it became difficult to draw on traditional moral systems to avoid policy and economic vacuums.

In a situation of potential risk for the destruction of workplaces by automation and generation of mass unemployment, policymakers have a number of alternatives. One of the unrealistic scenarios could be based on the limitation of automation and keeping available working places. In a more realistic scenario, policymakers can facilitate creation of new kinds of jobs while the older ones are being eliminated. Yet, another scenario can be assumed, such as a new societal order, where citizens are supported with the basic needs by the state. This scenario is presented in more detail below.

New changes in the level of employment and its structure introduced by IT gave rise to questions on the norm and right as to whether everyone needs to work for a living. Although the notion of everyone being employed is rather a new invention of western societies, in general, our society has a predominant market orientation and uses functionalist and instrumental views on humans (O'Donnell and Henriksen, 2002). People are mostly evaluated by their input to society and methods of distribution became unfair (Johnson, 2001, p. 36). "*We are now in the middle of a paradigmatic struggle. Challenged is the enriched utilitarian, rationalistic-individualistic and neoclassical paradigm which is applied not merely to the economy, but also, increasingly, to the full array of social relations*" (Etzioni, 2010, p. ix). New situations where forthcoming IT may eliminate jobs, create unfamiliar ethical issues. When we are faced with unfamiliar ethical problems we apply analogies known from the past and if that is not possible there is a call to reconsider and discover new moral and ethical values (Manners, 2008). Moreover, when people discuss ethical issues they have very little knowledge about the underlying reasons of why specific behavior is wrong or unfair Johnson (2001). Thus, we have to come to a common understanding on what we actually

want from technological progress.

An assumption that the effective economic system may lead to global prosperity and equality failed during the last Great Depression in 2008. Global inequality becomes a real problem. Therefore, global ICT ethics have to focus on the relationships "*… between the weak and the strong, the rich and the poor, the healthy and the sick worldwide – and it should explore the ethical problems from the point of view of both parties involved*" (Gorniak-Kocikowska 2007, p. 56). We have to accept that human life has the highest value despite its contribution to society. One of the potential practical solutions to the problem of technological unemployment could be the widespread introduction of basic security income as a basic human right (Van Parijs, 2004; Standig, 2005), so people can feel equally secure and still have purchase capability. Of course, this requires some knowledge of how to introduce this system and not destroy the intrinsic motivation of people to express their creativity in a socially useful form. Yet, some empirical evidence demonstrates that people want to contribute in a positive way to increase their minimal income. Surely, the process of reconsideration, modification and re-interpretation of moral principles is long and requires active participation of the whole global community (Bynum and Rogerson, 2004). Yet, while we will not challenge them, the global economy will continue to deteriorate, people will suffer from the lack of working places and tension in society will grow.

It is presumed that technological advancement will further transform the structure of employment and, most probably, the downward tendency of available working places will be checked. However, this seemingly horrifying tendency may be approached from a recognition that decreasing employment level is not only a matter of what IT is capable of doing or not. It is rather a matter of what society wants to happen. Do we want to keep people busy working, or do we want to free them up from the need to work and let them enjoy improved living standards due to technological advancement? More and more academics emphasize the need to take into account a human position as the basic and the most valuable unit of analysis to align technological features and new technological possibilities. These new ethical and social issues caused by IT development force us to search for new solutions from the core normative ethical premises on what is "right" and "wrong" for humans in the information society.

4. *Concluding Remarks and Some Thoughts about the Near Future*

Despite the destructive potential and risks of technological unemployment such as

social tension and differentiation, physical and mental illness and the growing level of crime, we cannot neglect some positive consequences such as totally new occupations, competition, and reconsidered value of labor and leisure. When we refer to technological advancement, we have to take into account the value of technologies which substituted people in heavy, dirty and dangerous work (Carro Fernandez et al., 2012). Many lives were saved through health information technologies. Telecommuting became one of the main factors of lower work-family conflicts and higher job satisfaction through flexible work arrangements (Severin and Glaser, 2009). Increased speed of communication allowed us to take place over distances and make decisions much faster. In relation to this, we can already admire some positive effects of computerization. Yet, according to the economic forecast, the number of workplaces will decrease enormously for both routine and non-routine work, and new workplaces will not be able to absorb all the unemployed. Therefore, the questions arise: what changes do we expect in the level of employment in the near future and how can we cope with them? Some key thoughts in favor of current changes brought about by technological advancement in the sphere of employment will be found below. The text ends with suggestions for further research about the interplay between computerization, productivity growth, technological unemployment and the societal consequences.

Appendix 1 [a]

Firstly, we can suppose that Brynjolfsson and McAfee (2011) cannot support their prediction that productivity growth and the level of employment do not have correlation anymore. This prediction is mostly based on historical patterns. Yet, it is quite difficult, if not impossible, to predict technological development and the

consequences of its use (Soete, 2001; Nye, 2006). Moreover, as we can observe from previous studies, it is extremely difficult to predict the precise effect of technological advancement on the structural and occupational composition of employment. One of the reasons for this challenge is much higher speed of technological development in comparison to knowledge development. The second reason for this is a challenge to extract the impact of technologies from other economic effects. Yet, there is still a consensus among policymakers, economists and academics that new ICT is important for both productivity growth and employment.

Appendix 1 [b]

Secondly, although technological unemployment is empirically observed, and as such a fact, it does not imply that all humanly conducted activities may or will be automated, indeed there still are many humanly conducted activities that cannot be automated at this time, such as the generation of new hypotheses or the transfer of tacit knowledge. In this line, Levy and Murnane, (2004) point out that though new technological paradigm change, the structure of employment and the demand for managerial, professional and technical occupations will grow. Computers are only complements of skills extension in the context of such non-routine work tasks (Autor, 2003). Another important issue to discuss is the automation of tasks in nursing and healthcare. Although a wide implementation of technologies in health care was expected, a considerable share of projects failed (Murray et al., 2011). That happened partly due to patients' mistrust of physicians using a computer-assisted diagnostic aid (Arkes et al., 2007), hence it does not matter if ICT automates a job task, if we do not accept it. Some occupations, such as dentists or recreational therapists cannot be replaced as their work requires hand-eye coordination and dexterity. In addition to the above-mentioned, we have to acknowledge that the implementation and maintenance of modern technologies

are quite costly and labor-demanding (Carro Fernandez et al., 2012). In conclusion, the forces that hinder or slow down automation include the current impossibility of automating certain work-tasks, and even if they can be automated, we may not wish to automate all of them, and then the significant costs inherent in automation and its maintenance. Therefore, we can predict that some human jobs will exist, at least for some time, despite a broader use of advanced technologies. Yet, from that we cannot derive that the initiated structural transformation of occupations will not continue, more likely the opposite.

Appendix 1 [3]

Thirdly, as human nature is characterized by a high level of adaptation and entrepreneurship, it is expected that the market of the digital workforce will expand. This will create new working places where the workforce can be re-deployed. Emerged information-service industries such as the software industry and the microelectronic industry will provide new opportunities for employing people. For example, it is projected that by 2018 the US labor market will have a shortage of 1.5 million data-savvy managers (Manyika et al, 2011). Many government unemployment diminishing policies and programs are devoted to the creation of new workplaces, education update and re-qualifying. For example, an electronic industrial strategy for growth of the micro- and nano-electronics components and systems industry in Europe to boost productivity, growth and jobs was adopted by the European Commission in 2013. The main purpose of this strategy is not only to facilitate investments in the industry, but also to create 250.000 jobs by 2020. Furthermore, Nye (2006) prescribes that a lack of jobs is a temporary situation while economists and politicians learn how to use advanced technologies in the best way.

Fourthly, a few attempts have been made towards stabilizing the level of

unemployment in advanced economies. For example, some countries such as France and Switzerland decreased working hours and, thus, tried to share the work among employees, yet keeping the same income as before (Van den Besselaar, 1997). Interestingly, the results of this practice were neither good nor bad. (Rifkin, 2001). Another promising attempt is the introduction of a basic secure income. This practice is intended to provide a reasonable income for everyone to satisfy basic needs. Eventually, it is expected that this practice will enforce humans to develop their capabilities and competencies in a society of rising prosperity. Yet, this will require reconsideration of other policies. Will human society be able to create a stable global society where man and machine can coexist with each other, to provide everyone with beneficial results? Undoubtedly, different scenarios of the future can be conceived and discussed. The stake here is no less if we wish to establish societies where social inequality grows and brings social unrest or if we seek societies where the highest value is human life and equal rights and opportunities to everyone.

Brynjolfsson and McAfee, 2011	The US data	Cyclicality, stagnation and the "end of work"	The pace of technological innovation is extremely high and leaves people behind.	IT advancement leads to Great Restructuring and indeed to unemployment growth. Compensation mechanisms cannot compete anymore with machines.
Weiss and Garloff, 2011	The US and Europe data	A model of differential dynamics of unemployment and wage inequality	Skill-biased technological change increases productivity of skilled workers faster than unskilled but the wage of unskilled workers increases faster than their productivity. All this leads to the increase of unemployment of unskilled labor.	Skill-biased technological change, indeed, increases the level of unemployment of unskilled labor force.

Appendix 1 [d]

Fifthly, and finally, technology is a part of social evolution (Nye, 2006), yet it forces us to "*…reconstruct our environment and to reconsider the ethical foundations of techno-economic decisions…*" (Peláez and Kyriakou, 2008, p. 1192). Both blandness of human thinking and desire for profit from individuals who have access to technological advancement make the process of moral principles re-consideration difficult. Instead of competing with machines, we have to accept a future of prolonged education, early retirement and free time. Yet, it will take time to establish acceptance for a desire for an integrative and harmonious society, where humans and machines can complement each other. Probably, together with a search for the reasons for technological unemployment and what the underlying economic theory is, we should focus on the human position in socioeconomic relationships and challenge normative assumptions of our expectations of technological progress. Brynjolfsson and McAfee (2014) claim that digitization of society will force us to reinvent social and economic life.

Furthermore, a new information age will change our consciousness about technological, societal and economic issues.

Given the above, we have to recognize that if we do not act now, but wait for years to see what the actual outcome of the present technology induced transformation will lead to, we may find us in societal and economic conditions that are highly undesirable; and it may be too late to address it then. Therefore, in order for the policymakers to make informed decisions there is a need to conduct investigations aimed to provide us with additional understanding of the underlying mechanism of the ongoing tendency. At the same time, we have to recognize that economic and societal mechanisms of technology adoption, productivity gains and unemployment are not governed by isolated deterministic laws, which implies that it is not enough to understand the ongoing tendency. It is also necessary to acknowledge what kind of economic and societal features are desirable with regard to moral considerations. Based on this knowledge, we may be able to develop future scenarios to bridge the current situation to what we desire from technological progress.

NOTES

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iii. This elaboration explicitly assumes a relationship between science, ethics and society, as justified by Nowotny et al. (2001), who noticed an increasing orientation of science systems towards the production of knowledge that is socially distributed and highly interactive. It is acknowledged by scientists that contemporary scientific practice has to be oriented towards research which satisfies the requirements, needs and goals of society (Hessels and Van Lente, 2008). As technology development strongly depends on science (Munoz, 2004), we assume that both have to serve the well-being of humankind.

REFERENCES

Adam, A. (2001). Computer ethics in a different voice. *Information and Organization*, 11(4), 235-261.

Alexopoulos, M. (2003). Growth and unemployment in a shirking efficiency wage model. *The Canadian Journal of Economics / Revue canadienne d'Economique*, 36(3), 728-746.

Arkes, H., Shaffer, V. A. & Medow, M. A. (2007). Patients derogate physicians who use a computer-assisted diagnostic aid. *Medical Decision Making,* 27, 189–202.
Aronowitz, S. & DeFazio, W. (2010). *The Jobless Future.* University of Minnesota Press, Minneapolis, MN.
Autor, D. & Dorn, D. (2013). The growth of low skill service jobs and the polarization of the labor market. *American Economic Review,* 103(5), 1553-1597.
Autor, D. H., Levy, F. & Murnane, R.J. (2003). The skill content of recent technological change: an empirical exploration. *Quarterly Journal of Economics*, 118(4), 1279-1333.
Baddeley, M.C. (2008). Structural shifts in UK unemployment 1979–2005: The twin impacts of financial deregulation and computerization. *Bulletin of Economic Research*, 60(2), 123-157.
Barnard, C. (2013). The changing ICT world and services transformation. *Annual Review of European Telecommunications and Networking, IDC EMEA*, 16-17.
Barnichon, R. (2010). Productivity and unemployment over the business cycle. *Journal of Monetary Economics*, 57, 1013-1025.
Bauer, T.K. & Bender, S. (2004). Technological change, organizational change, and job turnover. *Labor Economics*, 11(3), 265-291.
Bloss, R. (2011). Mobile hospital robots cure numerous logistics needs. *Industrial Robot: An International Journal,* 38(6), 567-571.
Brynjolfsson, E. & McAfee, A. (2011). *Race against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and The Economy.* Digital Frontier Press.
Brynjolfsson, E. & McAfee, A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies.* WW Norton & Company.
Bynum, T.W. & Rogerson, S. (2004). *Computer Ethics and Professional Responsibility.* Blackwell Published Ltd.
Bynum, T.W. (2001). Computer ethics: its birth and its future. *Ethics and Information Technology*, 3, 109-112.
Canova, F., Lopez-Salido, D. & Michelacci, C. (2013). The ins and outs of unemployment: an analysis conditional on technology shocks. *Economic Journal*, 123(569), 515-539.
Carre, M. & Drouot, D. (2004). Pace versus type: the effect of economic growth on unemployment and wage patterns. *Review of Economics Dynamics,* 7(3), 737-757.
Carro Fernandez, G., Gutierrez, S.M., Ruiz, E.S., Mur Perez, F. & Castro Gil, M. (2012). Robotics, the new industrial revolution. IEEE *Technology and Society*

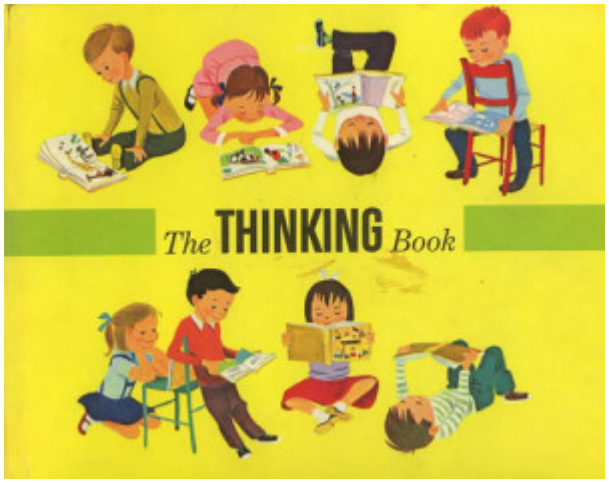
Magazine, 2, 51-58.
Cesaratto, S., Serrano, F. & Stirati, A. (2003). Technical change, effective demand and employment. *Review of Political Economy*, 5(1), 33-52.
De Witte, H. (2005). Job insecurity: review of the international literature on definitions, prevalence, antecedents and consequences. *Journal of Industrial Psychology*, 31(4), 1-6.
Eliason, M. & Storrie, D. (2009). Does job loss shorten life? *Journal of Human Resources,* 44(2), 277-302.
Etzioni, A. (2010). *The Moral Dimension: Toward a New Economics.* New York: The Free Press.
Fernandez-de-Cordoba, G. & Moreno-Garcıa, E. (2006). Union games: technological unemployment, *Economic Theory,* 27, 359–373.
Floridi, L., & Sanders, J. W. (2002). Mapping the foundationalist debate in computer ethics. *Ethics and information Technology*, 4(1), 1-9.
Frey, C. B. & Osborne, M.A. (2013). *The future of employment: how susceptible are jobs to computerization?* Available at: http://assets.careerspot.com.au/files/news/The_Future_of_Employment_OMS_Working_Paper_1.pdf
Goos, M. & Manning, A. (2007). Lousy and lovely jobs: the rising polarization of work in Britain. *The Review of Economics and Statistics*, 89(1), 118-133.
Gorniak-Kocikowska, K. (2007). From computer ethics to the ethics of global ICT society. *Ethics of Global ICT Society*, 25(1), 47-57.
Hessels, L. K. & Van Lente, H. (2008). Re-thinking new knowledge production: a literature review and a research agenda. *Research Policy,* 37(4), 740-760.
Johnson, D.G. (2001). *Computer Ethics*, 3d ed., Printice-Hall, Upper Saddle River, New Jersey.
Kreickemeier, U. & Nelson, D. (2006). Fair wages, unemployment and technological change in a global economy. *Journal of International Economics*, 70, 451-469.
Levy, F. & Murnane, R. (2004). *The New Division of Labor: How Computers Are Creating the Next Job Market*. Princeton University Press.
Manners, I. A. (2008). The normative ethics of the European Union. *International Affairs,* 84(1), 45-60.
Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C. & Byers, A. H. (2011). *Big data: the next frontier for innovation, competition, and productivity,* McKinsey Global Institute. Available at: http://www.mckinsey.com/insights/mgi/research/technology_and_innovation/big_d

ata_the_next_frontier_for_innovation.
Marchant, G.E., Stevens, Y.A. & Hennessy, J.M. (2014). Technology, unemployment and policy options: navigating the transition to a better world. *Journal of Evaluation and Technology,* 1, 26-44.
Merlino, L.P. (2010). *Unemployment Responses to Skill-Biased Technological Change: Directed versus Undirected Search*. Mimeo.
Michelacci, C. & Lopez-Salido, D. (2007). Technology shocks and job flows. *Review of Economic Studies,* 74, 1195-1227.
Moore, M.P. & Ranjan, P. (2005). Globalisation vs skill-biased technological change: implications for unemployment and wage inequality. *The Economic Journal,* 115(503), 391-422.
Munoz, J.M.V. (2004). Which ethics will survive in our technological society? *IEEE Technology and Society Magazine*, 1, 36-39.
Murray E, Burns J, May C, Finch T, O'Donnell C, Wallace P. & Mair F. (2011). Why is it difficult to implement e-health initiatives? A qualitative study. *Implementation Science*, 6(6), 1-11.
Nilsson, A. & Agell, J. (2003). Crime, unemployment and labor market pro-grams in turbulent times, *Working paper №14*, IFAU, Uppsala.
Nowotny, H., Scott, P. & Gibbons, M. (2001). *Re-thinking Science: Knowledge and the Public in an Age of Uncertainty*, Cambridge: Polity Press.
Nye, D. E. (2006). *Technology Matters: Questions to Live with* (pp. 194-198). Cambridge, MA: MIT Press.
O'Donnell, D. & Henriksen, L.B. (2002). Philosophical foundations for a critical evaluation of the social impact of ICT. *Journal of Information Technology,* 17, 89-99.
Ott, I. (2012). Service robotics: an emergent technology field at the interface between industry and services. *International Journal of Ethics of Science and Technology Assessment,* 9(3-4), 212-229.
Pavisou, N-E., Tsaliki, P.V. & Vardalachakis, I. N. (2011). Technical Change, unemployment and labor skills. *International Journal of Social Economics,* 38(7), 595-606.
Peláez, A.L. & Kyriakou, D. (2008). Robots, Genes and bytes: technology development and social changes towards the year 2020. *Technological Forecasting and Social Change*, 75(8), 1176–1201.
Pianta, M. (2005). Innovation and Employment, Chapter 22 in Fagerberg, J., D.C. Mowery and R.R. Nelson (eds.): *The Oxford Handbook of Innovation,* Oxford University Press, Oxford, New York 2005.

Pierrard, O. & Sneessen, H. (2003). Low-skilled unemployment, biased technological shocks and job competition, *IZA Discussion Paper* 784, Institute for the Study of Labor.
Postel-Vinay, F. (2002). The dynamics of technological unemployment. *International Economic Review*, 43(3), 737–760.
Prat, J. (2007). The impact of disembodied technological progress on unemployment. *Review of Economic Dynamics,* 10(1), 106-125.
Rifkin, J. (2001). *The Age of Access: The New Culture of Hypercapitalism, Where all of Life is a Paid-For Experience*, New York: J.P. Tarcher/Putnam.
Riley, R. & Young, G. (2007). Skill heterogeneity and equilibrium unemployment. *Oxford Economic Papers*, 59, 702-725.
Rotman, D. (2013). *How technology is destroying jobs.* MIT Technology Review.
Sarget, T.C. (2000). Structural unemployment and technological change in Canada 1990-1999. *Canadian Public Policy,* 26, S109-S123.
Sartor, G. (2012). Human Rights in the Information Society: Utopias, Dystopias and Human Values. Chapter 15 in *Philosophical Dimensions of Human Rights: Some Contemporary Views.* Ed by Corradetti, C. Springer Dordrecht Heidelberg, London, New York.
Schienstock, G.; Bechmann, G. & Frederichs, G. (1999). Information Society, Work and the Generation of New Forms of Social Exclusion (SOWING) – the Theoretical Approach. *TADatenbank-Nachrichten,* NR 1, 8. Jg., März 1999.
Severin, H. & Glaser, J. (2009). Home-based telecommuting and quality of life: further evidence on an employee-oriented human resource practice. *Psychological Reports*, 104(2), 811-821.
Shahkooh, K.A., Azadnia, M. & Shahkooh, S.A. (2008). An investigation into the effect of information technology on the rate of unemployment. *Proceedings of Third 2008 International Conference on Convergence and Hybrid Information Technology*, 61-65.
Sianesi, B. (2008). Differential effects of active labor market programs for the unemployed. *Labor Economics,* 15(3), 370-399.
Soete, L. (2001). ICTs, knowledge work and employment: the challenges to Europe. *International Labor Review*, 140(2), 143-163.
Stadler, M., & Wapler, R. (2004). Endogenous skilled-biased technological change and matching unemployment*. Journal of Economics,* 81(1), 1-24.
Standing, G. (2005). Why basic income is needed for a right to work. *Rutgers Journal of Law and Urban Policy,* 2(1), 91-102.
Tavani, H. T. (2001). The state of computer ethics as a philosophical field of

inquiry: some contemporary perspectives, future projections, and current resources. *Ethics and Information Technology*, 3(2), 97-108.
Tavani, H. T. (2002). The uniqueness debate in computer ethics: what exactly is at issue, and why does it matter? *Ethics and Information Technology*, 4(1), 37-54.
The Economist. (2014). Coming to an office near you, January 18, 7-8.
Van den Besselaar, P. (1997). The future of employment in the information society: a comparative, longitudinal and multi-level study. *Journal of Information Science*, 23(5), 373-392.
Van Parijs, P. (2004). Basic income: a simple and powerful idea for the twenty-first century. *Politics and Society*, 32(1), 7-39.
Vivarelli, M. (2007). Innovation and employment: a survey. *IZA Discussion Paper* No. 2621.
Weiss, M. & Garloff, A. (2011). Skill-biased technological change and endogenous benefits: the dynamics of unemployment and wage inequality. *Applied Economics*, 43(7), 811-821.

IIDE Proceedings 2014 – Toward Post Systems Thinking In the Conception of Whole-Part Relations



Systems thinking represent a diverse intellectual body that aims to support conception of phenomena. Systems thinking may be regarded as a reaction against the micro-reductionism inherent within the modernist scientific approach; more specifically in the latter's conception of *whole-part relations*. While the propositions offered by systems thinking

overcome that reductionism, we show that due to its biotic root-metaphor it instead imposes macro-reductionism. We proceed then by drawing on two alternative approaches that facilitate our conceptions of relations between a whole and its parts, in terms of *encaptic relations* and *assemblage relations*. A key conclusion advanced is that any utilization of analytical thinking and systems thinking must be conducted carefully and self-critically, due to their inherent limitations. As a consequence, this suggests an initiative for intellectual development of a post systems thinking approach, with regard to the conception of whole-part relations.

1. *Introduction*

We start this essay with an exposition of the micro-reductionism of modernist scientific thinking, called here analytical thinking. We then expose both the remedy offered by systems thinking and the macro-reductionism it imposes. We continue with our suggestion for a post systems thinking approach, where the whole-part relation is re-conceptualized to eliminate both micro-reductionism and macro-reductionism.**[iii]** This is done with the support of two rather different bodies of social ontology: Dooyeweerdian *encaptic* relations and DeLanda's notion of *assemblage* relations. Our overall aim is to direct a further development of the conception of the whole-part relations so that more justice can be done to our experiences of the complexities of social affairs. The content of the paper follows the structure of the argument outlined; however it is also includes an illustrative case of the dramatic and tragic event of the Soviet submarine K-19, which we present in the remaining part of this Introduction.

1.1. *K-19*

As the end of World War II had produced major tension between western countries and the Soviet sphere states, the cold war was established. Both sides raced to produce the most sophisticated and threatening weapons with the aim of demotivating the other from any aggressive actions targeted at the other side. Perhaps the most sophisticated weapon developed during the cold war was the nuclear submarine. Such a sub utilizes nuclear technology in two ways; one is that it is capable of launching ballistic missiles from the ship, which is equipped with nuclear bombs. The second means that the ship is powered by its nuclear power station and is thus independent of re-fueling operations for years, which makes it much harder to detect and strike against. USA was the first country to develop and introduce nuclear submarines in its weaponry arsenal, which in turn

created an imbalance, where Soviet perceived a major threat. This motivated Soviet to develop and launch its own nuclear submarine, the so-called 658 class of which K-19 was the first submarine introduced (Huchthausen, 2002).
On June 4th, 1961, while K-19 was on its maiden voyage conducting exercises outside southern Greenland, it developed a major leak in the reactor coolant system, causing the temperature to rise uncontrollably and putting the whole ship in a very dangerous situation – with no chance of external assistance … Faced with the choice of either abandoning ship or attempting its repair, the Captain First Rank *Nikolai Vladimirovich Zateyev* put together a team of eight crew members with the objective to implement a new cooling system and thereby prevent a disaster; this effort succeeded. Yet, the eight crewmen died of radiation exposure within a month and fifteen more died within two years (ibid.).
The recent release by Russian authorities (ibid.) of classified information about K-19 and its accident, has led to the 2002 film dramatization, entitled "K-19: *The Widowmaker*". In the early part of that film, we can see young men boarding K-19; some of them have to leave their fiancées and family members behind, and they promise to be back soon… One of these men is later chosen to participate in the special taskforce to repair the cooling system. We can follow this man's anxiety, desperation, refusal to cooperate and his finally being forced to do '*his duty for his mother country*' – the men died onboard.

Among many questions raised by this story, one concerns the man who did not want to die and therefore initially refused to join the special taskforce. Should we regard this man as a solider and as such under obligation to obey military rules, or should we regard him as being part of a family and as such entitled to refuse to be a part of the armed forces? Or should we regard this situation in another way?**[iv]**

2. *Analytical Thinking Versus Systems Thinking*

In this section we will expose so-called *analytical thinking*, including its key points, a brief application to the K-19 case, and reflections on its strengths and limitations. A similar account will then be given to the anti-pole of analytical thinking, so-called *systems thinking.*

2.1 *Analytical Thinking: the whole as an aggregate*

We expose *analytical thinking* to provide a *raison d'être* for the subsequent exposition of *systems thinking,* which is the subject of critical diagnosis in this essay. The concept called here *analytical thinking*, as suggested by Le Moigne

(1999), may also be called *modernist science thinking* (Checkland 1981: Ch.2).

Following the origins of rational thinking and inquiry in ancient Greece and the medieval period, the scientific revolution of the 17th century has provided us with one of the greatest inventions of the Western Civilization: Science. Copernicus and Kepler established the heliocentric model of the solar system, Galileo developed much of its mechanics and Newton put together terrestrial and celestial dynamics. In all this, Whitehead (1925: 77) characterized *science* as: "*…educated men searching for the general principles which the scientists believe underpin the natural order*". While there is no final characterization of what science is or is not, and there do exist a number of excellent characterizations (Jeans, 1947; Singer, 1941), science is often associated with such terms as: invariance and general principles, scientific method and controlled observation, hypothesis, isolation, reduction, designed experiments, laboratory, documentation and reporting of tests, and repeatability. One of the key hallmarks of science was the establishment of the scientific method that specifies what needs to be done to produce and reproduce scientific knowledge, as distinct from ordinary knowledge. Several thinkers may be associated with this establishment, including Bacon, Galileo, Descartes and Newton. In this context, we shall focus briefly on Descartes (1596 – 1650) who wrote the *Discourse on Method* (Descartes, 1960 / 1637) which has been called "*one of the really important books in our intellectual history*" (Butterfield, 1949). This small book offers four general rules for "*properly conducting one's reason*" and has influenced thinkers and scientists since (ibid.). It is the second rule provided that is most central as it articulates a key characteristic of science and the scientific method, as it has been practiced since (Checkland, 1981: 46). This second principle for the conduct of good reasoning stipulates *to divide each of the difficulties that are examined into as many parts as might be possible and necessary in order to best solve it* (Descartes, 1960 / 1637). The assumption here is that when one is faced with some kind of complexity, i.e. most non-trivial everyday situations, one should attempt to decompose (analyze, take apart) it into as simple components as possible, so that these components may be understood; and then put that knowledge of the separated parts together thereby producing comprehensive knowledge of the whole situation initially faced – hence: first *analyze* the phenomenon and then *synthesize* available knowledge of the parts of that phenomenon. This approach of breaking down, or reducing, the phenomenon in question has dominated and continues to dominate most scientific thinking to this day (Franklin, 2009). We

choose here to quote a contemporary analytical philosopher J.R. Searle (2007) who very clearly expresses this reductionist method of reasoning and understanding:
"*…in order to make any progress, we have to divide the huge problem /…/ into sets of smaller problems, and those into even smaller problems so that we can answer them in a piecemeal fashion. Our strategy is to divide and conquer: divide these questions into questions of a more manageable form, and then work on them one at a time. That at least is the method that I have followed all my life…*" (Searle, 2007, p.18)

He then continues with disclosing his underlying ontological assumption that motivates the reductionist method:
"*Just as human biology is an expression of the underlying physics and chemistry, so human culture, in all of its manifestations, is an expression of our underlying biological capacity for language, rationality, etc.*" (Searle, 2007. p.22)

Clearly, Searle articulates the underlying assumption that when faced with complexities (*here human culture*) that hinder straightforward understanding, one should break down the phenomenon into simpler components where some understanding is already available (*here language*). While this approach to reasoning and knowledge constitution is appealing and certainly may follow intuition, we shall soon see that it has at least one crucial shortcoming: it presupposes that comprehensive knowledge of a whole is equal to knowledge of each part as such, where the latter are understood to be isolated from the whole's context. Before detailing this shortcoming, however, we shall make a brief conception of the K-19 situation by employing the analytical approach to understanding.**[v]**

2.2 *K-19 conceived as an assembly*
When conceiving K-19 as an assembly or a set, we may understand it in terms of (a) its set of individual men serving onboard, conducting their pre-specified tasks, and (b) the submarine ship, made up of a number of mechanical and electric parts; all these components are put together into what was regarded as K-19. Conceiving K-19 as an aggregate (a collection, a set) informs us of the fact that K-19 includes two kinds of parts, human and non-human components, where each of these perform one or more specified functions. In this sense, the function of each crew member is to conduct well pre-defined activities that serve the ship in a purposeful manner. For example, a *Sonar Technician* operates sonar gear

('*sonar*' stands for 'sound navigation and ranging'). Thus the function of a Sonar Technician in the submarine is to operate sonar equipment in order to locate, identify and track submarines and surface ships – without this a submarine is blind. This specification of each component of the K-19 may go on until all components are understood. The analytical approach to reasoning and knowledge constitution assumes thus that once all components are understood, the knowledge of each component as such may be put together to make up knowledge of the whole: of K-19 as such.

2.3 *Assessment of analytical thinking*

It is now time to make a brief assessment of this analytical approach to comprehension and reasoning, as provided by modern science. The analytical approach regards any whole as an aggregate, that is to say as a set of parts that are put together to serve some end. Therefore, one of its key strengths is that it follows man's intuition: to isolate a whole from its context, decompose it into its parts until each part may be understood, put that knowledge of the separated parts together and thereby obtain knowledge of the whole. Secondly, this approach has clearly been successful in a number of situations. Since the time of the scientific revolution and Enlightenment, our societies have produced a never before experienced advancement in knowledge production and also the development of virtually every part of human life. To illustrate this, we can conceive of modern pharmaceuticals: scientists analyze a key recurring human illness, they identify its cause by means of isolation, experiments and observation, thereafter a solution is formulated in terms of a drug, and that drug is tested for its effects; if it fails a redesign of that drug is conducted and tested again. As a result, the pharmaceutical revolution has saved millions of lives.

As mentioned earlier, a limitation of the analytical approach is its key underlying onto-epistemological assumptions. It regards all wholes as mere aggregates, and therefore also assumes that knowledge of each part of a whole, obtained in isolation from its whole, is good enough for us to understand the whole after it has been synthesized with the knowledge of other parts of the given whole. The shortcoming comes from the common observation that a whole manifests characteristics that cannot be identified in any of its parts alone. This is so as these whole-properties emerge from a certain kind of interactions with the whole's parts and also the whole's environment (e.g. Checkland 1981, Klir, 1991). To continue with the pharmaceutical example, the pharma research industry has

learned that it is not enough to test a new drug in isolation only. It is now a common practice that more and more drugs are tested for their potential interactions with other medications, with life styles, with food and other factors. This is so as a certain drug may manifest a certain kind of properties on its own, and rather different properties when it operates, intentionally or unintentionally, in interaction with other drugs or conditions (for example, both aspirin and blood-thinners like warfarin Coumadin – used to prevent heart attacks – help to prevent blood clots from forming; using these medications together, however, may cause excessive bleeding). Returning to the K-19 case study, we can see that the submarine as a whole manifests various characteristics that cannot be derived from any of its parts on its own, such as sailing, submerging and surfacing, striking against other ships, conducting rescue operations not programmed in advance. Just as flight is a key emergent characteristic of an airplane – none of an airplane's parts, such as the wings or the engine, can fly on its own – the submarine has its emergent properties. Therefore, it does not matter how much analysis is conducted on the K-19, providing us with detailed knowledge of its various parts – e.g. torpedoes or navigation functions – this will not provide us with knowledge of how the sub can submerge or surface, as these functions are emergent characteristics of the sub's parts interacting with each other in a certain manner. Further, no analysis, however sophisticated, may inform us why K-19 came into existence nor why it is equipped with a nuclear power-station or nuclear missiles, as the reasons for all these and other properties of K-19 are to be found outside it, within its environment. Clearly, when a phenomenon is decomposed into its parts, its emergent properties are dissolved and cannot be accounted for when any part on its own is investigated. This key limitation constitutes the key *raison d'être* for *systems thinking*, detailed below.

2.4 *Systems Thinking: the whole as a system*

This section comprises a description of *Systems thinking*, as a reaction to analytical thinking as discussed above; the following account includes an exposure of its key message, an illustration of its working with the K-19 case, and then a reflection upon some of its strengths and limitations.

Just after WWII, Warren Weaver (1948) published an important message that the conventional methods of science are not good enough for the comprehension of the complexity perceived in non-trivial everyday phenomena. Weaver introduced a three-level classification of phenomena – problems of *simplicity*, problems of *disorganized complexity* and then problems of *organized complexity*. In this,

phenomena of *simplicity* are represented by the engine, telephone, and radio, automobile or hydroelectric plant, etc. Its scientific methods come from classical mechanics dealing with a handful of variables with some kind of one-way deterministic relation. This implies that these methods of few-variables cannot help us much with the comprehension of phenomena that are complex in terms of many variables that interact, for example comprehension of living processes, cultural and political structures and dynamics.

Toward the end of the 18th Century, new methods were established for dealing with what Weaver calls disorganized complexity, where a very large amount of variables, say, one million, are addressed. Probability theory and statistical methods were developed to support our conception and reasoning with such phenomena as gases where a huge amount of molecules interact and whose behavior is averaged rather than exactly specified. More specifically, Weaver (ibid.) explains "It is a problem in which the number of variables is very large, and one in which each of the many variables has a behavior which is individually erratic, or perhaps totally unknown. However, in spite of this helter-skelter, or unknown, behavior of all individual variables, the system as a whole possesses certain orderly and analyzable average properties." (ibid. p.227), and "the motion of the atoms which form all matter. As well as the motions of the stars which form the universe, come under the range of these new techniques". (ibid. 228).

Weaver then continues with the question: "Why can one particular genetic strain of micro-organisms synthesize within its minute body certain organic compounds that another strain of the same organism cannot manufacture?" (ibid., p.230). "These problems – and a wide range of similar problems in the biological, medical, psychological and political sciences – are just too complicated to yield to the old nineteenth-century techniques which were so dramatically successful in two-, three- or four-variable problems of simplicity, these new problems, moreover, cannot be handled with the statistical techniques so effective in describing average behavior in problems of disorganized complexity." (ibid. p.230) These challenges represent situations where neither classical mechanics nor thermodynamics (i.e. statistical methods) can help us much, according to Weaver (ibid), as such problems are of organized complexity, that is: *"…problems which involve dealing simultaneously with a sizeable number of factors which are interrelated into an organic whole"* (ibid. p.231). Therefore, Weaver calls for a new advancement of scientific methods, to develop approaches that can support our conception and reasoning with organized complexity. Furthermore he suggests that there are early signs that such methods are being advanced, which

includes sophisticated computation methods and mixed-team operations analysis practices. In this, he referred to the development of that which became known as cybernetics and control theory, information and communication theories, a heterogeneous body of thinking known as systems science, and also chaos theories, and complexity theories. While all these bodies, and other not mentioned here, have their own peculiarities, they all seemed to have at least one common denominator: they regard any whole as a system (Checkland, 1981, Ch:2).

Ludwig von Bertalanffy (1968), a thinker contemporary with Weaver and sometimes called the father of Systems Sciences (Hammond, 2003), offers us some further motives for the emergence of systems thinking, that is for our conception of something as a system rather than as mere aggregate or set. Hence: "One formulation of /…/ cosmic order was the Aristotelian world view with its holistic and teleological notions. Aristotle's statement, "*The whole is more than the sum of its parts*" is a definition of the basic system problem which is still valid". (von Bertalanffy, 1972, p. 407 – italics original). He continues with: "We must strongly emphasize that order or organization of a whole or system, transcending its parts when these are considered in isolation, is nothing metaphysical, not an anthropomorphic superstition or a philosophical speculation; it is a fact of observation encountered." (LvB: 408). He then concludes with: "The properties and modes of action of higher levels are *not* explicable by the summation of the properties and modes of action of their components taken in isolation. If, however, we know the ensemble of the components and the relations existing between them, then the higher levels are derivable from the components." (ibid. p.411)

J. Klir (1991: Ch.1), following R. Rosen (1986), suggests that any system manifests two fundamental yet very different kind of properties. *Thing-hoods* are properties belonging to the individual parts of a system, whether they are regarded being part of the whole or isolated. On the other hand, *Systems-hoods* are properties manifested by the whole only, and not manifested by any of the parts as such. For example, the ability to fly may be manifested by an airplane as a whole. Its engine or wings cannot fly on their own. Systems-hoods are in a sense independent of any particular part, in the sense that a system-hood may be produced by other different wholes, for example some birds can also fly.

P. Checkland states then that "The idea of emergent properties is the single most fundamental systems idea and to use this (and other) systems ideas in a conscious organized way is to do some 'systems thinking'." (Checkland, 1981: 667). He then

continues with: “Throughout systems literature the core image upon which systems thinking is based is that of the *adaptive whole*. The concept of some whole entity (which may be seen as a whole because it has emergent properties) existing in an environment which may change and so deliver shocks to it. The adaptive whole may then survive in the changing environment if it can adapt to the changes.” (Checkland, 1981: 668; our emphasis). Produced by his extensive review of systems literature, Checkland has identified four fundamental characteristics of an adaptive whole, as follows (bid: 678):

• *Emergence*: “… the whole will be seen as a system (rather than simply as an aggregate)
if the observer can identify some emergent properties of it as an entity”

• *Hierarchy*: “… the whole system may contain parts which are themselves smaller wholes (or ‘sub-systems’). Thus, the human body can be regarded as a system but sub-systems such as the respiratory system or the blood-circulation system can also be identified within it. This means that systems thinking postulate a *layered or hierarchical* structure in which systems, part of wider systems, may themselves contain sub-systems, which may contain sub-sub-systems, and so on.”

• *Communication & Control*: “… if a system is to survive in a changing environment it must have available to it processes of communication and processes of control. It must be able to sense the change in the environment and adopt a suitable response in the form of some so-called ‘control action’.”

Checkland continues therefore: “With the four concepts of emergent properties, a layered structure and processes of communication and control a very wide range of wholes may be described as systems capable (within limits) of surviving in a changing environment, systems thinking applies these ideas to a wide range of observed features of the world, the purpose being, in general, either to understand the world better or to intervene to improve some part of it.” (ibid. 678).

In parallel with, yet independently of, Checkland’s work, J.L. Le Moigne (1990) formulated similar terms in Francophone literature. In his conception, any system is regarded as a set of components that give rise to functionality and transform, all within an environment and in relation to some intentions (Le Moigne 1990: Chap. 3). Furthermore, an adaptive whole is understood as a hierarchy of three key sub-systems: operations, information and communication, and decision-making; all aimed at a successful survival (Le Moigne 1990: Chap. 4).

To be clear here, while von Bertalanffy’s (1968, 1972) and his colleagues’

contributions focused on theories of systems, the interest of Checkland and some followers was to assume selected parts of theory of systems and to employ them as intellectual guidelines for conception and planning of changes in social affairs; the interest there is thus not 'systems theory' but 'systems technology', or more specifically, its subset: 'systems methodology' (Checkland 1981, Ch: 2).

Before moving our attention to how systems thinking can help us conceive the situation of K-19, we wish to articulate a central implication of systems thinking regarding the constitution of knowledge of some selected phenomenon. This is that no amount of *analysis* of any phenomenon can provide us with comprehensive understanding of it. This is because when a phenomenon is taken apart, systems-hoods (i.e. emergent properties) disappear and thus cannot be perceived and understood e.g. when a child takes a radio apart to find the voice the radio emits. As a consequence, a key methodological implication is that *synthesis* should (also) be utilized when conceiving a non-trivial phenomenon. This implies that a phenomenon under consideration needs to be regarded as a whole, and within its context, so that its role and functionality may be comprehended.**[vi]**

2.5 *K-19 conceived as a system*

It is now time to conceive the K-19 situation as a system. To start with, K-19 may be regarded as a system in itself, constituted by a set of sub-systems and at the same time being part of a larger system. Examples of sub-systems include its engine department, made up of the ship's engines, engine staff, working procedures, tools etc. There also is the missiles department with the missiles themselves, its crew and also standard operating procedures, and there are a number of other sub-systems such as navigation, food, health, and the command function that directs and controls the behavior of K-19 as a whole, as a response to the command signals received from the Navy headquarters. The above and other sub-systems of K-19 may in turn be further decomposed into sub-sub-systems, such a missile or an engine, with further de-composition being possible until it ceases to make sense; all this analysis is aimed at generating knowledge of the phenomenon at hand, here K-19. All these K-19 sub-systems and their various sub-systems, are organized in a particular hierarchy, to give rise to the emergent behavior of K-19, including its ability to sail from one place to another place, to submerge and surface, to conduct a torpedo strike against another ship, and to fire off a missile whether submerged or not. These behavioral patterns are a

result of the interaction of the various sub-systems, hence the ship's engine cannot sail on its own, nor can any other part of the ship do so; a torpedo as such cannot fire off by itself, it requires the assistance of the other sub-systems, such as navigation and command. Further on, we understand that K-19 regarded as a system is part of a larger system, firstly the Soviet Navy's submarine division, which in turn is part of the Soviet military system, which in its turn is part of the Soviet country, which in turn is part of… From this kind of contextualization of K-19 we may understand why it was brought into existence, and also the role or function of its unique capability to sail submerged for very long period of time, due to its nuclear powered engines, namely, to present a threat to the NATO countries. Without such a synthesis we may never produce the answer to the question of why does K-19 exist and whether it was designed to manifest some of its emergent characteristics, or systems-hoods in system language. If we advance this investigation further, we may recall that on 4 June 1961, when K-19 was conducting exercises outside southern Greenland, a major leak developed in the ship's reactor coolant system, causing the temperature to rise uncontrollably, and putting the whole ship in a very dangerous situation. The ship's command sub-system was not allowed to communicate with the Navy's command system, because of the radio silence it had imposed; this made it impossible for the ship's captain to request permission to abandon ship and rescue its crew, nor could any assistance be requested. Therefore, Captain *Nikolai Vladimirovich Zateyev* decided that a team of eight crew members would implement a new cooling system, and thereby make an attempt to prevent a disaster. This means that articulated in systems terms, K-19's decision sub-system initiated control actions, that by means of internal transformations could bring the systems into stability and thus ensure its survival, even though some of its internal components (crew and mechanical devices) ended their functionality and indeed their existence – however K-19 regarded as a system survived the adaptation process, and could thus be perceived as a viable system.

2.6 *Assessment of Systems Thinking*

A central strength and at the same time shortcoming of systems thinking is its central assumption of *functional alignment*. More specifically, the assumption implies that a system, such as K-19, is composed of a set of parts that are organized hierarchically so as to give rise to the emergent functions of the whole. In this, a second underlying assumption is that the parts of a system have only one role, which is to function in the context of its single whole: its system. The

reason for this is that the root metaphor of systems thinking comes from studies of biological organisms. In these cases, a system's parts typically have one pre-determined specific functional area within its whole and have no meaning or identity outside its whole. For example, the heart or lungs of the human body have their own specific functions, both are needed by the human body to produce its systems-hoods, yet these sub-systems, or organs, have no meaning or independent identity outside the whole, and cannot survive there (other than by artificial means imitating the original context). While this biotic conception of a system certainly makes sense for the conception of biological phenomena, it presents a key limitation for the conception of social phenomena. This is so as parts of a social system, such as a human-being or a group of people operate differently: they are not limited to being fully aligned with one social whole only. For example, a body's organ, such as the lungs, cannot say: '*I am tired of working today so I will rest*', or '*I wish to quit my job for the moment*'. These sub-systems do not manifest separate interests, multiple or conflicting interests or aims; however this is something that we do experience in the domain of social phenomena. Also, people tend to be part of a set of social wholes, sometimes under a limited period of time and they can switch their social contexts. Peoples' desire and capacity to participate within several social contexts may also generate conflicting interests between these contexts. Clearly, parts of social wholes are not fully aligned and limited to one function only.

In the case of K-19 we know that some of the crew members did not wish to board the ship prior its departure and that some of crew members did not want to participate in the special taskforce assigned to rescue the ship; this being so as they expected, or knew, that they would never rejoin their families. Here we can clearly perceive a conflict of loyalty: the loyalty to the mother country and particularly its navy versus loyalty to their families. The Soviet state, and its armed forces, assumed that it owned the lives of their soldiers and could sacrifice them for the sake of the security of the country while some of these soldiers were not convinced about that commitment as their loyalty to their families proved to be stronger.

Empirical experience shows that humans, whether individually or group-wise, have various aims simultaneously in social contexts and that these aims or interests may change over time. In that way, the basic model of *a system* is too limited as intellectual spectacles to guide our conceptions of social phenomena, as the system genotype reduces or disregards key empirical features inherent in

social phenomena, and thus limits our understanding of these phenomena.**[vii]**,**[viii]** More specifically, systems thinking commits itself to a kind of macro-reductionism, where the behavior or function of a whole's parts is fully determined by and aligned with its whole. In a sense this is not so surprising, as this shortcoming represents an anti-pole to the limitation of analytical thinking's micro-reductionism, which caused a reaction and development of systems thinking.

3. *Towards Post Systems Thinking*

In the text above we have made an attempt to expose two key approaches to support our conception of and reasoning about complexities: analytical thinking with its taking-apart and system thinking with its holism. While each of the two approaches manifests various merits and limitations, we have exposed a key limitation in their conceptualization of a social phenomenon, respectively. A question that now emerges is: *Is there any alternative to the two*?

In the next section we shall expose two very different alternative approaches to comprehension, where each offers its own way to overcome the limitations of both analytical thinking and systems thinking. We start with the exposition of the *encaptic relations* and then follow this with an exposition of *assemblage relations*. We proceed by exposing each of these together with a brief illustration of the K-19 case, and will then conclude with a short assessment of the merits of the two approaches.

3.1 *Encaptic relations*

The late Dutch philosopher and professor of law, Herman Dooyeweerd (1894-1977), developed a highly original philosophical body sometimes called the *Philosophy of the Cosmonomic Idea*. This includes contributions regarding the nature of diversity and coherence of everyday experience (ontology), the transcendental conditions of theoretical thought (epistemology), and the relationship between philosophy and religion, among others – most comprehensively presented is his opus magnum: *A New Critique of Theoretical Thought* (Dooyeweerd, 1955).

In this context we have utilized Dooyewerd's (1997) proposal for the notion of encaptic relations and the associated notion of aspects or modalities of reality. Dooyeweerd observes that things can be combined into a whole in at least two ways. One is the biotic notion of the *whole-part*, as summarized in the Aristotelian expression 'the whole is more than the sum of its parts' and as articulated in

systems thinking above. In this a whole's parts cannot exist or function, nor be understood comprehensively, apart from the whole of which it is part, such as an organ being part of an organism. The second combination of things is what may be termed here as a whole-whole relation, where one whole is encapsulated with another whole, as a *sub-whole*, can thus not be subsumed as a part. This kind of encaptic relation attempts to do justice to our empirical experiences when a particular whole is encapsulated within another whole as sub-whole, however, where that sub-whole can exist and function and also be comprehended apart from the other whole into which it is encapsulated. An example illustrates this as follows: a small rock in a bird's gizzard may assume a function in the bird's digestive process. The rock is not a part of the bird, rather it assumes a kind of passive function and the rock can exist without the bird yet it cannot perform the same digestive function without the bird. Dooyeweerd notes that in such whole-whole relation, one whole is governed or obeys one kind of norms or laws while the other whole is governed or obeys another kind of norms or laws; this means that there is a significant difference in the nature of the two entities and therefore these should be conceived in terms of encaptic relations. Dooyeweerd says: "… *an encaptic relation occurs between idionomies with an intrinsically different nature; these idionomies can never relate as part to a whole.*" (Dooyeweerd 1997: 66-67). In the example of the bird and its rock, the first mentioned is qualified biotically while the last mentioned is qualified physically. On the other hand, in a genuine whole-part relation both the whole and its part are governed by the same kind of norms or laws, such as is the case with human body and its heart or lungs that are all qualified biotically. We may thus define an encaptic, or whole-whole, relation as taking place when a sub-whole exists and acts within the internal organization of a 'larger' whole which has a different qualifying function from the sub-whole, while the qualifying function of the sub-whole is over-ridden by that of the larger whole. In all this, the notion of encaptic relations presupposes Dooyeweerd's notion of human reality manifesting a number of distinct characteristics, also called modalities or aspects (ibid.). More specifically, Dooyeweerd maintained that human thought is based upon and bound to our experience and that experience exhibits a number of distinct modalities (or aspects, or dimensions, or spheres) of normativity and laws. Dooyeweerd proposed fifteen modalities, in the following order: arithmetic, spatial, kinematic, physical, biotic, sensitive or psychic, logical, historical, lingual, social, economic, aesthetic, juridical, ethical and pistic; however, Dooyeweerd's intention was not to construct a final and exclusive map of human experiences, it is a proposition and he welcomed

motivated suggestions for modifications.
The significance of this Dooyeweerian encapsis is central for our investigation here. This is so as this encapsis clarifies why the nature of a whole cannot be explained or predicted from the knowledge of sub-wholes that are bound to it, namely sub-wholes are governed by other norms or laws than the larger whole, and therefore cannot be considered as causes of the larger whole in which they happen to be bound, at the moment. Indeed, these sub-wholes may be regarded as necessary for some specific functioning yet not as sufficient.**[ix]**

3.2 *K-19 as Encaptic relations*
We will now turn our attention again to the case of K-19 where we can regard an individual in her social roles of a crew member and of a family member. As crew member, a soldier on a submarine was part of the navy and the military defense establishment, and ultimately part of the Soviet country, where the latter is founded historically and qualified juridically. The individual versus the country manifest an encaptic relation, as she is transcendent to legal norms (ref), yet may submit herself to these. On the other hand, in the context of a family the same individual simultaneously assumes an encaptic relation to that other social whole: the family. In the context of the latter she is qualified ethically, with the kernel, or motivation, of love (the family maybe *founded* biotically, in the parent-child or sibling relations, yet is *qualified* ethically). We can now identify a conflict zone: a family may span across one or more countries – disregarding geographical and legal boundaries and their diversities. It is thus possible that two individuals who belong to the same family may be subordinated to two different countries, with two very different juridical standards that may or may not be in conflict with each other. Further on, Dooyeweerd postulates clearly that ethical norms surpass legal norms – the latter results from a social contract and seeks justice while the former from an individual's values and conviction, ultimately her love. This distinction can be illustrated by the following brief example: imagine a couple about to be married in Church. Legal standards may establish certain conditions of the two newlyweds, such as their belongings being shared equally. However, it would be nonsense to stipulate legally that the two ought to love each other, as that is a moral condition which cannot be enforced legally.

3.2.1 *Assessment of Encaptic relations*
The conception of the K-19 situation and its crew members described above articulates some hidden circumstances which cannot be accounted for by either

analytical thinking or system thinking. One is that individuals should not be regarded as independent parts of the Soviet country (as the analytical approach implies) or as fully dependent parts of that country (as the system approach implies). An individual may assume a whole-whole relation with different social entities and thus submit herself to different normative standards at the same time, sometimes conflicting.

However, this gives rise to a key question: how can we understand a conflict between two social entities where each is qualified, by or operates upon, two different normative standards, such as in the case K-19 case? While Dooyeweerd (1997) does not provide a final solution to this kind of normative challenge (as we understand it) he does offer conceptual guidance for how to think about such situations. This includes an entity's sphere of sovereignty, the aspects of reality with its norms or laws guided by their respective kernels: all these modalities characterize entities. Our interpretation is here thus that the family as an entity is qualified by ethical norms which surpass a state's juridical normativity, and thus that the individual should be given the ability to make her own choice whether to join the military service or not. This suggests that is more appropriate that a crew member is loyal to, and prioritizes, her family rather than the state.

3.2.2 *Assemblage relations*

In this section we shall expose yet another approach to the conception of social relations: the *assemblage approach*. Similarly to the encaptic approach detailed above, the assemblage approach offers an alternative to both the analytical and the systems approaches, and potentially offers conceptual support that deals with some of the limitations of the two mentioned approaches. We will start this exposition with a brief summary of the assemblage approach and then illustrate its working on the K-19 case; its assessment will follow.

Assemblage theory is a kind of social ontology that has been formulated by the contemporary philosopher Manuel DeLanda (2006). However, his effort is based on the novel work of two renowned French philosophers Gilles Deleuse (1925-1995) and Pierre-Félix Guattari (1930 – 1992). DeLandas contribution is to bring their work together into one coherent theoretical body and to expose it systematically, including clarifications and some additions. In this sense, DeLanda calls his work the '*neo theory of assemblage*', or 'assemblage theory 2.0' (ibid.) – we will assume that version of the assemblage conception here.

Assemblage theory proposes that there are two kinds of relations in social

phenomena; these are called *totalities* and *assemblages*. Totalities refer to a situation where relations between components of such a phenomenon are set in such a way that they have no independent identify, meaning independent existence from the phenomenon that they are a part of, from the relation in which they exist; this is also known as the relation of *interiority.* In such cases, parts are fused into a whole, as is the case of organs within the human body: the brain or kidneys have no meaning and function without the whole, the body (not to be confused with the situation when an organ is taken out of a body for transplantation and for a moment functions within an artificial context that imitates the original environment).

Assemblage relations, on the other hand, are said to be characterized by their relations of *exteriority*, meaning relations where components within a phenomenon may be detached from it and enter a relation within another phenomenon: changing its participation from one assemblage to another assemblage.

Totalities generate emergent properties from the interaction of their parts, and the relations between the parts are conceived in a similar fashion as within systems thinking. In contrast, assemblage is understood as another kind of a whole that also generates properties of its own, not reducible to its parts. However, parts within an assemblage are not assumed to be fused into its whole and fully aligned, integrated with, or absorbed by, it. Parts of an assemblage may exercise some capabilities or functions that are unique to its being part of a particular assemblage, however, its parts can be detached from that assemblage, followed by independent function and/or entering into a relation with another kind of assemblage, where such a part may assume some new functioning specific for that context. To provide a brief illustration of this, we can refer to our own way of functioning. When a part of our employer (assemblage), e.g. as an airline pilot, we can function in a certain manner, however when being part of another assemblage, e.g. a family, we function in very different way. Next, Assemblage Theory postulates that any assemblage operates with two kind of functional modes.

The first mode of functioning refers to the situation when a part of an assemblage functions *materially, expressively,* or both. Material-functioning refers to a part's materiality such as its physical location, structure, shape, or movements, for example a building, a machine and individuals and groups of people. Expressive-functioning refers to a part's expressiveness that gives rise to information that is communicated, in some manner. This includes both linguistic and non-linguistic

expression; the latter may be signals sent by a building's shape or a human posture. For example, the headquarter building of the US Military is constructed in the form of a pentagon, and is officially known as the Pentagon; in this instance the building operates both materially and expressively.

The second mode of functioning refers to the situations when parts of an assemblage This first describes a situation where the components of an assemblage contribute to a stabilization of the whole assemblage. The second instance accounts for a situation when the components contribute to a destabilization or a change of the assemblage. For example: a building, such as the Pentagon, is built in such a manner that its components keep it fixed, both materially and expressively. Archeologists, on the other hand, have found certain cave paintings, which are exceptionally well-preserved after several thousand years, yet their intended expressivity has vanished, we can only guess what their message was. Likewise, a social organization such as the Roman-Catholic Church has been preserved, both materially and expressively, for two thousand years, while other organizations may emerge rapidly and then vanish. As an example of this, the company *Instagram* which provided functionality for sharing pictures via Internet was less than a year old when it was acquired by another company (Facebook) followed by a process where the first-mentioned organization was fused into the second, and thus ceased to exist as an independent entity.

The development of Assemblage Theory was initiated by a reaction to two kinds of reductionism (DeLanda, 2006). The first is what he calls *micro-reductionism;* it assumes that all phenomena may be decomposed into their very basic parts and thereby understood; this implies that individuals determine completely the behavior of its whole, and assume a similar position to that of analytical thinking as discussed above. The second kind of reductionism is labeled *macro-reductionism* by DeLanda. This assumes that only the function of a whole is of interest, as its parts are only there to serve it so that the interests of the whole are fulfilled; this implies that the whole determines the behavior of any individual that participates in the whole. This macro-reductionism assumes a position similar to systems thinking as discussed above. By offering a distinction between two kinds of wholes – *totalities* and *assemblages* – Assemblage Theory attempts to do more justice to empirical experiences, by accounting for two kinds of wholes, one where parts are fully absorbed and can only function and be meaningful within its whole and one where a part can be detached from its current whole and engage within another one.

3.2.3 *K-19 as an assemblage*

From the exercise conducted above, we may clearly conclude that K-19's actual behavior more meets the conditions of an assemblage than of a totality (i.e. a system). This is so as various parts of K-19 may be detached from it and can assume a function in the contexts of other assemblages; such was the case with the crew members who were part of their families, and at the same time part of K-19. Other parts, such as the ship's unique nuclear power station or its torpedoes, its navigation units and its food-providing arrangements, could all be detached and installed with some other context, such as a on a surface-ship or on land. This shows that conceiving K-19 as a totality eliminates the understanding of its parts' ability to change its contexts, thereby potential loyalty conflicts.

Next, the K-19, the ship as such, manifests a clearly material functionality, as do its various parts – torpedoes, nuclear power station, ballistic missiles, and various departments within the ship – and its context – such as the sea it navigates in and the other ships it relates to. K-19 also manifests expressivity in various manners; its physical shape signals that it is an entity for war, likewise the soldiers are organized into a strict hierarchical system that is communicated with various symbols, such as names for grades and symbols on the uniforms, the soldiers also assume various rituals, such as songs, sayings and stories, that function as community bonding and identity establishing. Furthermore, materially manifested acts, such as punishment of a soldier who performed unwanted behavior, signal to other crew members what is expected of them.

Finally, moving on to the material aspect of the (de)territorialization functionalities, the whole ship was built to withstand material challenges such as weather, pressure of deep water and weapon strikes. Here, K-19's accident was the result of a faulty nuclear power station, when the cooling systems broke down. This put the whole ship into serious danger whereby the process of its de-territorialization was initiated. On the other hand, the crew's hierarchical organization and informal loyalty saved it from another kind of de-territorialization that was initiated yet held back, when some crew members' loyalty for their families made them refuse initial orders to repair the cooling systems and thus expose themselves to deadly radiation. This initiated de-territorialization was stopped by the soldiers' expression of belonging to a community and by the formal hierarchy.

In this case, we may conclude that K-19 as an assemblage was exposed to two kinds of *de-territorialization*: first a process of *de-territorialization* (i.e. cooling

system) and secondly the crew members' simultaneous belonging to another assemblage (i.e. family) initiated the other process of de-territorialization, through an attempt at mutiny; in the second instance however, the specific formal hierarchy and its culture (with its code of conduct, songs, rituals, histories) contributed to maintaining organizational stability, or territorialization, where it also produced a recovery of the assemblage's cooling system, hence *de-territorialization* of its ship – this is shows the interplay between two kinds of *de-territorializations*: material and expressive.**[x]**

3.3. *Assessment of Encaptic and Assemblage relations*

It is now time to make an evaluation of the encaptic approach and the assemblage approach to the conception of a phenomenon, in relation to the limitations presented by the analytical and the systems approaches.

To start with, we can conclude that both encapsis and assemblage, as intellectual conceptions, offer us the ability to account for the empirical experience that a phenomenon may be conceived as a whole, with its emergent properties, and with parts of the whole that are either fused into that whole and lack their own identity, or that can maintain a certain level of autonomy, and therefore function within various wholes. This is something that neither analytical thinking nor systems thinking can offer us.

This means that both the encaptic conception and the assemblage conception are able to recognize that we experience two kinds of wholes. On the other hand, while encaptic conceptions rely on the notion of norms and laws as well as founding and qualifying modalities, assemblage conceptions utilize conceptions of materiality and expressivity as well as of territorialization and de-territorialization. The two approaches can thus be perceived as rather different from each other, yet can both be used to offer a plausible conception of complex phenomena's functioning.

To be sure, neither of these two approaches was intended as operational theory or methodology; they are rather philosophical bodies (social ontologies) aimed to guide a conception of our experience and thus potentially inform development of empirical theories of our experiences.

4. *Discussion and Conclusions*

Modern systems thinking with its holistic message has emerged as a reaction to analytical thinking's atomism. In this essay, we have attempted to advance the argument that systems thinking, as an intellectual position while offering us some

important conceptual features – the explicit recognition and accounting for emergent properties manifested by a phenomenon at hand – also imposes on us the macro-reductionism; this conceives parts of a whole fully aligned with its whole's aim and being devoted to it only, without the possibility of being part of another whole, whether simultaneously or at another point of time. This is unfortunate as such conception does not do justice to our empirical experiences, as we have shown with the case of the Soviet submarine K-19. We have recalled that others have pursued a similar argument, in one way or another, however, we have not only provided a critique of systems thinking and related it to analytical thinking; we have also presented two different theoretical bodies that may surpass both the macro-reductionism of systems thinking and the micro-reductionism of analytical thinking; these are the notions encaptic relations and assemblage relations.

At the moment, holistic or systems thinking often presents itself as a solution to the limitations of analytical thinking, their micro-reductionism (e.g. von Bertalanffy, 1968, 1972; Checkland 1981, Klir, 1991, Le Moigne, 1990; Flood & Jackson, 1991). While systems thinking may remedy the limitation of analytical thinking we should not become blind and assume that it does not impose on us its own shortcomings. From our elaboration of the situation of the submarine K-19, we can clearly see that *each* of the four intellectual devices reviewed here – *analytical, systemic, encaptic,* and *assemblage* – can offer us something in their function of intellectual guide for the conception and comprehension of a complex phenomenon at hand. As a consequence, we suggest that there is a need to further advance our conceptual apparatus, so that it can account for all identified features of a phenomenon rather than account for only some of them, as is the current tendency.

It was not the purpose of this elaboration to list all existing post-systems approaches; we have presented only two rather different approaches to support our conclusion here for a *complementary approach*, rather than the current more imperialistic where one approach surpasses another. After an identification of potential candidate approaches, there is a need for theoretical elaboration and practical tests with regard how to synchronize or even integrate the various approaches – with the clear aim of offering us an intellectual device that can guide a more comprehensive conception than otherwise.
Such advancement must not however be limited to theoretical bodies, as reviewed

here. The various operationalizations of these theoretical bodies, often in the form of methods and methodologies, should also be addressed as these are utilized as intellectual tools for actual intervention in social affairs. To illustrate this point, we may consider one of the most sophisticated systems tools: Peter Checkland's *Soft System Methodology* (SSM), (Checkland, 1981; Checkland & Scholes, 1990). Among its various features, SSM mandates the utilization of the so-called conceptual modeling that is about the conception of a subsequent series of activities to be conducted by the phenomenon conceived. For example, painting a fence may require such activities as assessment of the current state of the fence, decision of desired color, acquisition of paint and brush, etc. SSM links these activities to key features of the phenomenon at hand: customer, actors, transformation, world view and environment (e.g. Checkland & Scholes, 1990). While such an exercise is certainly suitable for understanding key features of the phenomenon at hand, it manifests the above-mentioned macro-reductionism as it disregards the involved actors' multi-functionality, that is their synchronic or a-synchronic participation in other contexts and thus the potential emergence of conflicts of interest; an example of such a conflict of interest could be the workman painting the fence in our illustration, who also owns a company that sells paint and brushes; this would motivate him to choose his company as the supplier for the paint and brushes whether these are the most appropriate or not; due to its systemic roots, SSM cannot recognize such an everyday tension of interests; to be sure Checkland (e.g. Checkland & Scholes, 1990) proposes later in the development of SSM the so-called 'Political Analysis', yet this is in practice limited only to the question: 'are there any power-tensions involved here?', without offering any direct linkage to the SSM's modeling tools, making it impossible to detect such conflicts of interest). Similar critique may be delivered to other operationalizations of both analytical and systems thinking, including R.L. Ackoff's sophisticated 'Interactive Management' approach (e.g. Ackoff et al 2006), S. Beer's 'Viable System Model' (e.g. Beer, 1985), or the 'System Dynamics' approach (e.g. Sterman, 2000).

Given the argument developed here, we would like to invite the reader to pursue a most necessary development of theoretical bodies and their operationalization, so as to do justice to our experiences, offering increased understanding and thus more informed decision-making about various interventions in human and social affairs.

NOTES

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iii. To be sure, systems thinking can be charged with several other kinds of reductionism not addressed here. One is manifested by the famous debate between J. Habermas and N. Luhmann during the 1970's (e.g. Habermas & Luhmann, 1971). In this, Habermas charged Luhmann, among others, with the inability of systems theory to properly account for central social characteristics: the life world (Lebenswelt), understanding (Verstehen) and trust (Vertrauen), thereby reducing the social to the biological. Another critique is delivered by Strijbos (1995, 2010) who observed that system thinking is unable to address human and social normativity, rather it continues with a technical worldview. In his ground-breaking attempt to deal with questions of systems normativity, W. Ulrich uncovered another kind of reductionism, the so-called open system fallacy, for example systems thinking may ignore a system's victims, or those affected by it yet not affecting it, or as he puts it: "'open,' in contrast to 'closed' systems models consider the social environment of the system; but as long as the system's effectiveness remains the only point of reference, the consideration of environmental factors does nothing to increase the social rationality of a systems design. In fact, if the normative orientation of the system in question is socially irrational, open systems planning will merely add to the socially irrational effects of closed systems planning. For instance, when applied to the planning of private enterprise, the open systems perspective only increases the private (capital-oriented) rationality of the enterprise by expanding its control over the environmental, societal determinants of its economic success, without regard for the social costs that such control may impose upon third parties." (Ulrich, 1988, p. 156, orig. italics; with reference to Ulrich, 1983, p. 299).
iv. Methodological note: the case study of K-19 presented here is used throughout this essay in a rudimentary manner, more sophisticated elaborations would require more space; the presented illustrations fulfill their function as an illustration of the pursued argument.
v. Analytical thinking has attracted a significant amount of criticism, not least from systems thinking, for some central criticism see Checkland (1981), Klir (1991), Flood and Jackson (1991), Le Moigne (1990). However a review of that critique is outside the scope of the argument advanced here.
vi. Systems thinking has attracted some criticism, (e.g. Klir 1991), however review of that critique lies outside the scope of the argument pursued here.

vii. We wish to make a brief mention of the fact that somewhat similar critical remarks have been delivered by some key systems thinkers, unfortunately without much recognition. For example Ackoff and Gharajedaghi (1996) proposed an ontology of systems that differentiates between mechanical systems, biological systems and social systems, in terms of their teleology. W. Ulrich (1983) makes us aware of the open system fallacy, which implies that the biological root of systems thinking makes us disregard the actors that are affected yet cannot affect the system, which he calls the victims. Also, E. Moring (1977) presented critical remarks against holistic thinking.

viii. We also wish to highlight the fact that the systems thinking approach, or its holistic conception, is not limited to the domain of systems science or systems thinking. More implicitly, the idea of a whole, where its parts are infused and thus lack their own independent identity or multiple roles, is also inherent in central theoretical bodies of social thinking; one such notable idea is the structuration theory as put forward by A. Giddens (1984). However, investigation of these theoretical bodies lies outside the scope of this elaboration, and our intention is only to highlight that the message advanced here has a wider relevance.

ix. Dooyeweerd's philosophical work has attracted some criticism (e.g. Wolterstorff, 1983; Friessen, 2009; Strauss, 2009; Chaplin, 2014), but a review of that critique lies outside the scope of the argument pursued here.

x. Assemblage Theory has also attracted some critical remarks (Brown, 2010), however a review of that critique lies outside the scope of the argument pursued here.

References

Ackoff R. L., Gharajedaghi, J. (1996). Reflections on systems and their models. *Syst. Res.* 13(1), 13–23.

Ackoff, R. L., Magidson J., Addison H. J. (2006). *Idealized Design: How to Dissolve Tomorrow's Crisis… Today*. Upper Saddle River: Pearson Prentice Hall.

Beer, S. (1985) *Diagnosing the System for Organizations;* John Wiley, London and New York.

Bertalanffy, Ludwig von (1968). *General system theory: foundations, development, applications.* New York: Braziller.

Bertalanffy, Ludwig von (1972). The History and Status of General Systems Theory. *The Academy of Management Journal*, Vol. 15, No. 4, 407-426.

Brown, S.D, (2010). Between the planes: Deleuze and social science. In: *Deleuzian Intersections: Science, Technology, Anthropology*, eds: Jensen, C.B., Rödje, K.,

Berghahn books, London, pp. 101-121.
Butterfield, H. (1949). *The Origins of Modern Science* 1300-1800. London: Bell.
Chaplin, J. (2014). *Herman Dooyeweerd: Christian Philosopher of State and Civil Society*. Notre Dame: University of Notre Dame Press, 2011.
Checkland, P. B. (1981). *Systems Thinking, Systems Practice*, John Wiley & Sons Ltd.
Checkland, P. B., Scholes, J. (1990). *Soft Systems Methodology in Action*, John Wiley & Sons Ltd.
DeLanda, M. (2006). *A New Philosophy of Society: Assemblage Theory and Social Complexity* London & New York: Continuum.
Descartes, R. (1960 / 1637). *Discourse on Method and Meditations.* New York: The Liberal Arts Press (trans. : L. J. Lafleur).
Dooyeweerd, H. (1986). A Christian Theory of Social Institutions. The Herman Dooyeweerd Foundation, *La Jolla, California*; pp. 64-78.
Dooyeweerd, H. (1997) [1955]. *A New Critique of Theoretical Thought, Edwin Mellen*. Volume III: The Structure of Individuality of Temporal Reality.
Flood, R.L., Jacksson, M.C. (1991). *Critical Systems Thinking: Directed Readings*. Wiley, London.
Franklin, J. (2009). *What Science Knows: And How It Knows It,* New York: Encounter Books.
Friessen, G. (2009). 95 Theses on Herman Dooyeweerd. *Philosophia Reformata* 74: 78-104.
Giddens, A. (1984). *The Constitution of Society. Outline of the Theory of Structuration.* Cambridge: Polity Press.
Habermas, J., Luhmann, N. (1971). *Theorie der Gesellschaft oder Sozialtechnologie – was leistet die Systemforschung?*(TSG), Frankfurth a.M., Suhrkamp.
Hammond, D. (2003). *The science of synthesis. Exploring the social implications of general systems theory.* University Press of Colorado, Colorado.
Huchthausen, P., (2002). K-19: The Widowmaker, *National Geographic* (Washington, DC).
Jeans, J. (1947). *The growth of physical science*. Cambridge: University Press.
Klir, J. (1991). *Facets of Systems Science*. Plenum, New York.
Le Moigne, J.L. (1990). *La modélisation des systèmes complexes,* Éd. Dunod, Paris.
Morin, E. (1977). *La Methode. 1. La Nature de la nature.* Paris: Seuil.
Rosen, R. (1986). Some comments on systems and system theory. *Int. J. Gen.* Syst.

13, 1.
Searle, J.R. (2007). *Freedom & Neurology. Reflection on Free Will, Language and Political Power.* Colombia University Press.
Singer, C. (1941). *A short history of science to the nineteenth century.* Oxford: University Press.
Sterman, J. D. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World.* New York: McGraw.
Strauss, D.F.M. (2009). *Philosophy: Discipline of the Disciplines.* Paideia Press, Grand Rapids, MI, USA.
Strijbos, S. (1995). How can systems thinking help us in bridging the gap between science and wisdom? *Systems Practice* 8.4 (1995): 361-376.
Strijbos S. (2010). Systems thinking In: *The Oxford Handbook of Interdisciplinarity,* Frodeman R, Thompson KJ, Mitcham C. (eds.). Oxford University: Oxford; p. 453–470.
Ulrich, W. (1983). *Critical Heuristics of Social Planning: A New Approach to Practical Philosophy.* Bern, Switzerland: Haupt. Pb. reprint ed. New York: Wiley, 1994.
Ulrich, W. (1988). Systems thinking, systems practice, and practical philosophy: a program of research. *Systems Practice* 1, No. 2, pp. 137-163.
Weaver, W. (1948). Science and Complexity. *American Scientists* 36, 536.
Whitehead, A.N. (1925). *Science and the Modern World.* New York: Macmillan Company, Vol. 55 of the Great Books of the Western World series.
Wolterstorff, N. (1983). *Until Justice and Peace Embrace.* Grand Rapids: Eerdmans.

IIDE Proceedings 2014 ~ Cognitive Time Distortion As A Source Of Risk In Economic

Organizations: Conceptual Foundations

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This paper introduces two kinds of risks present in any economic organization: the risk of cognitive time distortion and the risk of economic distortion. These two kinds of risks are related in a complex and non-linear manner, so that the cognitive distortion risk gives rise to the economic distortion risk. By monitoring the cognitive distortion risk, managers may also control the economic distortion risk. Basic conceptual foundations for the conception of these two kinds of risks, originating in unconditional human cognitive time distortion, are elaborated in this paper.

".. if economic organization is formidably complex, which it is, and if economic agents are subject to very real cognitive limits, which they are, then failures of alignment will occur routinely." – O.E. Williamson, 1991: 79

1. Introduction

Whether we like it or not, our lives are highly dependent upon, and conditioned by, a large number of economic organizations, such as hospitals, schools, banks, pharmaceutical companies or governmental bodies. At the same time, today's economic organizations are exposed to a never before experienced amount of challenges of various kinds. To handle these challenges successfully, a manager's job includes the identification and management of various organizational risks. To this end we introduce here two kinds of risks present in any economic organization, yet not previously articulated. These are the *Cognitive Time*

Distortion Risk and its consequence, the *Economic Distortion Risk.*
The first-mentioned risk constitutes a source of economic inefficiencies, output quality deficiencies, and human ill-being. The second-mentioned risk articulates the economic inefficiencies. Both risks may be identified and monitored, which constitutes an opportunity for their management. This paper provides the conceptual foundation for the conception of the two kinds of risk.
The approach of the concept *distortion of risk* is inspired by systems theory, though this paper is focused on elaborating the operationalization of distinct mathematical metrics. In this paper, the term "risk" is applied since it has a mathematical definition in economic and psychological science based on probability theory. In systems theory however, the term "risk" is not applied or defined, but we interpret the systems theoretical concept of "variety" as being a proper connotation of 'variance' or 'standard deviation'. Therefore, we will conclude this paper with a more general discussion about risk, variety and system homeostasis.
We will start with a brief recapitulation of the notion of an economic organization and some of its central characteristics pertinent for this elaboration, including the temporality of an economic organization, and then introduce the central notion of cognitive time distortion, unconditionally inherent to all human activities. This cognitive time distortion is then introduced into the conventional profit equation and further transformed into a workload equation, which results in the expression of the risk of economic distortion introduced here. A brief illustration of the model introduced here is provided followed by a discussion where we put the risk distortion concept into a systems theoretic perspective. The paper ends with some key conclusions.

2. Economic Organizations and their Temporality

Before presenting the actual mechanism that gives rise to operational and economic risks due to cognitive time distortion, we would like to provide some of its background in terms of the conception of an economic organization, its relation to time and the crucial articulation of Cognitive Time Distortion.

2.1 Economic Organizations and their Temporality

Starting with the observation that our contemporary societies are inevitably populated by a large set of social organizations of various kinds (e.g. Pfeffer, 1997), one central subset of social organization is the *economic organization*, as manifested by a firm, a public organization, and an NGO (e.g. Foss & Loasby,

1998). Briefly, economic organizations are understood here as those legal entities where coordinated activities are conducted by human and non-human actors, and where these activities, together with their various resources, give rise to economic incomes and costs (ibid.). Further, and central here, is that the governance of an economic organization includes formal (and informal) contracts, with both factor and product markets (ibid). In the present context we wish to articulate the distinction between two ordinary kinds of contracts: *fixed-price contracts* and *current-account contracts*, applicable to both factor and product markets, and to both goods and services. Fixed-price contracts are understood as business agreements with a *predefined* time-volume, price per time unit and date for delivery, while current-account contracts are understood as business agreements with only a *predefined* price per time unit – we will return to the two contract forms later, and now turn our attention to *time*.

Central to this elaboration is the fact that all kinds of social organizations, hence also the economic organization; unconditionally operate *temporally* simply because of their constituting actors: human beings; these experience time (e.g. von Schéele, 2001). Further, it is now well established that organizations may operate simultaneously with *different kinds of time* (e.g. Orlikowski & Yates, 2002; Dooyeweerd, 1955). In the present context we wish to draw attention to the fact that for a long time studies in mental and medical sciences have reported that humans operate simultaneously with *physical (clock) time* and *cognitive (mental) time* (e.g. Block & Eisler, 1999; Levin & Zackay, 1989) – unfortunately and strangely these well-documented observations have largely been ignored by economic, organization and management studies, which this contribution will attempt to remedy. The complex relation between physical time and cognitive time is addressed below.

2.2 Cognitive Time Distortion and its Nature

From our everyday experience, we know that in relation to any event such as an organizational process, project, or even a single activity, *physical time* measures time in terms of what the clock measures, which in turn has an established relation to a particular physical event (i.e. a *second* is conceived as *duration of a specified amount of periods* of the radiation of cesium atom in its ground state at a temperature of 0 (ISU, 1998)). On the other hand, *cognitive time* is what an individual human actor perceives in relation to the given event and the related clock-time measure. Cognitive time assessment made by an individual tends to

move in jerks and jumps, while physical time passes smoothly and at an

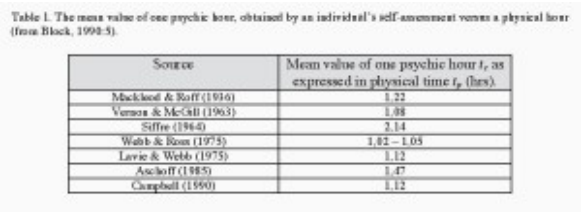

Table 1. The mean value of one psychic hour, obtained by an individual's self-assessment versus a physical hour (from Block, 1990:5).

Source	Mean value of one psychic hour t_c as expressed in physical time t_p (hrs).
Mackland & Roff (1916)	1.22
Vernon & McGill (1963)	1.08
Siffre (1964)	2.14
Webb & Ross (1975)	1,02 – 1.05
Lavie & Webb (1975)	1.12
Aschoff (1985)	1.47
Campbell (1990)	1.12

even pace (e.g. Levin & Zackay, 1989). For example, if a software consultant works for *three and a half hours* for a given client (measured in reference to a clock) however without consulting her watch, she may have perceived and also reported that she worked *three hours only*, meaning that half an hour has been '*lost*'. When individuals estimate time durations they nearly unconditionally, unintentionally and unknowingly, commit errors resulting in significant differences between the self-assessed cognitive time duration and the corresponding physical time duration, as measured by a clock (ibid.). A review of current research within cognitive time distortion suggests that the gap in correct assessment of one hour may vary between 1,02 – 2,14 hours, see Table 1 for an overview.

In general terms, cognitive time distortion (CTD) is understood here as being the ratio between cognitive time (t_c) and physical, or clock, time (t_p). In appraising time distortion, it is necessary that cognitive and physical time have the same *frame of reference*, and that they address the *same event* – e.g. an activity, a process, a project, or a service contract. Therefore, and more specifically, time distortion, denoted here with "τ_i", is defined as the ratio between cognitive time, t_c, and physical time, t_p, of a certain event "i", hence formally:

$$\text{Cognitive Time Distortion, } \tau_i = \left(\frac{t_c}{t_p}\right)_i \qquad 1.$$

One central implication from the empirical studies conducted is that CTD is unconditional to human nature (Aschoff, 1985); hence it is not a question of whether we commit a CTD or not, it is a question of how much distortion is produced.

2.2.1 The Probabilistic Nature of Cognitive Time Distortion

Cognitive time distortion exhibits a *stochastic pattern*, *varying* serendipitously during any one day. Empirical investigations show that CTD has a stochastic pattern *both* at the level of an *individual subject* and at the level of a *group of subjects*; however the deviations are more pronounced when, for example, a service is performed by a group of individuals than by an individual actor, hence at the group level (von Schéele, 2001) – see Figure 1.

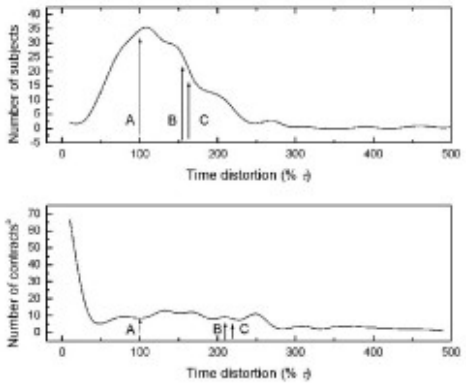

Figure 1. Shows the asymmetrical probability-distribution P(τ) of cognitive time-distortion. The Top Panel illustrates the distribution of cognitive time-distortion for individual time-assessments in a laboratory experiment (N = 224), while the Bottom Panel illustrates the distribution of cognitive time-distortion at the level of a group of individuals (here service contracts,

where N = 233 in five service organizations). Arrow 'A' indicates the mean value, μ, of a Gaussian distribution, while arrow 'B' indicates the approximate mean value, μ, and arrow 'C' the approximate expectancy value, E(τ), of the probability distributions P(τ), (based on empirical data from laboratory experiments and a survey of service contracts; von Schéele; 1999, 2001).

2.2.2 The Statistic and Asymmetric Nature of Cognitive Time Distortion

To further elucidate the statistical nature of the time distortion τ, consider $P(\tau)$ as being the probability function of the stochastic time distortion variable τ. Let also $p(\tau)$ express the probability that a time distortion of magnitude τ occurs. The expectancy value $E(\tau)$ of the time distortion τ in a set consisting of "*i*" events, [$i = 1 \ldots r$], can then be defined as $E(\tau) = \Sigma\, p(\tau_i)\, \tau_i$. Provided that the individuals of a given population are unbiased or randomly biased, the time distortion will then exhibit a probability distribution $P(\tau)$ with the following properties:

i. *$P(\tau)$ is not symmetrically distributed around $\tau = 1$*, which implies that the arithmetical mean value μ_τ [1] 1 and the expectancy value $E(\tau)$ [1] There exist several empirical evidences supporting this, showing that individuals assessing time exhibit a tendency to *overestimate* the passage of time (e.g. Aschoff, 1985; von Schéele, 2001).

ii. *$P(\tau)$ is not Gaussian-distributed*, but exhibits instead an asymmetric distribution with a long "tail" for values of $\tau > 1$ (von Schéele & Haftor, 2013). In such distributions it should not be expected that the arithmetical mean value μ_τ corresponds to the expectancy value $E(\tau)$. Serious errors will be committed if a Gaussian distribution of time distortion is assumed in economic calculus, as such an assumption, in turn, builds on presuppositions that both the arithmetical mean value μ_τ and the expectancy value $E(\tau)$ are equal to unity.

To illustrate this point, an investigation of five service organizations (von Schéele, 2001) showed that the arithmetical mean value μ_τ and the expectancy value $E(\tau)$

of P*(τ)* were greater than 2. Thus, the time estimations of the employees exceeded the actual contracted time, indicating a general *overestimation* of the passage of time. Furthermore, only 16% of the customers received a service-time that matched contractual time. The practical consequences of this were large deviations from budgeted economic outcome as well as poor profitability of the investigated service operations, ultimately resulting in the need to discharge employees (see von Schéele (2001) for further details).

3. The Dissimilar Effects of Cognitive Time Distortion due to Contractual Form
We would like to recall a central operating assumption of this elaboration: that an economic organization is made up of purposeful conduct by humans, whatever kind it may be, and of contracts between, on the one hand, the client or customer and the organization, and on the other hand, between the employee and the organization (e.g. Coase, 1937).

Given these assumptions, cognitive time distortion may cause an *economic distortion* in the manufacturing of products, in two alternative ways, both related to the nature of the *contract* between the supplier and the customer, and are specifically linked to the irreversible property of time. In general, the two different economic agreements applied on the market are:
i. *Service delivery at a fixed price (fixed-price contract).* The service provider and the customer have agreed upon the time-volume of the service (t_p), the price, and the date of delivery, after which the service delivery starts. The service delivery ends when the *predefined service* has been executed. The time distortion τ (alternatively δ) is considered here with reference to the predefined time t_p (alternatively predefined target capacity e_p) in the fixed price contract.

ii. Service delivery at current account. The service provider and the customer have agreed upon the price per time-unit for the service. The total time-volume (t_p), however, remains *unspecified*. This implies that the service also remains unspecified. For each additional performed hour of the service delivery, the service provider will charge the customer. For this economic agreement the time distortion τ is considered with reference to physical clock time (t_p).

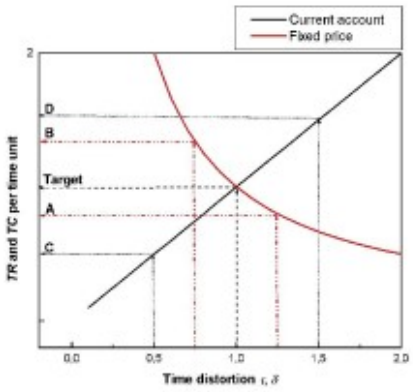

Figure 2. Shows that cognitive time distortion generates dissimilar effects and is determined by contractual category: current account vs. fixed price. There is a variation of Total Revenues, *TR*, and Total Costs, *TC*, per time unit due to contractual category, and as a function of the cognitive time distortion. Figure 1 illustrates the *lever-effect* between cognitive time distortion and *curve-linear* economic outcome with reference to the fixed price contract (von Schéele, 2001). The lever-effect is also relevant to the workload, see eq. 7 below.

The total revenues per time unit (income; *TR*), and the total costs per time unit (*TC*), are both influenced, however differently, by cognitive time distortion through the two distinct contractual means in Figure 2, as discussed below.

First, consider the *fixed-price contract*. If employees overestimate the time-volume delivered, resulting in cognitive time, t_c, exceeding contracted or physical time, t_p, the time distortion, τ will be larger than unity, thus decreasing *TR* per time unit (A in Figure 1). On the other hand, an underestimation of the time delivered affords a time distortion, τ, less than unity, and *TR* will increase (B in

Figure 1). Thus, from this we are able to draw the conclusion that time distortion, τ, is *inversely proportional* to *TR* for the fixed-price contractual model.
Secondly, consider now the *current account* contract. Here, the customer is charged for the contractor's cognitive time assessment, t_c, regardless of whether it equals the actual clock, i.e. physical, time delivered, t_p, or not. Underestimation of the passage of time – leading to undercharging – causes a decrease in *TR* (C in Figure 1) and the time, t_c, reported to the customer will be less than the actual time delivered, t_p. The opposite will occur if time is overestimated (D in Figure 1). Therefore, the influence of time distortion, τ, on *TR* is *linear* for contracts on current account (von Schéele, 2001).

Before moving on to elaborate the consequences of these dissimilar effects of cognitive time distortion due to contractual form, we wish to make a brief observation. The key role of the mode of a commercial contract in relation to production time and for economic results of an organization, as we understand it, appears so far to have passed unnoticed in economic studies. Subsequently, the relation between cognitive time leakage and the economic outcome has traditionally been assumed to be *linear*.

4. Cognitive Time Distortion, Contracts and Risk

We can conclude now that the emergence of cognitive time distortion is an unconditional state of human affairs, both at the level of a single human and at the level of a group of humans. We also know that CTD is not symmetrically or normally distributed, which implies that there are no simple means for ignoring it. Next, CDT has a dissimilar effect on an economic organization due to the contract form assumed. Indeed, in a previous elaboration where CTD was embedded into the traditional profit equation, we showed that CTD may have a non-linear and somewhat dramatic impact on costs, revenues and thus profits of a firm (von Schéele & Haftor, 2014). It is also argued there that CDT has a negative impact on economic productivity, output quality and human worker well-being (ibid.).
As CDT emerges both in *prospective* (e.g. budgeting) and *retrospective* (e.g. reporting) worker assessments (e.g. von Schéele, 2001), and as formal contracts are bound to physical time only, i.e. do not account for cognitive time, CDT gives rise to an undesired behavior in the economic organization, when the latter deviates from the ideal of a perfect contract where no difference between the physical time and the cognitive time is present.
On the other hand, as CTD can be estimated empirically, both at the level of an

individual and the level of a group of individuals, a probability distribution may be identified and constitute the *source of risk* assessment and management. For example, if measurements show that a given economic organization manifests a CTD of 1,12, this shows that each individual leaks on average 12% of its time, where *time leakage* may be understood here as an individual human worker consuming 12% time more than accounted for by the formal contracts. We denote this kind of risk here as "*CDT-risk*" (alternatively as *first order risk*). The key question here is *what magnitude* of CTD is present in a given economic organization (rather than if *it is present*). While this first order risk can be measured and identified quite straightforwardly, we also wish to introduce here another kind of risk that is related to the first order risk yet hidden in the economic set-up of an economic organization. We denote it here as "*CTD-economic risk*", alternatively as second order risk. We will show later that this second order risk is related in a complex manner to the first order risk, and indeed caused by CTD-risk, and that it has important implications on the performance of an economic organization.

5. The Second Order Risk: CTD's Economic Risk

We will start the elaboration of the second order risk with the conventional notion of profit, as expressed in the following equation:

$$\pi = TR - TC \qquad [U] \qquad 2.$$

In Eq. 2, π signifies here profit per time unit, *TR* the total revenues per time unit, and *TC* the total costs per time unit. The parameters are expressed in monetary units (U), preferably defined for the time unit of one year. It is useful to consider the *total workload-time to customers*, t_{vol}, of an economic organization on a yearly basis, while the market price for each hour delivered, p, is considered on an hourly basis. Accordingly, the expression $TR = p\ t_{vol}$ denotes the total annual revenues of one economic organization, here a service provider, that charges its customer the price of p U/hour, for the total workload time-volume of t_{vol} hours in a year. The employee salary per time unit is related to the market price, p, by the weight v_p, where $[0 < v_p < 1]$, so that the salary cost per time unit of one employee becomes $v_p\ p$. Thus, we can write eq. 1 as follows:

$$\pi = p\ t_{vol}(1 - v_p) \qquad (U) \qquad 3.$$

The expression between the parenthesis in Eq. 3 is the expression that will be further elaborated into the distortion economic function Q(τ). Firstly, consider a modification of Eq. 3 to express *total workload-time* to customers:

$$t_{tot} = \frac{\pi}{p}\frac{1}{(1-v_p)} \quad \text{(Hours)} \quad 4.$$

From Eq. 4 follows, that the more approaches 1, the higher the workload becomes, as measured in hours. Since CTD affects economy differently, depending on mode of contract, the variable α, [0 £ α £ 1] is used, where a value of unity signifies 100% of fixed-price contracts (and a value of zero signifies contracts on current account). In the following equation, it is assumed that the TR may consist of a mix of fixed price contract and a contract on current account.

$$t_{tot} = \frac{\pi}{p}\frac{1}{(\alpha+(1-\alpha)-v_p)} \quad \text{(Hours)} \quad 5.$$

Now we insert the CTD-variable *t* from Eq. 1 to Eq. 4, paying attention to the *linear* or *inverse* effects of CTD due to contractual category (von Schéele, 2001; von Schéele & Haftor 2014). Observe that the fixed price contracts are multiplied by (or), as discussed in Figure 1 above, while contracts on current account are simply multiplied with . In addition, CTD on Total Costs is here denoted by the symbol. For an organization with *one* customer contract (partly fixed price and partly on current account) and *one* employee, the workload is consequently as follows:

$$t_{tot} = \frac{\pi}{p}\frac{1}{\left(\alpha\frac{1}{\tau}+(1-\alpha)\varepsilon-v_p\frac{1}{\delta}\right)} \quad \text{(Hours)} \quad 6.$$

Eq. 6 exhibits time distortion in workload, as expressed in the case of one customer contract and one employee contract. Should the economy consist of several customers and employees, eq. 6 becomes more elaborate, with summation signs for “i” customer contracts and “j” employee contracts. This, however, lies outside the scope of this paper. We have now arrived at an equation in the following form:

$$t_{wd}(\tau,\delta) = \frac{\pi}{p}\frac{1}{Q(\tau,\delta)} \quad \text{[hour]} \quad 7.$$

Eq. 7 articulates that the total workload is dependent on τ and δ, and that the distortion function, , has an inverted influence on the total workload. Eq. 7 expresses the workload-time to customers, and signifies that the physical time values are dependent upon two kinds of risks:
i) T*he first order risk, here mathematically defined by P(τ) alternatively P(δ), which is an expression of the concept of CTD. This risk expresses the probability that a time distortion of magnitude τ (alternatively δ) will occur.*
ii) *The second order risk, here mathematically defined by the distortion function P(1/Q(τ)), which expresses the probability that an error of magnitude 1/Q(τ) will occur. This economic risk spells out the lever effect between the CTD and specifically the workload of an organization.*

To demonstrate the relation between the first order risk and the second order risk – the lever effect – we consider a CTD with a magnitude of $\tau = 1{,}1$, which means that each subjective hour is 10% longer than the physical hour. In addition, we assume a service delivery on a fixed price contract (= 1) and the market price margin corresponding to 0,6 (which means that salary level per hour is 60 % of market price per hour). A value of τ exceeding 1 automatically makes δ fall below the value of 1, so we insert $\delta = 0{,}9$.

Consider first Eq. 6 *without* any CTD:

$$t_{vol} = \frac{\pi}{p} \frac{1}{\left(1\frac{1}{1} + (1-1)1 - 0{,}6\frac{1}{1}\right)} \quad \text{(Hours)}$$

$$t_{vol} = \frac{\pi}{p} \frac{1}{(1 - 0{,}6)} \quad \text{(Hours)}$$

This shows that a workload of 2,5 times profit per market price corresponds to the budgeted time under present conditions.

Consider now Eq. 6 *with* CTD of 1,1:

$$t_{vol} = \frac{\pi}{p} \frac{1}{\left(1\frac{1}{1{,}1} + (1-1)1{,}1 - 0{,}6\frac{1}{0{,}9}\right)} \quad \text{(Hours)}$$

$$t_{vol} = \frac{\pi}{p} \frac{1}{(0{,}91 - 0{,}67)} \quad \text{(Hours)}$$

$$t_{vol} = \frac{\pi}{p} 4{,}17 \quad \text{(Hours)}$$

This shows that a CTD of 10 % has increased the workload by:

$$\Delta = \frac{4{,}17}{2{,}50} = 1{,}67$$

This represents an augmentation of 67 %. We can spell it out more formally by writing:
$\tau = 1{,}1 \rightarrow 1/Q(1{,}1) = 1{,}67$ under present conditions; (the arrows symbolizes ‘bring about’).

This is the so called ‘lever-effect’. It cannot be argued that first order risks, $P(\tau)$, occur with the same probability as second order risks, $P(1/Q(\tau))$. We do not have any support that there is any linear correlation between the first order risk (CTD) and the second order risk (economy). However, due to the lever effect, there is a mathematical-statistical support that the standard deviation of $1/Q(\tau)$ exceeds

that of τ.

Indeed, Figure 1 above shows that the asymmetrical probability function P(τ) of CTD differs, depending on whether the CTD originates from a laboratory setting or a business setting. In a business setting, the compounded time distortion τ exhibits a larger standard deviation, and there is a lower probability that it corresponds to unity (100 %), compared to laboratory settings. One explanation of this phenomenon is that any compounded time distortion forms an addition of the stochastic variables τ_a and τ_b, and addition of stochastic variables also induces an addition of their mean values as well as their *standard deviations*. Thus, compounded time distortion, such as for instance the aggregated time records of employees in a project, always has a *larger variance* than that of a single individual.

With these facts in mind, we can therefore make the following proposition:
CTD Risk Proposition: *The CTD risk on the first level in a system always gives rise to greater risks in interrelated second order systems.*

Therefore, with due respect to the perilous mechanism between CTD and the distortion function, we need to investigate *how to control Q(τ), by means of controlling* τ. This however lies outside the scope of this paper.

6. Discussion

In a systems science perspective, this paper addresses several different kinds of systems. According to the General Living Systems Theory (GLS, Miller; 1978), the variation dealt with here occurs within and between the Organism, the Group and the Organization. While Miller points out that each of these living systems include many non-living components or *artefacts*, that are crucial for the living system, we argue that some of the artefacts (economic formulas) are *erroneous* or *wrong* and misinterpret the environment in which the living system is trying to survive. Our suggestion is subsequently, that living systems with erroneous artefacts are endangered.

Miller argues that each level in the GLS is dependent on 20 subsystems to be able to support the phenomenon of life. For instance, subsystem “Input transducer” (no 11), “Internal transducer” (no 12), “Timer” (no 14), “Decoder” (no 15), “Encoder” (no 19) and “Output transducer” (no 20) may be relevant for the future research of CTD. At the present, however, we have treated them as a black box, mainly focusing on the variation between the different levels of living systems; the

Organism, the Group and the Organization. There does exist one important difference in our approach compared that discussed by Miller; we stress that the variation – the CTD – occurs *without the living systems being aware* of it. Regardless of whether it is an organism, a group or an organization, the CTD is an *unapprehensive variety*.

The Viable System Model (VSM, Beer, 1972) suggests a recursive model comprising of 5 different managerial subsystems. To handle the organization, the manager has to tame the mess according to some principles of the model, where the main concern is the *control function* and the concept of *variety*. The word "control function" should not be interpreted mathematically, since Beer does not suggest any particular mathematical approach. Instead, he focuses on the structure of the management system and defines the roles of each subsystem. In his VSM, Beer pronounces the importance of the terms variety, comparator, oscillation, attenuator, amplifier and transducer, to mention a few. However, little is said about *operationalization* of the terms with reference to individuals and economy. To this end, we present an operationalization of the variety (time-based variety) which may support measurement of amplification, transduction, oscillation and attenuation in systems as well.

Finally, the account for two kinds of temporal experience as offered here – the mechanical and the cognitive, echoes the antireductionist signals suggesting that humans operate with several kinds of temporal experiences, where the late Dutch philosopher Herman Dooyeweerd (1894-1977) proposed fifteen modalities of human experience, hence fifteen kinds of temporal experience, such as physical, biological, historic, economic, cognitive, social, and moral (Dooyeweerd, 1955). One of his key messages was not to reduce one kind of experience – here concerning time – to another one. In this sense, we offer one small step toward such an agenda, where we formalize two kinds of temporal experiences – the physical and the cognitive – and we also offer a formal relationship between the two, and a link between the described relation and the economic implications of an organization. In that manner our contribution validates Dooyeweerd's argument of multiple temporal experiences, and probably also extends it somewhat by showing that the various modalities may manifest non-trivial intermodal relationships, due to the latter's non-linear character.

7. Conclusions

In this paper we have presented two kinds of risks present in any economic

organization, namely:
The first order risk, understood as the magnitude of Cognitive Time Distortion, or the probability that the human cognitive system conceives a time assessment of level τ (or δ).
The second order risk, understood as the probability that the distortion function, here defined by 1/Q(τ,δ), assumes a given value with respect to budgeted economic targets.

The two kinds of interrelated risks introduced here, present in any economic organizations, stem from the inevitable human fallacy of time assessment. In this, the second order risk may be conceived as a lever effect of the first order risk, implying that the second order risk may be controlled when the first order risk is monitored and influenced. This, in turn, suggests that there is a need to identify practical means for identifying and influencing cognitive time distortion in economic organizations, with the potential benefit of improving their economic productivity, output quality, and peoples' well-being.

NOTES

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REFERENCES

Ashoff, J. (1985). On the perception of time during prolonged temporal isolation, *Human Neurobiology, 4,* pp.41 – 52.
Beer, S. (1972). *The Brain and the Firm*, Penguin Press, London.
Block, R.A., Eisler, H. (1999). *The complete bibliography on the psychology of time, 1839 –1999*. [Machine readable data file]. Bozeman: Montana State University, Department of Psychology [Producer and Distributor].
Campbell, S. S. (1990). Circadian Rhythm and Human Temporal Experience. In R. A. Block (Ed.) *Cognitive Models of Psychological Time*, Lawrence Earlbaum Ass. pp. 101–118.
Coase, R.H. (1937). The nature of the firm. *Economica*, N.S., 4 (16), 386-405.
Dooyeweerd, H. (1955). *A New Critique of Theoretical Thought*, Edwin Mellen.
Foss, N.J., Loasby, B.J. (1998). *Economic Organization, Capabilities and Co-ordination. Essays in Honour of G.B. Richardson*. Routledge, London.
ISU (1998). Organisation Intergouvernementale de la Convention du Métre, 1998. *The International System of Units (SI), 7th Edition* (PDF). Retrieved 2011-04-09.

Levin, I., Zackay, D. (Eds.) (1989). *Time and Human Cognition*. North-Holland: Elsevier Science Publishers.
Macleod, R., B., Roff, M.F. (1936). An experiment in temporal disorientation. *Acta Psychologica*, Vol. 1, pp.381–423
Miller, J. (1978). *Living Systems*, McGraw-Hill, NY.
Orlikowski, W. J., Yates, JA., (2002). It's about time: temporal structuring in organizations. *Organization Science*, Vol. 13, No. 6, pp. 684–700.
Pfeffer, J. (1997). *New Directions for Organization Theory. Problems and Prospects*. Oxford University Press, Oxford
Siffre, M. (1964). *Beyond time*. New York: McGraw-Hill.
Vernon J.A., Mcgill T.E. (1963). Time estimations during sensory deprivation. *J Gen Psychol*. Jul; 69:11-8.
Von Schéele, F. (1999). Business Risks in Service Companies due to Poor Temporal Assessment. In: B. Green (Ed.) *Risk Behavior and Risk Management in Business Life*. Kluwer Academic Publishers.
Von Schéele, F. (2001). *Controlling Time and Communication in Service Economy*. Doctoral Thesis. Royal Institute of Technology, Stockholm.
Von Schéele, F., Haftor, D.M. (2014). Cognitive Time Distortion on the Performance of Economic. *Systems Research and Behavioral Science*, Vol. 31, No.1, pp. 77-93.
Williamson, O.E. (1991) Strategizing, Economizing, and Economic Organization. *Strategic Management Journal*, Vol. 12, 75-9

IIDE Proceedings 2014 – Information – The 'I' In 21st Century Organizational IT Systems: An Informed Systems

Methodology

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In development for over a decade in three North American academic libraries, the Informed Systems Methodology offers transferable organizational development for fostering workplace learning empowered by catalytic relationships among information, technology, and people. With an explicit emphasis on using information to learn, 'soft' systems design tools aid co-creation of communication systems and professional practices that enable information sharing and knowledge creation processes. When contextualized by local values, experiences, and purposes, the ISM fosters organizational transformation and creative innovation.

1. *Introduction*

The development of information technology during the last decade or so has produced vast consequences and opportunities for many professionals. As an example in the academic environment, teachers in educational settings have had to adopt various Learning Management Systems and related pedagogy, and also to offer web based courses and programs. This radical departure in higher education from campus based teaching and face-to-face interaction with students necessarily requires significant re-thinking about how students learn within a virtual environment, and how teachers interact to engage students in learning experiences.

A second related example, which has been in our research focus for more than 10 years, concerns libraries and librarians' changing professional roles. This context

has driven our slong-term research efforts towards developing a methodology for designing and implementing new workplace processes, organizational structures, co-design tools, and conversation patterns by engaging library practitioners (Mirijamdotter & Somerville, 2008; Somerville & Mirijamdotter, 2014).
Before the development of web based technology, libraries and librarians were viewed as gatekeepers to information. Traditionally, library professionals described information objects through cataloguing metadata for indexing inventory, and manipulated information-finding tools through reference, research, and instruction services (Somerville et al, 2006). This mediation role originated as 'reader services' in the days of inadequate indexes (or no indexes) to published scholarly content. Then, in the early stages of computer-generated indexing, librarians were necessarily 'intermediaries' between the inhospitable 'native interfaces' to electronic databases of publisher(s) aggregated content. However, all this changed as searching algorithms for 'born digital' content permitted 'disintermediated' Google-like searching, without need of a librarian coach (Somerville et al, 2012). More recently, new researcher productivity tools (Somerville & Conrad, 2014a; 2014b) accentuate the possibilities for independent research unaided by library science expertise. At the same time, librarians are experiencing decreasing gate counts and diminishing consultation transactions, despite increased student enrolment (Mirijamdotter & Somerville, 2009). Even as libraries and librarians became increasingly marginalized in the academic environment, advanced information and communication technologies (ICT) and plentiful digital information resources encouraged heightened expectations from academic library users. These developments necessitated re-thinking within academic libraries about professional purposes, conventional processes, and traditional relationships.

Our research focuses on information and its connection to learning and is based on the assumption that changes in organizational patterns of behaviour need to build on inclusive workplace learning processes. For facilitating these processes, we both adopt and adapt Peter Checkland's Soft Systems Methodology (e.g., Checkland, 1981; 2000; 2011; Checkland & Holwell, 1998a; Checkland & Poulter, 2006), that focuses on collaborative design of communication, decision-making and planning systems, which are necessary for purposeful workplace activities that support change in understanding (i.e., learning) and, thereby, change in behaviour. Complementary theories, such as Christine Bruce's Informed Learning theory (e.g., Bruce, 2008; Bruce & Hughes, 2010; Bruce et al, 2012), emphasize

experiences of using information to learn. Dialogue and reflection processes further activate information experiences through information transfer and knowledge creation. Together, these guiding philosophies, design tools, and theoretical insights enable and enliven re-thinking workplace systems and associated professional practices. Thus, the research efforts include challenging underlying assumptions that historically guided the library workplace and build on inclusive workplace learning processes by means of participatory action research. Such a unified approach that emphasizes information and its connection to learning, including initiating inquiring workplace culture encouraged by collaborative professional practices, was found to be absent in existing theories of organizational learning (Crossan et al, 2011; Somerville et al, 2014).

Information nowadays includes both electronic and physical forms, known as e- or p-resources. Therefore, organizational structure and workplace processes must ensure management of needed information, regardless of authoritative source, resource format, or delivery channel. This requirement is particularly relevant to libraries, which must select, organize, and manage information. To know what information to collect and then how to make it discoverable and accessible requires understanding how the library's role furthers the current mission and vision of the educational institution and, relatedly, the changing expectations and needs of campus constituencies. Findings in each academic library that we have studied showed that this was not initially the case. Therefore, we have explored participatory approaches in our research that build a holistic perspective to raise awareness of individual, group, and organizational contributions to the mission and purpose of the overall organization through conscious use of information to enable changes in organizational behaviour. Toward these ends, this paper presents essential elements of the Informed Systems Methodology (ISM) and infrastructure requirements for activating and sustaining informed learning and systems thinking in contemporary organizations, as represented in the ISM. The paper ends with some concluding remarks about the methodology's transferability, and further challenges to address.

2. *Theoretical foundations*

The Informed Systems Methodology (ISM) is the result of a decade of design and implementation activities related to library services, organizational systems, and library facilities (e.g., Somerville & Howard, 2008; Somerville, 2009; Mirijamdotter & Somerville, 2009; Somerville & Howard, 2010; Somerville & Farner, 2012; Somerville, 2013; Howard & Somerville, 2014; Somerville, 2014).

The theoretical foundations are based on Systems Thinking and Information Management as represented particularly by Soft Systems Methodology (e.g., Checkland, 1981; 2000; 2011; Checkland & Holwell, 1998a; Checkland & Poulter, 2006) and Informed Learning Theory (e.g., Bruce, 2008; Bruce & Hughes, 2010; Bruce et al, 2012) respectively.

Systems thinking recognizes that each individual and organizational unit is a part of a whole. Systems thinking acknowledge that any organization is also part of a larger enterprise, in other words, "an autonomous whole while at the same time being a functioning part in a larger whole" (Checkland, 2011, p. 490). Each part therefore needs to reflect the mission of the overall system and identify its contribution to the whole. Additionally, each part is related to other parts within the whole by information and communication flows and thus affects and is affected by information, whether deliberate or unintended.

Information Management (IM) entails organization and coordination of the structure, processing and delivery of information. The aim is to "provide data and information to users with the appropriate levels of accuracy, timeliness, reliability, security, confidentiality, connectivity, and access and … tailor these in response to changing business needs and directions" (Mithas et al, 2011: 238). The area itself can be traced back a century and has gone through several stages, where organization and control were considered central regardless of whether information was on paper or online, records management through use of computers and other related technologies, or so called management information systems (MIS) elaborated for the purpose of supporting decision-making and prognostics (Dias, 2001). In the 1970s, strategies for managing all necessary information in an enterprise evolved and a new concept – knowledge management – appeared (Dias, 2001).

In more recent research, IM is associated with diverse applications, such as big data, data warehouse, and business intelligence (McKnight, 2014). It is also referred to in relation to a variety of purposes, such as development of multi-agent e-Government services (Teo & Koh, 2010) and internationalization of small and medium sized enterprises, so called SMEs (Dutot et al, 2014), in reviews on literature on Personal Information Management (Wiggins, 2014), and in bibliometric analysis and software tools (Gomez-Jauregui et al, 2014). IM also includes models of information flows (Durugbo et al, 2013), information technology capabilities and companies' information requirements (Dutot et al, 2014), and information systems management – "managerial and technical

strategies and competencies that significantly improve or add value to the use of information systems within an organisation" (Booth & Philip, 2005: 287).
The commonality among all these approaches is related to managing information for the purpose of developing or operating the business more efficiently, and the focus is on digital technology and information systems. However, as stated on the International Journal of Information Management homepage, "The challenge for Information management is now less about managing activities that collect, store and disseminate information. Rather, there is greater focus on managing activities that make changes in patterns of behaviour of customers, people, and organizations, and information that leads to changes in the way people use information to engage in knowledge focussed activities"
(http://www.journals.elsevier.com.proxy.lnu.se/international-journal-of-information-management).

3. *Assumptions*
The Informed Systems Methodology (ISM) recognizes that all human practices and information experiences are social. They originate from interactions (and ultimately relationships) among community members and within communities-of-practice (Wenger, 2000), including formal and informal learning communities. Our approach reflects a holistic systems perspective, which acknowledges that any organization is part of a larger enterprise. However, while fulfilling a function in relation to the larger whole, the part in itself is an autonomous whole, which, in turn, includes parts that have a relation to each other. Thus, there is an interconnection between organizational parts and members.
ISM also assumes that:
"*people can learn to create knowledge on the basis of their concrete experiences, through observing and reflecting on that experience, by forming abstract concepts and generalizations, and by testing the implications of these concepts in new situations, which lead to new concrete experience that initiates a new cycle. This assertion fortified our aspiration to develop reflective practitioners who learn through critical (and self-critical) collaborative inquiry processes that foster individual self-evaluation, collective problem-formulation, inclusive contextualized inquiry, and professional development*" (Somerville & Mirijamdotter, 2014, p. 206).

A workplace organization is therefore operationally defined as a purposeful social interaction system in which collective information experiences and new

knowledge develop through workplace socialization processes. From this standpoint, projects aim to establish and embed the sustainable social interactions which, through organizational systems animated by careful attention to information experiences, dialogue and reflection enable investigation and negotiation of the interests, judgements, and decisions by which people learn interdependently.

To animate workplace environments, participants inclusively design (and re-design) enabling information systems in which they advance understanding of topics under discussion as they simultaneously further improvements in organizational systems and information practices. Within this context, *culture* is understood as a shared basis of appreciation and action, developed through communication and maintained through relationships within an organization.

A final assumption is that the employment of inclusive design and evaluation practices furthers professional information practices and strengthens contextualized information experiences. Informed organizational learning is thereby promoted. Practical learning outcomes include collective alignment and shared understanding of the organization's purposes and priorities, which guide fiscal and human resource allocations, as well as day-to-day decision-making. In addition, pervasive "systems thinking" incorporates and values people's information experiences and encourages understanding self and others as part of a larger whole. In combination, these elements inform concerted action to ensure that organizations continue to foster informed learning through evolving organizational structures, services, processes, and roles. We mention these factors as assumptions since we cannot empirically 'prove' that these are 'true' and because we base the methodological processes on these assumptions.

4. *Methodological Principles*

Informed Systems Methodology (ISM) is a framework that co-creates organizational learning and agile responsiveness through application of the principles of systems thinking and informed learning. Its focus is on managing activities that make changes in organizational behaviour, building both on information that leads to changes and the way people use that information. This is accomplished by establishing an appreciative setting for the co-design of workplace and inquiry activities. Thus, it incorporates notions of parts existing within a whole and varying information experiences as a vital part of using information to learn.

Situated real world initiatives are conducted according to Soft Systems Methodology (SSM) processes, which necessarily include multiple stakeholders and beneficiaries who share information and professional and positional perspectives during structured inquiries, discussion and debate. Processes involve using information to learn through engaging participants in a variety of information experiences that typically consists of these elements:
* Enter a situation deemed problematical and take part in improving it;
* Find out how the situation is understood and identify multiple world views;
* Make purposeful activity models based on declared pure world views;
* Use models to question the real world, structuring discussion and debate;
* Use the discussion/debate to find accommodations among conflicting world views, to allow action-to-improve which is both systemically desirable and culturally feasible;
* Take the action; and
* At a meta-level, continually iterate among the above to ensure sustained learning (adapted from Checkland, 2011).

In an iterative fashion, the preceding elements generate evidence from multiple perspectives, which inform intentional dialogue and reflection on both the research investigation content and process, and thereby also the enabling workplace systems and structures. Thus, the prevailing methodological perspective is based on participatory actions research in which concerned are part of the process and together reflect on its outcome in organised evaluative sessions. What will come out and what will be reflected on are not decided on before-hand through controlling models and parameters; being a learning process, the outcomes evolve through participatory reflections in which relevance and significance are jointly discussed and debated among the partakers, focusing the themes of the inquiring process, and reported on for the purpose of communicating to other stakeholders including own organization (Checkland, 2011; Checkland & Holwell, 1998b).

5. *Experience*
Bruce's informed learning conception (2008) purposefully advances participants' consideration and experience of the role of information in ever expanding professional contexts. Her research demonstrates the need for workplace learning to recognize that people experience information and use information to learn in differing ways. Therefore, the Informed Systems Methodology (ISM) places

information in ever expanding professional contexts through purposefully varying individual and group information experiences.

For instance, a successful web-scale discovery service (Somerville et al, 2012) implementation originated with technical services leadership in 2010. Over the course of two years, various organisational task forces applied their collective professional expertise to advance the discovery service lifecycle from selection and procurement to implementation and customization. Throughout, meeting minutes and e-mail updates, complemented by unit level conversations and enterprise level coordination, ensured organization wide awareness of progress and problems, as well as "forward thinking" anticipation of customizations and refinements (Somerville, 2013a). At the enterprise level, the Shared Leadership Team (SLT), which at that time consisted of 23 staff members from different organizational units (out of total 76 library staff), provided high level coordination of the human and fiscal resources and logistical support needed to implement this new service over twenty three months. The high percentage of staff directly involved ensured that, in this way, collective capacity for knowledge advancement and, ultimately, workplace reinvention, evolved.

Viewed through an information management lens, the discovery service task force participants, comprised of five staff members from different organizational units, collectively expanded the information horizons of their work environments. While engaging with new information types and communication processes, they established valuable information-sharing relationships that extended beyond the team boundaries of each organizational unit and continued beyond the twenty-three month life of the task force as members applied insights to on going evaluation and improvement of workplace decision-making and action taking systems, with coordination oversight by the SLT. This example demonstrates the inter-related elements of workplace information experience: its situatedness; its connection with informed learning and transformative outcomes; and its cognitive and social dimensions, through critical and creative information use and the generation and sharing of new knowledge.

In an iterative fashion, the ISM generates evidence from multiple perspectives and informs intentional dialogue and reflection on both the research content and process and also the enabling workplace systems and structures. This workplace information experience can be characterized as a cyclical spiral composed of planning, action and evaluation about the result of the action. Participants therefore enter into "a problematical situation and becomes a participant as well

as a researcher, using reflections on the experience gained as his or her source of learning" (Checkland, 2011, p. 499).

6. *Design and Implementation*

A series of workshops conducted at the University of Colorado Denver in March 2009 enabled the creation of a technology-enabled systems infrastructure in an evidence-based organizational culture grounded in shared leadership principles.

Over three days, employing Soft Systems Methodology (SSM) philosophy and tools, Mirijamdotter (2009) delivered workshops in which 16 organizational participants analyzed communication channels, respective benefits, and current structures, as well as workplace processes and purposes of communicating, deciding, and planning. She guided participants from surfacing general observations about characteristics of various communications channels in the current environment to identifying design characteristics for ideal communications, decision making, and planning systems.

Since ideal systems must satisfy shared needs, she also elicited common concerns on the "problem situation". These included: to inform oneself, inform others, practice collaborative evidence based decision making, avoid duplication of effort, ensure team accountability, solve technological problems, share "big picture" professional frameworks, and disseminate organizational policies and procedures (Mirijamdotter, 2009). In moving from needs finding to system designing, Mirijamdotter further exercised participants' unexamined assumptions about framing research questions, identifying authoritative sources, and applying interpretative frameworks.

Outcomes of Mirijamdotter's workshop for the Shared Leadership Team (SLT) illustrate the potential of this generalizable workplace learning approach. During the session, members expressed collective appreciation for the potential of shared leadership and common agreement on the role of this organizational oversight group. They understood that, given the breadth and depth of the SLT charge, members are recruited from across the organization to ensure rich representation of functional unit perspectives, both among formally designated leaders (on the organizational chart) and also informal thought leaders, knowledge enablers, and culture shapers throughout the organization. During the workshop, SLT members produced visual renderings ("rich pictures") illustrating various perspectives on ideal workplace systems, of which they were a part (Mirijamdotter & Somerville, 2011).

The SLT rich pictures represented a workplace environment of dialogue and reflection that provided sufficient time for fruitful discussion enabled by constructive "meaning making" behaviours. The renderings incorporated the inclusive inquiry processes introduced in the initial SSM needs finding workshops, preparatory to addressing issues in the perceived problem situation in the second phase. In this instance, focus of concern involved identifying ideal modes of communication for shared leadership through informed learning grounded in effective information experiences. Workshop participants evaluated the process and outcomes positively, as illustrated by the following appreciative observations: "It was a pleasure to collaboratively work together and experience commonalities, as well as different points of view." "The structured learning exercises offered rich communication opportunities, which enabled decision making and action taking." "It's possible to establish shared priorities" (Mirijamdotter, 2009). These intentional information experiences served to prepare staff members to continuously use information to learn within an enabling systems infrastructure, designed *with* and *for* them (Mirijamdotter, 2010).

7. *Implications in practices*

As a direct result of these workshops, the process, outcomes, and aspirations of the Shared Leadership Team (SLT) meetings continue to evolve, with the intention of creating more shared information experiences in which disciplinary (and transdisciplinary) questions inform information practices. Agendas are collectively constructed in advance of meetings. Time limits are allocated for agenda items with the aim of encouraging dialogue and reflection followed by decision making to inform action taking. Conference rooms have been equipped with laptops and monitors, permitting simultaneous note taking that support collective sense making. In addition, the experience of agenda building, meeting presentation, and minute taking offers valuable practice with wikis and other 2.0 technologies (Somerville & Howard, 2010).

These collaboration innovations recognize that the organization's communication system can "flourish like an eco-system, with the SLT as a primary source of energy radiating" (Mirijamdotter, 2009) through appropriate communication channels employing effective information practices within enabling organizational systems. To ensure organization wide benefit, SLT minutes are regularly discussed in various face-to-face meetings to ensure ample dialogue and reflection on organizational governance outcomes, of critical importance as

employees re-invent themselves (Pan, 2012; Somerville & Farner, 2012) and their workplace.

Since these Informed Systems Methodology (ISM) workshops, SLT members continue to analyze and (re)design systems and practices. Meeting agendas explore such questions as how to build heightened awareness of information experiences through using information to learn, rather than merely acquiring specific skills. To further cross-functional teamwork, members consider how to advance social collaboration and inter professional interdependence, rather than emphasize individual capability.

Complementary activities cultivate organizational and team leaders, who further dialogue and reflection for sense making and knowledge creation. They encourage and resource robust partnerships among library employees, campus leaders, and academic beneficiaries, which extend collaborative, informed practices sustained through continuous campus wide learning relationships (Somerville, 2014). As a consequence, a pilot project aims to engage professors and librarians in co-creating learning partnerships that transfer 'lessons learned' from workplace inquiry, research, reflection, dialogue, and planning practices to co-design of robust classroom for information experiences (Hughes & Bruce, 2012).

Highlighting the informed learning experience, the ISM cultivates recognition that workplace learning requires heightened appreciation of information and improved understanding of information gathering, evaluating, interpreting, sharing, and using, given varying contexts. It also requires reflection followed by opportunities for participants to apply their new learning to novel contexts. In this way, ISM provides infrastructure for intentionally designed informed learning environments, which simultaneously develop learning processes and professional practices (Somerville, 2014; Somerville & Mirijamdotter, 2014; Somerville, Mirijamdotter, Bruce, & Farner, 2014).

8. *Concluding Remarks*

In order to amplify workplace learning and organizational development, and accelerate changes in organizational behaviour, formal organizational leaders and others designated as thought leaders, culture shapers, or knowledge enablers must understand how participants (inside and outside the organization) are experiencing both information content and use. Such insights permit design of optimal learning experiences through simultaneous cultivation of discipline and process learning, which also requires consideration of what constitutes

knowledge from different points of view in various problem situations.
The Informed Systems Methodology (ISM) also encourages evolution of collaborative, socio-cultural practices – a constellation of skills, practices, and processes (Lloyd 2006) – within context specific environments. When supported by enabling face-to-face and technology enabled organizational systems that advance communication and sustain relationships, workers can learn to see the world in new or more complex ways as they progressively use information to engage in varied knowledge-focussed activities. Such heightened interaction with information in context transforms both workplace learning and organizational culture. In other words, ISM nurtures informed learning through the creation of new and more complex experience of using information for learning within systems infrastructure paired with negotiated professional information practices.
Characteristically, the ISM builds on systems thinking expressed as systems design enriched by informed learning theory. When integrated into workplace culture, this approach furthers co-workers' shared visions and common values. The participatory nature of this approach, combining systems and experiential thinking, invites stakeholders to contribute their varied knowledge and offers a framework for informed decision making and action taking. When staff members are invited and enabled to participate in decisions likely to affect their work, the resulting creativity and collectivity, people and perspectives, and cooperation and negotiation change the nature of both work and the workplace.

However, for the application of ISM to be efficient and sustainable, it needs to activate thought leaders, culture shapers, boundary spanners, and knowledge enablers throughout the organization who are willing to lead. Furthermore, enterprise level communication systems and shared focus on creating information experiences in work processes are essential to catalyse and sustain collective learning (Somerville, 2013b). Finally, successful practice of innovative Informed Systems leadership requires support from top management within an organization. These are lessons learnt through testing the applicability of the ISM approach in different organizations.
Other persistent implementation challenges relate to introducing new, dynamic expectations about traditional roles and cultural values, including decentralized and transformational leadership, within traditional hierarchical organizational structures and information flows fortified by legacy traditions and established conventions. – It's akin to building the plane while flying it, as re-invention necessarily occurs simultaneous with keeping the doors open for business. –

Additionally, as the organization hires new employees who have not participated in the development of the 'new organization', how are they best oriented, invited, and enabled to build information experiences within continuously improved systems infrastructure? These are some of the issues we continue to explore as we gain further experience with methodology use, its transferability and its generalizability.

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NOTES

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REFERENCES

Booth, M.E., & Philip, G. (2005). Information systems management in practice: An empirical study of UK companies, *International Journal of Information Management*, vol. 25(4), pp. 287-302.
Bruce, C. S. (2008). *Informed learning.* Chicago: Association of College & Research Libraries.
Bruce, C., & Hughes, H. (2010). Informed learning: a pedagogical construct attending simultaneously to information use and learning. *Library and Information Science Research*, vol. 2, pp. A2-A8.
Bruce, C. S., Hughes, H., & Somerville, M. M. (2012). Supporting learners in the 21st century. *Library Trends*, vol. 60(3), pp. 522-545.
Checkland, P. (1981). *Systems Thinking, Systems Practice*. Chichester, U.K.: John Wiley and Sons.
Checkland, P. B. (2000). Soft Systems Methodology: A Thirty Year Retrospective. *Systems Research and Behavioral Science*, vol. 17(S1), pp S11-S58.
Checkland, P. (2011). Autobiographical retrospectives: Learning your way to 'action to improve' – the development of soft systems thinking and soft systems methodology. *International Journal of General Systems*, vol. 40(5), pp. 487-512.

Checkland, P. and Holwell, S. (1998a). *Information, systems and information systems – Making sense of the field.* Chichester, U.K.: John Wiley and Sons.
Checkland, P. and Holwell, S. (1998b). Action Research: Its nature and validity. *Systems Practice and Action Research,* vol. 11(1), pp 9-21.
Checkland, P. and Poulter, J. (2006), *Learning for action: A short definitive account of Soft Systems Methodology and its use, for practitioners, teachers and students.* Chichester, U.K.: John Wiley and Sons.
Crossan, M. M.; Maurer, C. C.; White, R. E. (2011). Reflections on the 2009 AMR Decade Award: Do We Have a Theory of Organizational Learning? *Academic of Management Review* vol. 36, pp. 446-460.
Dias, C. (2001). Corporate portals: a literature review of a new concept in Information Management, *International Journal of Information Management,* vol. 21(4), pp. 269-287.
Durugbo, C., Tiwari, A., & Alcock, J.R., (2013). Modelling information flow for organisations: A review of approaches and future challenges. *International Journal of Information Management,* vol. 33(3), pp. 597-610.
Dutot, V., Bergeron, F., & Raymond, L., (2014). Information management for the internationalization of SMEs: An exploratory study based on a strategic alignment perspective, *International Journal of Information Management,* vol. 34(5), pp. 672-681.
Gomez-Jauregui, V., Gomez-Jauregui, C., Manchado, C., & Otero, C., (2014). Information management and improvement of citation indices, *International Journal of Information Management*, vol. 34(2), pp. 257-271.
Howard, Z., & Somerville, M. M. (2014). A comparative study of two design charrettes: Implications for codesign and Participatory Action Research. Co-Design: *International Journal of CoCreation in Design and the Arts*, vol. 10(1), pp. 46-62. (Special Issue on 'codesigning through making') doi: 10.1080/15710882.2014.881883
Hughes, H., & Bruce, C. (2012). Informed learning in online environments: Supporting the higher education curriculum beyond Web 2.0. In P. Godwin and J. Parker (Eds.), *Information literacy beyond Library 2.0*, pp. 65-79. London, UK: Facet.
International Journal of Information management. http://www.journals.elsevier.com.proxy.lnu.se/international-journal-of-information-management (retrieved Aug. 1, 2014).
Lloyd, A. (2006). Information literacy landscapes: An emerging picture. *Journal of Documentation,* vol. 62(5), pp. 570-583.

McKnight, W. (2014). Information management : strategies for gaining a competitive advantage with data. Waltham, MA : Morgan Kaufmann.
Mirijamdotter, A. (2009). *Auraria Library report on communication systems*. Unpublished paper.
Mirijamdotter, A. (2010). Toward evidence based information practices: Organization and leadership essentials. *Evidence Based Library and Information Practice*, vol. 5(1), pp. 17-25.
Mirijamdotter, A., & Somerville, M. (2008). Systems thinking as a leadership tool for organizational effectiveness: A North American case study. In Basden, A, Eriksson, D. M., & Strijbos, S. (Eds.), *Combined Proceedings of the 13th and 14th Annual Centre for Philosophy, Technology, and Systems* (CPTS) Working Conference, Maarssen, The Netherlands: CPTS, pp 82-105.
Mirijamdotter, A. and Somerville, M.M. (2009). Collaborative Design: An SSM-Enabled Organizational Learning Approach. *International Journal of Information Technologies and the Systems Approach,* vol 2 (1), pp. 48-69.
Mirijamdotter, A. and Somerville, M.M. (2011). From Vision to Action : a Collaborative Organizational Informatics Initiative. In: Skaržauskienė, A., Paražinskaitė, G., Tamošiūnaite, R. (eds.) *Proceedings of Social Technologies '11: ICT for Social Transformations, Vilnius, Lithuania*, Nov. 17-18. ISBN 978-9955-19-378-4.
http://lnu.diva-portal.org/smash/record.jsf?searchId=2&pid=diva2:474788
http://www.mruni.eu/mru_lt_dokumentai/fakultetai/socialines_informatikos_fakultetas/Konferencija/Conference-proceedings_Social-Technologies-11.pdf
Mithas, S., Ramasubbu, N. & Sambamurthy, V. (2011). How Information Management Capability Influences Firm performance. *MIS Quarterly*, vol. 35(1) pp. 237-256.
Pan, D. (2012). Staffing changes to facilitate the shift to electronic resources. In *Managing Electronic Resources: A LITA Guide*, R. Weir (Ed.), Chicago, Illinois: American Library Association, pp. 121-136.
Somerville, M. M. (2009). *Working together – Collaborative information practices for organizational learning*. Chicago, IL: Association of College & Research Libraries/American Library Association.
Somerville, M. M. (2013a). Digital Age discoverability: A collaborative organizational approach. *Serials Review*, vol 29(4), pp. 234-239.
Somerville, M. M. (2013b). *Toward Informed Learning in professional practice.* Keynote address at The Fifth Information Literacy Research Symposium, The Purdue University Libraries, West Lafayette, Indiana.

Somerville, M. M. (2013b). Digital Age discoverability: A collaborative organizational approach. *Serials Review,* vol. 29(4), pp. 234-239

Somerville, M. M. (2014). Organizational systems, learning processes, and knowledge practices: Informed Systems Methodology elements. *International Conference Proceedings –Information Systems and Technology Innovations 2014* (ISTI 2014), Tirina, Albania.

Somerville, M. M., & Conrad, L. Y. (2014a). *Collaborative improvements in the discoverability of scholarly content: Accomplishments, aspirations, and opportunities.* A SAGE White Paper. Los Angeles, CA: SAGE Publications Ltd. doi: 10.4135/wp140116. Available: http://www.sagepub.com/repository/binaries/pdf/improvementsindiscoverability.pdf

Somerville, M. M., & Conrad, L. Y. (2014b). Toward improved discoverability of scholarly content: Cross-sector collaboration essentials. *Collaborative Librarianship*, vol. 6(1), pp. 42-46.

Somerville, M. M., & Farner, M. (2012). Appreciative Inquiry: A transformative approach for initiating shared leadership and organizational learning. *Revista de Cercetare si Interventie Sociala* [Review of Research and Social Intervention], vol. 38 (September), pp. 7-24.

Somerville, M. M., & Howard, Z. (2008). Systems thinking: An approach for advancing workplace information literacy. *Australian Library Journal*, vol. 57(3, August), pp. 257-273.

Somerville, M. M., & Howard, Z. (2010). 'Information in context': Co-designing workplace structures and systems for organisational learning. *Information Research*, vol. 15(4, December): paper 446. http://InformationR.net/ir/15-4/paper446.html

Somerville, M. M., & Mirijamdotter, A. (2014). Information experiences in the workplace: Foundations for an Informed Systems Approach. In: C. Bruce, H. Partridge, H. Hughes, K. Davis, & I. Stoodley (Eds.), *Information Experience: Approaches to Theory and Practice*, pp. 203-220. (Library and Information Science, Vol. 9) Bingley, United Kingdom: Emerald. doi: 10.1108/S1876-056220140000010010

Somerville, M. M., Mirijamdotter, A., Bruce, C. S., & Farner, M. (2014). Informed Systems Approach: New directions for organizational learning. In: Jaabæk, M., & Gjengstø, H. *Proceedings of the International Conference on Organizational Learning, Knowledge, and Capabilities* (OLKC 2014: Circuits of knowledge), Oslo, Norway: BI Norwegian Business School.

http://www.diva-portal.org/smash/get/diva2:714317/FULLTEXT02.pdf
Somerville, M. M., Mirijamdotter, A., and Collins, L. (2006). Systems thinking and information literacy: Elements of a knowledge enabling workplace environment. In: *Proceedings of the 39th Annual Hawaii International Conference on Systems Sciences* (HICSS-39). (CD-ROM) Also available: http://csdl2.computer.org/comp/proceedings/hicss/2006/2507/07/250770150.pdf.
Somerville, M. M., Schader, B. J., & Sack, J. R. (2012). *Improving the discoverability of scholarly content in the Twenty-First Century: Collaboration opportunities for librarians, publishers, and vendors*. A SAGE White Paper. Los Angeles, CA: SAGE Publications Ltd. Available: http://www.sagepub.com/repository/binaries/librarian/DiscoverabilityWhitePaper/
Teo, T.S.H., & Koh, T.K., (2010). Lessons from multi-agency information management projects: Case of the Online Business Licensing Service (OBLS) Project, Singapore. *International Journal of Information Management,* vol. 30(1), pp. 85-93.
Wenger, E. (2000). Communities of practice and social learning systems. Organization, vol. 7(2), pp. 225-246.
Wiggins, B. (2014). Reviews – Transforming Technologies to Manage Our Information. The Future of Personal Information Management: Part 2, W. Jones. Morgan & Claypool, San Rafael (2014), 179 pp., price: £24.99, ISBN: 978-1-59829-937-3. *International Journal of Information Management*, vol. 34(4), pp. 562-564.

IIDE Proceedings 2014 – A Dooyeweerdian Understanding Of Affordance In Information Systems And Ecological Psychology

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Affordance is attracting considerable interest but it poses significant philosophical challenges, around meaningfulness and the subject-object relationship, as well as less fundamental methodological challenges, such as complexity and translation of idea from one field to another. At this point, the fields in which the notion of affordance is discussed, from ecological psychology to information systems, do not speak to each other and especially in the IS field the treatment of affordance is ad-hoc. This paper discusses how Dooyeweerd's philosophy can very readily address the philosophical challenges, and provide validation and guidance for the methodological challenges. Dooyeweerd would base affordance in his 'oceanic' idea of meaningfulness, and provide a workable definition of affordance as the relationship between two ways of being meaningful (two aspects). The usefulness of this is explored. The paper also discusses some practical applications of a Dooyeweerdian understanding of affordance.

1. *Introduction*

The idea of affordance has aroused interest in several fields of study of information and communication technology (ICT). Especially in the fields of human-computer interaction (HCI), which focuses on how individuals use ICT, and information systems (IS), which focuses on the benefits of using ICT, affordance was called upon to address issues that had long been found challenging.

In the field of HCI, it was noticed that some designs of the user interface (the screen etc. with which the user interacts in HCI) were easier to use than others – that is, they afforded greater or lesser ease of use. Though ergonomics, psychology, and the amount of skill the user has, affect ease of use, there also seemed to be something about the design and shape of the user interface objects

themselves that affected ease (of difficulty) of use. The notion of affordance was harnessed by Norman (1988) and others (e.g. Hartson 2003) to explain this.
More recently, in the field of IS, affordance has been harnessed by several scholars to explain why ICT facilities make specific human activities easier or more difficult, and tend to bring certain benefits rather than others. For example, triggered attending to online conversations (Majckzrak et al. 2013) reduces need to keep watch on conversations, but it can also reduce the depth of engagement. Networked ICT can assist speedy change to documents (Conole & Dyke 2004) but can also bring confusion. Attempts to account for these solely in terms of power relations, attitude or capability of users proved insufficient, because the actual design of the facilities 'affords' these activities or benefits.
Originally proposed by J.J. Gibson (1979) in the field of ecological psychology, the idea of affordance shows considerable promise in these fields. It also presents new challenges. Some challenges arise from complexity, some arise from translating the idea from psychology, and some arise from fundamental philosophical issues like the subject-object relation and understanding what affordance is.
This paper discusses these challenges, and explores briefly whether the philosophy of Dooyeweerd can address them. The emphasis will be on affordance in the field of IS more than in HCI or psychology, because of its greater complexity. The idea of affordance and its roots in psychology are explained, with a discussion of how it has been translated across to HCI and IS. Four kinds of challenges are outlined. How these challenges may be addressed by Dooyeweerd's philosophy is explored, and a few practical examples are given.

2. *Affordance*

A rock (a flat, horizontal, extended, rigid surface up to knee-high) affords climbing to an animal and a hole in a hedge or wall affords going-through (Gibson 1979, 127): "The affordances of the environment are what it offers the animal, what it provides or furnishes." The word 'affordance' was coined by Gibson to denote a phenomenon that had not been adequately discussed and did not even have a name before, and his exploration of this notion stimulated the field of ecological psychology. The notion of affordance, at root, does not just deal with animals climbing rocks, but with any situation in which an agent interacts with things in its environment – or indeed with the environmental situation as a whole. It addresses issues of perception and what is perceived, of action and possibility, and how these are 'afforded' by properties of things in the environment. Gibson

(1979, 129) characterizes affordance as “physical and psychical”, in that the physical properties of the environment afford psychical properties like ‘climbability’, which are meaningful to the animal.

The relationship between agent and environment is very similar to that between subject and object. Yet Gibson and other ecological psychologists have found that current presuppositions about subject and object need to be questioned. “Gibson’s concept of affordances was an attempt to undermine the traditional dualism of the objective and subjective” (Costall 2012). Shaw (2003, 93) praised Gibson’s courage: “where most psychologists and philosophers are happy naming the divide the subjective-objective, Gibson would rather we repair the cut entirely by a kind of relational integration”. With Gibson, “one gets subjectivity and objectivity wrapped up in a single package” (Shaw 2003, 97).
The idea of affordance as an attempt to understand the relationship between agent and environment is relevant across many fields. In the field of artefact design, for example, some door handles afford pulling (those that can be grabbed), while others (those that look like plates) afford pushing (Norman 1988). Though plate-like door handles can also be pulled if bent round, they do not invite pulling, and labels saying ‘Pull’ must be installed. What is it about such artefacts that does the affording? How much is social convention, and how much is psychological or even physical?

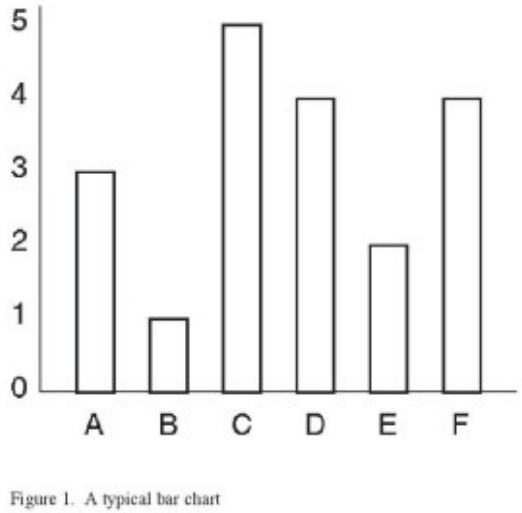

Figure 1. A typical bar chart

Figure 1. A typical bar chart

The field of human-computer interaction faces similar issues (Hartson 2003). The

agent is the computer user, and the environment is what of the user interface is seen, heard and manipulated via mouse or finger. What is meaningful to the user is not just these sights, sounds and muscular controls, but the information they carry. For example, a bar chart (a set of long thin rectangles arranged side by side, as shown in Figure 1) is most naturally interpreted by the user as a set of quantities that can be compared. For example, if A-F are nations, then we would expect the numbers 0-5 to indicate population, size of GDP, proportion of land devoted to agriculture, for each nation. However, if the numbers 1-5 indicated religions, main language spoken, this would be possible, but not so natural. The naturalness can be explained by affordance: length of bar affords quantity, not relationship, and proximity of bar affords comparison.

In the field of information systems (IS) the agent is the user and those with whom the user engages, while the environment is the ICT facilities they use – but it is not what the user sees or hears, as in HCI, but the information that is carried via the user interface. It is an informational environment, not physical nor sensory. What they afford is human activities that are meaningful in the life, work and roles of the user. The presence and the shape of ICT facilities available enable or constrain such activities, yielding benefits or problems.

Various kinds of IS affordance have been discussed. For example, Internet-connected ICT affords accessibility to information, speed of change of information, communication etc., but also monopolization and risk (Conole & Dyke 2004). If affords visibility of content, persistence of content, editability of content, and association (Treem & Leonardi 2012). Social media in organisations afford metavoicing (ability to comment on the presence rather than content, e.g. by voting 'Like'), triggered attending (setting emails or blogs to alert us to certain topics so we don't need to keep watching), etc. (Majckzrak et al. 2013). ICT in businesses affords visualization of entire work processes, flexible product creation, virtual collaboration, etc. (Zammuto et al. 2007).
Just as in ecological psychology, so in the field of IS, affordance challenges traditional understandings of subject and object, possibility and action. It is hailed by Hutchby (2001) as enabling us, after an era dominated by social constructionist perspectives, to pose questions about the 'objective' reality of ICT without falling back into a technological deterministic perspective. However, there are challenges, which are discussed next.

3. *Some Challenges*

Affordance challenges us in at least four ways. Some arise from the complexity of the IS field itself, especially that of multiple levels of activity, benefit and problem. Some challenges arise from the translation from that field to those of HCI and IS, especially that of accounting for what is common to all fields. Two more fundamental challenges have been widely discussed in the field of ecological psychology, including what affordance actually is, and how agent and environment relate.

3.1 *The Challenge of Complexity*

If we compare the above affordances of accessibility of information (Conole & Dyke 2004), visibility of information (Treem & Leonardi 2012), triggered attending (Majchrzak et al. 2013) and ability to visualize the entire work process (Zammuto et al. 2007), it is clear that they are of different kinds or levels, leading to confusion or complexity. Is one kind 'right' and the others 'wrong'? Can they all pertain, and if so how do they relate to each other? Are there other kinds yet to be discovered? On what basis may we judge candidates for new kinds of affordance? Moreover, how do these kinds of IS affordance relate to those found in artefact design, HCI and ecological psychology? Such challenges, which arise from complexity, have not yet been discussed in the IS community and possibly not even recognised as issues.

In IS, for each kind of affordance, a list of individual affordances is offered. Such lists are valueless unless we can rely on the list being well-formed or reasonably complete. Most of the authors cited discuss neither completeness nor well-formedness. Yet Mansour et al. (2013) use Treem & Leonardi's (2012) four affordances of social media as though they are complete – and then come up with four more, but with little discussion of how they relate to each other. When completeness is sought, as by Hartson (2003), over 80 affordances are found, which becomes cumbersome in practice.

3.2 *The Challenge of Translating Between Fields*

There has been substantial discourse about the nature of affordance in the field of ecological psychology. May we capitalise on that discourse in the IS or HCI fields, by translating concepts and issues across to those fields? If so, how and on what basis? It would seem that the concepts of agent, environment, and a relationship between them that enables or invites activity, is common to all, but this raises further questions.

On what basis is it valid to translate issues or concept from one field to another,

and how do we cope with the differences? In HCI and IS, the agent is human and the environment is no longer physical but sensory in HCI and informational in IS. What is the role of the agent's body, which is of primary importance in ecological psychology. Is there an equivalent of body-scale (e.g. leg length compared with rock height (Warren & Whang 1987; Alsmith 2012)) in IS? Also, issues arise in HCI and IS that are not present in ecological psychology. Rietveld (2008) argues that artefact affordances have a canonical and normative quality, and this carries across to IS, where Conole & Dyke (2004) and Majchrzak et al. (2013) discuss problems as well as benefits afforded by ICT.

3.3 *The Challenge of Understanding What Affordance Is*

What is affordance? Is it ontological, as Gibson believed, or epistemological, as Norman believed? If ontological several issues emerge in ecological psychology that are relevant to other fields.

Does affordance determine the agent's activity, or does it "offer" (Gibson 1979, 127), "enable" (Hartson 2003) or "invite" (Withagen et al. 2012) agent activity? What form does the agent's freedom take (Stoffregen 2000; Chemero 2003; Scarantino 2004)? Likewise, In IS, users of ICT are constrained by its features, yet they often innovatively reinvent use (Boudreau & Robey 2005; Leonardi 2011). Is affordance a property of a distinct object or a feature of a situation (Chemero 2003)? In IS, should we look at the ICT artefact alone, or the situation as a whole. Is affordance perceived, observed or acted on unreflectively? (Withagen et al. 2012; Rietveld 2008) In IS, what is the role of tacit and explicit knowledge in use of ICT facilities?

In what terms should affordance be discussed, as entities, activities, relationships, etc.? Discussion in terms of the interaction of distinct entities (agent and object), like animals, rocks or door-handles, precludes Chemero's (2003) insight that affordance is of situations. Discussion in terms of activities, like climbing, perceiving, opening, scrolling, associating, editing, tends to place the emphasis back on the agent, and downplays the importance of the environment. Discussion in terms of a relationship between agent and environment leaves open the question of the conceptual terms in which both are to be related: either in terms meaningful to the agent (e.g. climber-climbed) or in terms meaningful to the environment (e.g. force of foot and equal and opposite reaction from rock), which dichotomy misses the point that (in Gibson's cases) the physical features of the environment relate to the psychical features of the agent.

We need a way of discussing affordance that encompasses all these and more. Behind all the discussion of entities, activities, properties and relationships is concealed a notion that pervades them all, is occasionally mentioned in passing, but is not discussed: meaning or *meaningfulness.* Schmidt (2007) call's Gibsons ideas "an ecological theory of meaning". According to Costall (2012, 87), Gibson had written "a remarkable, though largely forgotten, chapter on meaning, in his first book, The perception of the visual world (1950)", which "anticipated the concept (of affordance) in several important ways". Gibson (1950, 199) talked about "use-meanings or meanings for the satisfaction of needs …" Gibson obviously had the idea in of meaning mind, but meaning is not a concept that 1950s psychologists liked to use, and many still resist doing so, so Gibson had to use terms that suggest meaning instead, such as in "what eyes are good for" (Gibson 1966, 155). Gibson (1979) again begins to speak of "the 'values' and 'meanings' of things in the environment" (p.127), and his "*relative to the animal*" (his italics) is a meaning concept. Later, Gibson (1982, 407) directly says "The meaning or value of a thing consists of what it affords".

Those who developed Gibson's ideas use the term 'meaning' often. For example, "an environment consisting of affordance is a meaningful environment" (Withagen & Chemero 2011, 4), "meaning-laden environment … Affordances are meaningful to animals" (Chemero 2003, 182). Gibson "gave us affordances … to account for meaning in the mutuality of the perceiver and environment" (Cutting 1986, 252). In addition, many use other words that imply 'meaning', such as: "significance" (Chemero 2003, 182), "animal referential or action referential … refer to some animal, person or group" (Michaels 2003, 139), "relative to the animal … without respect to the animal" (Stoffregen 2000, 9).

In each affordance there are two ways in which the environment is meaningful. In the rock's own terms, for example, properties like rigid, flat, extended, horizontal are meaningful. But in the animal's terms, properties like climbable or supportive are meaningful. So Gibson (1979, 129) speaks about such affordance as "both physical and psychical" – meaningful to both physical environment and to animal. "Affordances," says Chemero (2003, 184), "… are relations between particular aspects of animals and particular aspects of situations." (An aspect is a way of looking at something.) Affordance may thus be defined in terms of two ways of being meaningful, or a pair of aspects:

* an *agent aspect* that indicates a way in which the affordance is meaningful to agents,
* a *environment aspect* that indicates a way in which the affordance is meaningful

to the environment that makes the actualization of the agent aspect possible.

How this translates across to other fields is discussed later.
(Note: The concept of 'agent aspect' reveals an important distinction between two ways in which the environment is meaningful to the agent: more general and more specific or contingent upon circumstances. In general, the rock is climbable, but the specific reason for climbing might be to flee an enemy, to pursue food, or just to gain a vantage point. "Agent aspect" always refers to the more general meaning, which speaks of the potential of the environment, rather than its specific use.)
Thus affordance may be seen as a pairing of ways of being meaningful. However, it raises the challenge of how the two meanings relate. Chemero (2003) argues that this coupling of non-physical with physical meaning requires a new ontology that "is at odds with today's physicalist reductionist consensus (in the field of psychology)". This brings us to the subject-object relationship.

3.4 *The Challenge of the Subject-Object Relationship*
Affordance as a relationship between agent and environment inherently bridges between subject and object. That affordance must be seen as "relative to the animal" (Gibson 1979, 127) suggests that affordance is subjective. However, "affordance is not bestowed upon an object by a need of the observer and his act of perceiving it; it is always there to be perceived," located in the environment (p.139), which suggests it is objective. Of this tension, Gibson wrote (p.129):
"*an affordance is neither an objective property nor a subjective property, or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, and yet neither.*" (p.129)

A similar tension has been encountered in the IS field. The kinds of affordances discussed above are all, on the one hand, relative to (meaningful to) the user, while on the other hand being located in the environment, i.e. the ICT facilities themselves. Over the past few decades the IS field has increasingly emphasised the former, the subjectivity of IS use (Hartson 2003), including the flexibility with which users can resist use, adopt workarounds or use the facilities in innovative ways. Hutchby (2001) charts the dialectical reactions that have characterized perspectives in the IS field, between emphasis on objectivity with technological determinism, then on subjectivity with social construction of technology and social shaping of technology, and suggests that affordance might offer a next

phase, which he calls “technological shaping of sociality”, and which recognises the objectivity of technology alongside the subjectivity of the user. Like Gibson, he wants a reconciliation, and the debate about subject-object in that field can be useful in IS. However, the milieu mitigates against integration of them.

This must be addressed philosophically. Apart from a few passing allusions to Polanyi, James, Wittgenstein etc., Gibson, a radical empiricist, did not attempt a philosophical underpinning. Some have suggested basing Gibson in Heidegger or Merleau-Ponty (Dotov et al. 2012), but the former dissolves rather than “repairs” the difference between subject and object, and the latter’s focus on the body, make them less useful in the fields of ICT and IS. Moreover, neither offer a basis for addressing the diversity of kinds of affordance, nor the both-neither nature of affordance. Dooyeweerd (1955) provides a way to bridge the subject-object gulf without dissolving one into the other, and without undue emphasis on body, so it is useful in IS. This will be explored.

4. *A Dooyeweerdian Understanding of Affordance*

Dooyeweerd’s philosophy shows promise in understanding affordance. This is because Dooyeweerd came from a different direction, which places meaning at the centre in a way that resonates with the needs of understanding the nature of affordance, and as a consequence can address complexity. Dooyeweerd understands the subject-object relationship in a radically different way that allows genuine integration of subject and object, and addresses the ontology of affordance in a way that can be translated over different fields.

Dooyeweerd argued that most Western philosophers, including both Descartes and Heidegger, have presupposed that the fundamental principle on which all may be explained is to be sought within the created order, and that doing so inevitably divorces meaning from reality and makes it very difficult to address complexity. It also results in philosophical movements of thought being governed by dualistic pre-theoretical presuppositions that lead to deep antinomies in philosophy. The dualism that governs the current era, to which both Descartes and Heidegger belong, is the opposition of (deterministic) nature and (human) freedom. The Cartesian subject-object relationship is an expression of this, presupposing an unbridgeable gulf between (freely-perceiving) subject and (perceived) object so, Dooyeweerd argued, much as philosophers might try to bridge the gulf they will ultimately always be unsuccessful because their opposition is presupposed (Dooyeweerd 1955,I,64-65).

Resolution requires adopting different presuppositions. By presupposing that the fundamental principle lies outwith created reality, meaning is re-integrated with reality, and his philosophy is not dualistic but recognises a pluralistic diversity that coheres. This opens the way for a radically different idea of subject and object, which provides what Gibson was reaching for.

4.1 *Addressing the Challenge of What Affordance Is*

Dooyeweerd held that meaningful law is the transcendental foundation of all being, becoming, activity, possibility, knowing and rationality. He wrote:

"*Meaning* is the *being* of all that has been *created* and the nature even of our selfhood." (Dooyeweerd 1955, I, 4, his italics)

Meaning, in this sense, must be differentiated from subjective or intersubjective attribution of meanings to things, and from linguistic semantics or pragmatics. It is akin to what is referred to in "the meaning of life" – something beyond us, and to which all refers. Meaning in Dooyeweerd's sense will be called '*meaningfulness*' here. Meaningfulness is like an ocean in which fish swim, and which at the same time enables their swimming and even enables them to be fish. It is this 'oceanic' view of meaningfulness that is helpful for understanding affordance. Meanings, in the sense of specific attributions or significations, are made possible by this 'ocean' of meaningfulness. (It may be argued that what Heidegger did for existence, Dooyeweerd did for meaningfulness. Meaningfulness is not something we stand apart from, control or generate, as a property of objects, but something we 'live within', and we actualize or 'discover' it by living or occurring within it.)

In everyday experience we encounter a rich diversity of meaningfulness – physical meaningfulness, biotic, psychical, purposeful, informational, social, economic, aesthetic meaningfulness, and so on. Most philosophy has divorced meaningfulness from reality (Dooyeweerd 1955, II, 25-26) and thus has had little incentive to explore this diversity, so instead tries to reduce it to just a couple of aspects (ways of being meaningful). Dooyeweerd, by contrast, was motivated to do justice to our everyday experience and explore the diversity philosophically. In a discussion of over 400 pages in Dooyeweerd (1955, II), he delineated fifteen aspects or fundamental ways of being meaningful. These are shown in Table 1, below, each of which is irreducibly distinct from the others, and the laws of which cannot be reduced to the laws of others.

Dooyeweerd addresses the debate over whether affordance should be approached

as entities, activities or relationships, by grounding all three in a deeper notion of aspectual meaningfulness. Genuine existence presupposes meaningfulness. For example, a rock exists *qua* rock by reference to the physical aspect, and becomes rock by responding to laws of the physical aspect (which govern forces, energy, etc.). A climbable-thing exists *qua* climbable-thing by reference to the psychic aspect. An ICT system has no existence *qua* ICT system, and does not become an ICT system, except by reference to the informational ('lingual') aspect and its laws. Reference solely to the physical silicon, copper and plastic from which its hardware is constructed does not account for the ICT system. For fuller discussion of this, see Chapter V of Basden (2008). Each thing is a thing by reference to at least one aspect.

To Dooyeweerd, aspectual existence accommodates, but does not presuppose, distinct entities. Physical, social and aesthetic existence especially are often beyond entities, and are more properly called situations. But biotic and analytical existence especially are often discrete.

Likewise, activity presupposes meaningful law that defines and enables functioning and repercussions of that functioning ('causality'). Climbing, *qua* climbing, as opposed to exerting-force-on-horizontal-flat-rigid-rock, presupposes the sphere of meaningfulness that is psychical. Likewise, editing text, *qua* editing text, presupposes the lingual, and collaboration, *qua* colaboration, presupposes the social. To Dooyeweerd, this is not just epistemological (in that we call such activity "climbing", "editing" and "collaboration"), but it is ontological, in that climbing, editing and collaboration actually occur, and are not ontologically reducible to physical functioning such as exerting forces. (Arguing that requires more space than is available here.) Relationships also presuppose such aspects, in that the kind of relationship that is meaningful depends on the aspect.

This implies that each thing, activity and relationship that we encounter in the pre-theoretical (everyday) attitude actually exhibits multiple aspects. So, for example, the rock is both rock by reference to the physical aspect, and also at the same time, climbable-thing by reference to the psychical aspect. An ICT system exhibits many more aspects, discussed in Chapter V of Basden (2008). This informs the debate over whether perception of the environment is reflective or unreflective. It would be addressed by Dooyeweerd as the agent and environment functioning together in response to aspectual law. In the analytical aspect perception can be reflective, but in the psychical, formative, lingual, social and other aspects, it is unreflective (c.f. Basden 2008, 93).

Repercussions of functioning in the quantitative to physical aspects are largely deterministic, but are increasing non-deterministic in the later aspects, instead taking on a normative quality. In the case of the climbing animal, the psychical activity of its climbing will not be deterministic, even though the physical activity of contact between foot and rock functions largely deterministically. That later aspects are even less determinative can inform the debate over whether affordance offers or invites, rather than determines, activity.

Conventionally, each discipline or science focuses its gaze on one way of being meaningful (one aspect) and studies that (Basden 2008, 100). The temptation is strong to ignore all but the one aspect or to try to reduce phenomena meaningful in other aspects to those meaningful in their main aspect. The temptation to reduce psychical activity like climbing to physical activity is strong, but Gibson wanted to resist it. Yet the intellectual milieu of the time made it difficult for him. It still does. Dooyeweerd can provide sound philosophical support for Gibson's resistance – and also equivalent resistance in the IS field.

4.2 *Addressing the Challenge of Complexity*

Dooyeweerd's notion of aspects as ways in which things are meaningful can address the complexity of kinds of affordance, and also affordances within each kind. Whereas meaningfulness has been problematic in psychology, it has long been recognised in the field of IS for some time, for example via the *Weltanschauung* of Soft Systems Methodology (Checkland 1981), the hermeneutic circle of interpretive IS research (Klein & Myers 1999) and the semantics and pragmatics of knowledge engineering (Basden & Klein 2008). However, meaningfulness has seldom been discussed as such, having been largely taken for granted.

Dooyeweerd's exploration of the diversity of meaningfulness offers a basis on which to address the complexity of IS (see, e.g., Bergvall-Kåreborn & Grahn 1996; Eriksson 2006). All situations exhibit all aspects, either actually or latently, and identifying how it is meaningful in each aspect helps to separate out issues, draws attention to issues that have been overlooked, and helps to prevent category errors. If each affordance is a pair of ways of being meaningful, then we might expect many possible pairs, each being characteristic of a different kind of affordance. In artefacts, the agent aspect is the formative (achievement of some task like opening a door), while the environment aspect is the physical. In HCI, the environment aspect is the psychical aspect, i.e. things that are seen, heard or controlled by muscular action, while the agent aspect is the informational, insofar

as the user's seeing, hearing or manipulating is not for its own sake but always signifies something.

In the IS field as described earlier, the environment is informational, but the agent aspect is different in each case, and this provides a way to differentiate them. Zammuto et al. (2007) are primarily interested in how ICT affords benefits to the product-oriented organisation, such as flexible product creation and mass collaboration to achieve some productive end. These focus largely on the economic aspect. They also discuss visualization (of the entire work process), which is analytical. Majckzrak et al. (2013) are interested in how social media in organisations afford metavoicing, triggered attending, network-informed associating, etc. which are primarily meaningful in the social aspect. Treem & Leonardi (2012) are primarily interested in issues meaningful in the formative aspect of achievement, such as visibility, persistence, editability. Conole & Dyke (2004) are interested in general ICT-related possibilities, many of the meaningful in the lingual aspect.

Hutchby (2001) argues that affordance depends on a relationship between human activities and technological features, rather than on either separately, and that studying either informational or organisational aspects on their own is not helpful. However, these authors show that in the IS field the agent aspect varies, being respectively the economic,

Table 1. Dooyeweerd's Suite of Aspects as Spheres of Meaning

Aspect	Kernel (To do with)	Meaningful in Affordance
1. Quantitative	Discrete amount	-
2. Spatial	Continuous extension	-
3. Kinematic	Movement	-
4. Physical	Fields, Energy, material	Environment aspect of Gibsonian affordance
5. Biotic / organic	Life functions, organism	-
6. Psychical	Sensing, feeling and emotion	Agent aspect of animal affordance (Gibson 1979); Environment aspect of HCI and artefact affordance
7. Analytical / logical	Distinction, concepts	Agent aspect of analysis affordance (Zammuto et al. 2007)
8. Formative / technical	Formative power: design, construction; achievement, goals, techniques, tools	Agent aspect of artefact affordance (Norman 1988)
9. Informational / lingual	Symbolic signification	Agent aspect of user interface affordance (Norman 1988); Environment aspect of various ICT and IS affordances; Agent aspect of informational affordance (Treem & Leonardi 2012)
10. Social	Relationships, organisations, roles	Agent aspect of organisational affordance (Majchrzak et al. 2013)
11. Economic	Frugality, resources, limitations, management	Agent aspect of affordance oriented to assisting production etc. (Zammuto et al. 2007)
12. Aesthetic	Harmony, delight, fun	
13. Juridical	'Due', appropriateness; rights, responsibilities	
14. Ethical / Moral	Attitude, self-giving love	
15. Pistic / Faith	Faith, commitment, belief; Vision of who we are	

Table 1

social, formative and informational. This increased complexity can be addressed

by reference to Dooyeweerd's suite of aspects. Table 1 shows each aspect with its kernel meaning, and how each aspect might be an agent aspect or environment aspect for each kind of affordance in both IS and other fields.

This shows several things. One is that each kind of affordance discussed above can be situated within such a scheme. This provides a more general way of understanding affordance in general across all fields. It also shows that there is room for other kinds to be discovered. This provides an incentive to seek others and a basis on which candidate kinds of affordance may be judged – see later examples in which the agent aspect is the aesthetic or ethical. The fact that some aspects are both agent aspect for one kind of affordance and environment aspect for another suggests a way of relating different kinds of affordance together. Specifically, one kind of affordance might 'serve' or 'enable' another and, conversely, one kind might depend on another. For example, HCI affordances can serve IS use affordances. This dependency has been discussed by Dooyeweerd as interdependency among aspects, where each aspect depends foundationally on earlier ones insofar as functioning in that aspect depends on good functioning in the earlier aspect (e.g. social functioning requires lingual functioning of communication).

Aspects have a normative quality, with each aspect defining a distinct kind of good and bad. For example, lingual good includes understandability, social good and bad include togetherness versus enmity, and economic good and bad include frugality versus waste (Basden 2011). This can be a basis for studying the normativity that Rietveld (2008) found in artefact affordances and which pervades IS affordances. Sometimes, IS affordance seems to exhibit more than two aspects. For example, visualization of entire work processes, though it might serve economic purposes, seems mainly meaningful in the analytical aspect (visualization) and also the aesthetic aspect of harmony ("entire"). By prompting a decision on which aspect is intended to be primary, with appropriate rewording, Dooyeweerd's aspects are useful in removing possible category errors. Dooyeweerd recognised that multiple aspects could be important, in his distinguishing between qualifying, founding, leading and internal-leading aspects. In most cases, the founding aspect aligns with the environment aspect, and the qualifying aspect with the agent aspect, but that does not always work, because Dooyeweerd assumed that the founding aspect is always earlier, whereas we have one case in which the agent aspect is analytical, earlier than the lingual

environment aspect. Dooyeweerd's theory of roles of aspects seems underdeveloped (Basden 2008), and might benefit from study of a wide range of IS affordances.

4.3 *Addressing the Challenge of Subject and Object*

If we are to circumvent the problem of the Cartesian subject-object relationship, we need to understand what makes it problematic. Dooyeweerd (1955) located its root problem in pre-theoretical commitment to a dualism between nature and freedom, and this influenced the thought of both Descartes and Heidegger. Descartes' subject is presupposed to be free in its perceiving, thinking and acting, while his object is presupposed to be largely passive and unfree – of the nature pole. Heidegger could only remove the tension between subject and object by ignoring one of them, but this ultimately fails to fit everyday experience, in which subject and object both occur and neither can be ignored.

Dooyeweerd could overcome the tension while retaining both subject and object by recognising that, to be a subject (agent) is constituted in being subject to law (thus re-integrating the two English words 'subject'). Law does not refer to subjectively or socially constructed laws, rules or norms, whether spoken or unspoken, but to the deep law that enables reality to Be and Occur, and by which Time itself is generated. Law often takes the form of promise, and is different for each aspect; for example, a law of the lingual aspect might be expressed as "If we make sense in terms of what the reader already assumes or believes, then the reader will understand better". What Dooyeweerd called the law side of reality includes the deep laws of all aspects together.

All functioning in temporal reality is governed and made meaningful by this aspectual law, but subjects and objects function differently. Things function as subject (agent) when they respond to law, and as objects when their functioning, though still governed by law, is as a result of some agent's subject-functioning. For example, as I write this I am responding to laws of the lingual aspect, and thus function as lingual subject, but the words and sentences I write are functioning as lingual objects. The expected reader is also a lingual subject; Dooyeweerd's view enables a subject-subject as well as subject-object relations. So, as ICT is used, the words and other symbols they read or write are lingual objects while they, as lingual subjects, actively respond to lingual law. Likewise, when considered from the psychical aspect, the animal functions as subject when they climb, and the rock functions as psychical object in being climbed.

Agent and environment are governed, and their functioning enabled, by the same law side. However, they function differently in different aspects. To Dooyeweerd, whether an entity is a subject or object does not depend on the entity itself, but on how it functions in each aspect. An entity can be subject in one aspect but object in another, as in the example of the animal climbing a rock:
* The climbing animal functions as subject in both psychical (seeing, hearing, responding as climbing) and physical (feet exert force) aspects. The human user of a computer functions as subject in all aspects.
* The climbable rock functions as object in the psychical aspect ('letting itself' be climbed) but as subject in the physical (exerting equal and opposite force). Likewise, a computer may be said to function as subject in the physical aspect of silicon etc., but as object in the lingual, social and economic aspect.

This provides philosophical grounding, which has so far been lacking, for the idea that agent-relative properties like climbability or editability are located in the environment, without having to reduce the agent aspect to the environment aspect, and without having to posit it as being solely in the intentions or constructions of the agent. Unlike the Heideggerian escape, of merely dissolving the difference between subject and object, Dooyeweerd retained the distinction, which is found in everyday life and is also important for affordance. Dooyeweerd's understanding of subject and object provides the foundations for the bridge that Gibson and others have so long sought. It also enables IS scholars to conceive of how the information ('technical') characteristics of the ICT facilities have a role to play in response to the 'free', innovative activity of the user, without fear of returning to a technological determinism in which only the technology plays a role.

4.4 *Addressing the Challenge of Translation to Different Fields*
This provides a sound basis for translating the insights from ecological psychology across to other fields – and vice versa. For translation to be valid there must be some common thread that can be made the basis for translation. Chemero's (2003) suggestion that affordance is a relationship between a pair of aspects, combined with Dooyeweerd's notion of aspects, helps to generalise the idea of affordance across all fields, as a pairing of agent and environment aspects in each case.
Dooyeweerd's suite of aspects provides a useful conceptual tool with which to think about the different pairings. Dooyeweerd's notion of multiple aspects of one

activity means that when extra aspects are encountered they can be incorporated rather than ignored. Aspects are understood in the same way, as ways in which things can be meaningful, and meaningfulness is understood in the same way, as an 'ocean' that enables us to Be and Occur. This grounds entities, activities and relationships of affordance across all aspects, as explained above.

What differs through the aspects, and thus what influences the way issues encountered in one kind of affordance are translated to others, are three things: the precise meaningfulness that each offers, that the laws of earlier aspects are more deterministic than the more normative laws of later aspects, and that functioning in later aspects depends on that in earlier ones for its actualization. The following are issues discussed above:
* Activity. Each agent aspect enables a distinct kind of activity, but this is likely to be more varied and less predictable in IS than in ecological psychology.
* Normativity. This should be expected in all kinds of affordance, though in than psychical affordance normativity is minimal. That normativity differs for each aspect provides clarity.
* Enabling. Functioning in the environment aspect enables that in the agent aspect. This can often be understood in terms of Dooyeweerdian interdependency between aspects.
* Unreflective perception. The knowing in most aspects is unreflective, but takes a different form.
Formative, lingual and social perception all differ, but are all present in IS use, so understanding the difference can help study.

In ecological psychology, the body is important, and body-scale is a key concept. How might this translate across to information systems? There have been two main ways, neither of which are ideal. One approach is to ask where 'bodies' are found in IS, such as in avatars in virtual reality or characters in computer games. This can lead to confusion, as in (Rambusch & Susi 2008) and is limited in application. Another is to seek analogies to the body, as Bloomfield et al. (2010) do, taking Scarry's (1985) view that made objects are projections of the human body (e.g. bandage replaces skin). Then "Such 'affordances', we might say, name the various ongoing exchanges of attributes between human bodies and the world made of objects" (Bloomfield et al. p.421). But they provide no precision, as the "we might say" indicates, and arguments cannot be based on analogies.

Seeing affordance as meaningfulness opens up a third, more satisfactory way.

This involves we asking why body scale is important (meaningful) in ecological affordances: It is because of the physical and pre-physical properties of the animal – how the animal is meaningful in terms of the environment. That is, the environment aspect in which both agent and environment function are compared. Usually a subject-subject relationship is discovered in this aspect, which is the basis for genuine interaction. In the IS field, we can likewise compare the environment aspect of both user and ICT facility. Several affordances are founded in information (Dooyeweerd's lingual aspect), so the equivalence of body scale is: What are the lingual (informational) characteristics of the afforded human task, and how do they compare with those available in the ICT facility? One example might be language difference, which can hinder social affordance.

5. *Practical Application*

A few examples are now offered of how this might work in practice. Aspectual normativity provides a way to separate out issues (Ahmad & Basden 2013) and locate more precisely where the problems might lie. For example, information overload (Conole & Dyke 2004) is problematic by reference to the lingual aspect but not the formative, while groupthink (Majchrzak et al. 2013) is problematic by reference to the social and pistic aspects, but possibly not directly problematic in the economic aspect. Dooyeweerd's aspects are intended to apply across all cultures, and to be intuitively grasped. This opens up the possibility of distinguishing affordances that are culturally specific from those which apply across all cultures. To understand affordances which apply across cultures is very important when considering ethical and beneficial development in which ICT plays its part.

Some extant lists of affordances are incomplete or not well formed, and aspects can help reveal and even correct these. In the ideal case, all affordances of a given kind should have the same agent and environment aspects, but may be differentiated from each other by a tertiary aspect. This can help prompt critique and refinement of lists, as in the following example, which critiques Zammuto et al.'s (2007) five affordances of: Visualizing entire work processes, Flexible product creation, Virtual collaboration, Mass collaboration, and Simulation and synthetic representation (what-iffing). For all these, the environment aspect is the lingual. From the way they are worded, each is meaningful in a different aspect, respectively: analytic/aesthetic, formative, social, social and analytic.

If this is the agent aspect, then the list is not well-formed. However, examination of their explanation of each shows that each is related to the economic

functioning of a product-oriented organisation, so these aspects might be the tertiary ones. The dual aspect in visualization suggests the affordance can be meaningfully split, one dealing with analysis of work processes, the other with harmonizing them. The two social aspects prompts a question of whether there is any important difference between virtual and mass collaboration. The text reveals that though both involve collaboraton, which is indeed social, the emphasis in the former is on communication and in the latter is on working together, suggesting lingual and social aspects respectively. The 'virtual' tag, though fashionable in IS circles, is not useful as a differentiator since most of their affordances involve virtuality. It might be useful to relabel both.

Dooyeweerd's suite of aspects can help direct search for new kinds of affordance. Table 1 contains aspects for which no IS affordance has yet been discussed – aesthetic to pistic – which suggests possible new kinds of affordance. The way to begin to consider these is to assume an environment aspect of lingual, but an agent aspect of each of these, and ask for each "What benefits or problems meaningful in this aspect would the user experience?" For the aesthetic aspect, such benefits might be fun or enjoyment. "How can ICT facilities afford fun?" is an IS question, to which Dooyeweerd can direct our attention. Computer games are a genre dedicated to this, so exploration of aesthetic-lingual affordances might begin there.

Though Rambusch & Susi (2008) try to discuss affordances in computer games, but their treatment is confused, and can be an example of how a Dooyeweerdian approach can remove confusion. They mix together affordances that are meaningful to the avatar (opening a door in a virtual room) with those meaningful to the human player (keyboard buttons), and yet they miss the main point of computer gaming: fun. Using Dooyeweerd's aspects, Breems & Basden (2014) are able to distinguish these as: opening a virtual door in a virtual room is 'engaging with meaningful content'; hitting keyboard buttons is 'human-computer interaction', and having fun is 'human living with computers', and all three involve all aspects, though in different ways.

Finally, aspectual affordance might provide insight into societal and developmental issues. Recognising that no affordance has been discussed in which the ethical is the agent aspect (Table 1), this directs our attention to the question, "How can ICT facilities afford self-giving attitudes such as generosity?" Attitude is not just individual but also pervades society in ways that are not obvious, but which become felt after a time. So this affordance needs to take a

societal perspective. This is especially important in development ethics. Generosity is an attitude which pervades Sub-Saharan Africa, but which by comparison is lacking in the wealthy, European North. This directs us to the important question of the impact of ICT on African attitudes, whether it will afford a strenghthening or weakening of such generosity, and how to strengthen rather than weaken. Given the individualized nature of mobile ICT, this is a serious challenge. Much will depend on whether the ICT available for use there is self-protective or tends to open up self. The tendency of application developers to self-protection of economic and legal interests is likely to afford a turn to selfishness and self-centredness, undermining traditional generosity. There is much other potential applicability, such as how the Dooyeweerdian idea of affordance can guide research agendas, and how it can be used to bring disparate kinds of affordance together into a wider picture. Those are still to be explored.

6. *Conclusion*

Affordance is a useful notion with which to think about and discuss the relationship between an agent and its environment across many fields – whether animals in a physical environment, or people using ICT facilities in an organisation. Several challenges have been mentioned: complexity and different kinds of affordance, the translation of concepts and findings about affordance from one field to others, and two more fundamental challenges, those of meaningfulness and of the subject-object relationship.

Dooyeweerd's philosophy is ideal for grounding an understanding of affordance, because the two main fundamental challenges that affordance presents are directly and centrally addressed by Dooyeweerd, and the other two challenges are addressed on the basis of those. To Dooyeweerd, meaningfulness is foundational to all, and his exploration of diversity of meaningfulness, which resulted in his famous suite of fifteen aspects, can be very helpful in understanding affordance as the relationship between pairs of aspects. Until now, though the discourse around affordance frequently mentioned meaning, there was little understanding of meaning as such. Dooyeweerd's reinterpretation of the subject-object relationship enables us to understand how agent-relative features like climability or editability can be located in the environment rather than solely in the agent. A number of issues that depend on these foundational ones have been also discussed, and some practical examples have been given for how Dooyeweerd might be useful when discussing affordance.

This might make a number of contributions. The field of ecological psychology

might benefit from a philosophical grounding to the concepts that circulate in its discourse, as well as from a confidence that there is at least one philosophy that can support both Gibson's desire to bridge between subjective and objective and the growing importance of meaning. The field of IS can benefit from recognising distinct kinds of affordance as defined by different agent aspects. Dooyeweerd's suite of aspects can direct research into new kinds of affordance. The generation of lists of affordances of each kind can benefit from reference to aspects. The idea that the environment aspect is the lingual rather than the physical provides a starting point for translating insights emerging from the field of ecological psychology into the field of IS. In these ways, IS research into IS use can be strengthened and given a firmer foundation.

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NOTES

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REFERENCES

Ahmad, H. & Basden, A. 2013. Down-to-Earth Issues in Information System Use. *Proceedings of the Pacific Area Conference on Information Systems* (PACIS). Paper 191.

Alsmith, A. 2012. The concept of a structural affordance. *AVANT*, III(2), 95-107.

Basden A. 2008. *Philosophical Frameworks for Understanding Information Systems*. IGI Global Hershey, PA, USA.

Basden, A. 2011. A Presentation of Herman Dooyeweerd's Aspects of Temporal Reality. *International Journal of Multi-aspectual Practice*, 1(1), 1-28. Available at "http://www.dooy.info/papers/ijmap/".

Bergvall-Kåreborn, B. and Grahn, A. (1996). *"Expanding the Framework for Monitor and Control in Soft Systems Methodology" Systems Practice* 9:469-495.

Breems, N., Basden, A. (2014). *Understanding of computers and procrastination: A philosophical approach. Computers in Human Behavior*, 31(2014), 211-223.

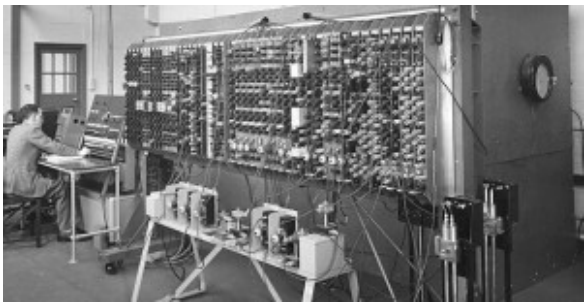
Basden, A. & Klein, H.K. (2008) New Research Directions for Data and Knowledge Engineering: A Philosophy of Language Approach. *Data & Knowledge Engineering*, 67(2008), p.260-285.

Bloomfield, B.P., Latham, Y., Vurdubakis, T. (2010). Bodies, technologies and

action possibilities: When is an affordance? *Sociology,* 44, 415-433.
Boudreau, M-C. Robey, D. (2005). Enacting integrated information technology: a human agency perspective. *Organization Science.* 16(1), 3-18.
Checkland, P. (1981). *Systems Thinking, Systems Practice,* Wiley, New York.
Conole, G. & Dyke, M. (2004). What are the affordances of information and communication technologies? Alt-J, *Research in Learning Technology*, 12(2), 114-124.
Costall, A. (2012). Canonical affordances in context. *AVANT,* III(2), 86-93.
Cutting, J.E. (1986). *Perception with an eye for motion*. MIT Press, Cambridge, MA, USA.
Dooyeweerd H. (1955). *A New Critique of Theoretical Thought,* Vol. I-IV, Paideia Press (1975 edition), Jordan Station, Ontario.
Dotov, D.G., Nie, L., de Wit, M.M. (2012). Understanding affordances: history and contemporary development of Gibson's central concept. *AVANT*, II(2), 28-39.
Eriksson DM (2006) "Multimodal Investigation of Technology-Aided Human Practice in Business Operations" pp.165-184, In: Strijbos S. and Basden A. (eds.) *In Search of an Integrative Vision for Technology: Interdisciplinary Studies in Information Systems.* Springer.
Gibson, J.J. (1950). *The perception of the visual world.* Boston: Houghton-Mifflin.
Gibson, J.J. (1966). *The Senses Considered as Perceptual Systems.* Boston: Houghton-Mifflin.
Gibson, J.J. (1979). *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.
Gibson, J.J. (1982). Notes on affordances. In: E. Reed, 8 R. Jones (Eds.), *Reasons for realism: The selected essays of James J. Gibson* (pp. 401- 418). Hillsdale, NJ: Erlbaum.
Hartson, H.R. (2003). Cognitive, physical, sensory, and functional affordances in interaction design. *Behavior & Information Technology,* 22(5), 315-338.
Hutchby, I. (2001). Technologies, texts and affordances. *Sociology*, 35(2), 441-56.
Klein, H.K., Myers, M.D. (1999). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly* 23(1), 67-93.
Leonardi, P.M. (2011). When flexible routines meet flexible technologies: affordance, constraint, and the imbrication of human and material agencies. *MIS Quarterly,* 35(1), 147-67.
Majchrzak, A., Faraj, S., Kane, G.C., & Azad, B. (2013). The contradictory influence of social media affordances on online communal knowledge sharing. *Journal of Computer-Mediated Communication*, 19, 38-55.

Mansour, O., Askenäs, L., Ghazawneh, A. (2013). Social media and organizing – an empirical analysis of the role of Wiki affordances in organizing practices. *Thirty Fourth International Conference on Information Systems,* Milan 2013.
Michaels, C.F. (2003). Affordances: Four Points of Debate. *Ecological Psychology,* 15(2), 135-148.
Norman, D.A. (1988). *The Psychology of Everyday Things.* Basic Books, New York, USA.
Rambusch J. & Susi T. (2008). The challenge of managing affordances in computer game play. *HUMAN IT* (publ. University College of Borås), 9(3), 83-108.
Rietveld, E. (2008). Situated normativity: the normative aspect of embodied cognition in unreflective action. *Mind, New Series*, 117(468), 973-1001.
Scarantino, A. (2004). Affordances Explained. *Philosophy of Science* 70, 949-61.
Scarry, E. (1985). *The Body in Pain: The Making and Unmaking of the World*. Oxford: Oxford University Press.
Schmidt, R.C. (2007). Scaffolds for social meaning. *Ecological Psychology*, 19(2), 137-151.
Shaw, R. (2003). The agent-environment interface: Simon's indirect or Gibson's direct coupling? *Ecological Psychology*, 15(1), 37-106.
Stoffregen, T. (2000). Affordances and events. *Ecological Psychology,* 12, 1-8.
Treem, J.W. & Leonardi, P.M. (2012). Social media use in organisations: exploring the affordances of visibility, editability, persistence and assocation. *Communication Yearbook,* 36.
Warren, W.H., & Whang, S. (1987). Visual guidance of walking through apertures: Body-scaled information for affordances. *Journal of Experimental Psychology: Human Perception and Performance*, 13(3), 371-383.
Withagen, R. & Chemero, A. (2011). Affordances and classification: on the significance of a sidebar in James Gibson's last book. *Philosophical Psychology*, 2011, 1-17
Withagen, R., de Poela, H.J., Arafijob, D., Pepping, G-J. (2012). Affordances can invite behavior: reconsidering the relationship between affordances and agency. *New Ideas in Psychology*, 30, 230-258.
Zammuto, R.F., Griffin, T.L., Majchrzak A., Dougherty, D.J., Faraj S. (2007). Information Technology and the Changing Fabric of Organisation. *Organisation Science,* '8(5), 749-62.

IIDE Proceedings 2014 – The Triple I Model: A Translation Of Dooyeweerdian Philosophical Concepts For Engineers



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Inspired by Dooyeweerdian philosophy and in dialogue with different groups of engineers the Triple I model for design problems has been developed. It offers a vocabulary to deal and unravel the ‘complexity’ of modern technological systems, propose methods and techniques to understand the nature of an innovation. The ‘I’ of ‘intrinsic’ refers to the inherent normativity of the user practice, the ‘I’ of ‘inclusive’ to the presence of justified interests of different stakeholders, and the ‘I’ of ‘idealistic’ to the values or dreams that play a role.

1. *Introduction*

The time in which one single engineer could develop a whole product all alone is gone. Nowadays, engineers work in multidisciplinary teams and have to communicate with many stakeholders. They often lose the overview and do not understand anymore the ‘complexity’ of the functionalities of the integrated design. In practice, engineers work with simplified models resulting at best in inadequate solutions and at worst in big disasters. It is therefore of utmost importance that design tools are developed that do justice to the intricate relation between ‘man, technology, and society’.

In the last decade, the use of Dooyeweerdian philosophy for technology has been widely discussed (De Vries, 2006; Strijbos & Basden, 2006; Verkerk, Hoogland, Van der Stoep & De Vries, 2007; Basden, 2008; Van Burken & De Vries, 2012). These studies show a certain potency of this philosophical tradition for making a valuable contribution to the practice of engineers. It is generally agreed that in particular three elements are important for the field of engineering: a) the theory of modal aspects supports engineers to understand the multi-sidedness and intrinsic normativity of their designs, b) the idea of qualifying function is of utmost importance to do justice to the nature of a technological design, c) and cultural values or ground motives play an important role in designing technology. There is no doubt, however, that still a lot of work has to be done to realize this promise.

This paper aims to stimulate further discussions about how to make Dooyeweerdian philosophy available for engineers. It reports about the experiences of the author on his dialogues with engineers that resulted in the Triple I model. For a philosophical contribution to the mindset of engineers three challenges have to be met. First, the model has to be presented in an appealing way for engineers.**[iii]** Theoretical richness and engineering clarity have to be integrated in self-explaining drawings and heuristics. Second, the model has to guide engineers in dealing with and unraveling the complexity of technological designs, identifying normative moments in designing new products, and understanding how values guide their creative design processes. Third, the model has to focus on the organizational context in which technological innovations are used.
This article has the following set-up. Section 2 tells the story of two groups of engineers that developed philosophy-based tools to design 'complex' systems. These stories describe the state of the art in the field, the problems to cope with complexity, and the catch ball process to translate philosophical Dooyeweerdian concepts in engineering tools. Section 3 integrates the results of these two groups and other groups in the so-called Triple I model. Section 4 presents some additional tools. The paper ends with some conclusions.

2. *Exploring the Scene*

This section tells the story of two groups of engineers in which a philosophy-based toolbox for engineers was developed. One group focused on tools to design the electrical system of the future and the other one on tools to design long-term

housing for elderly with dementia. These groups worked parallel to each other and there was no interaction between these groups. Every group had its own problems and own dynamics. The only 'linked pin' was the author of this article.

2.1 *Designing smart grids*

In 2008, I met Dr. Paulo Ribeiro, an eminent electrical engineer, at the time professor at Calvin College (Grand Rapids, USA). Dr. Ribeiro's main research topic is electrical energy infrastructure of the future. In the coming decades, our energy systems will change strongly. It is believed that large scale power plants will be complemented by a large number of small scale energy generation units; amongst others, individual households will generate solar or wind energy. It is also believed that intelligent systems will be used to more comprehensively communicate, control, protect and balance supply and demand of energy. The whole system of central and local energy generation, transmission and distribution, and enabling intelligent control and information systems is called a smart grid. Smart grids will be integrating micro grids (local systems) and super grids (high voltage transmission and bulk generation systems). Figure 1 illustrates the new concept of smart grids and the functional relationship among the different subsystems and technologies. The bulk generation, transmission, distribution and customers are directly and electrically connected and are themselves linked via communication systems with the Markets, Operations and Service Providers. The most important characteristics of smart grids are described by the European Commission (2010) and the European Electrical Grids Initiative (2010).

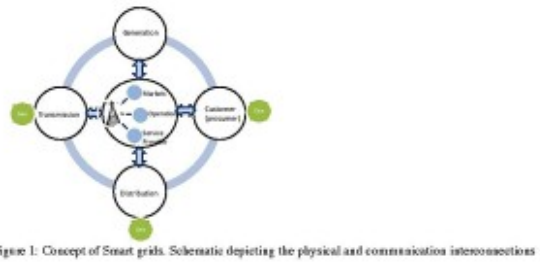


Figure 1: Concept of Smart grids. Schematic depicting the physical and communication interconnections

During an extensive discussion Ribeiro sighed: 'It is impossible for an engineer to take the "full complexity" of these systems into account. I only have reduced

models resulting in reduced designs that for their part result in sub-solutions and even wrong designs.' He underlined his sight with reference to a report of the European Commission (2011) that concluded that it is very difficult to grasp technological and non-technological key characteristics of the electrical system of the future. Especially, this report showed 'a lack of specific attention to the social implications of Smart Grids.' This conclusion also has to be understood from the economic interests in this field. At this moment, grid project investments in Europe currently amount to over 5 billion Euros and are estimated to reach 56 billion by 2020 (Pike Research, 2011).

Dr. Ribeiro's complaint about the reduced models resulted in a challenging question: 'Can Dooyeweerdian philosophy support me to understand the "complexity of this type of systems" and to support me to design better systems?' I should mention here that in our conversations Ribeiro honestly showed his disappointment about the value of this philosophy for his scholarly work. E.g. a study produced at Calvin College by Monsma et al. (1986), *Responsible Technology: A Christian Perspective*, has in his opinion not succeeded in bridging the gap between Dooyeweerdian philosophy and the daily practice of engineers.
Anyhow, Ribeiro's challenge marked the start of an intensive cooperation between two engineers (Ribeiro, Polinder) and one philosopher (Verkerk). On the one hand, it was believed that philosophy would offer theories that could cope with 'the complexity of these systems' and that also could guarantee (a certain degree of) completeness. On the other hand, it was believed that a catch ball process, in which ideas are thrown and caught back and forth between the participants, was necessary 'to translate' philosophical theories in engineering tools. This process resulted in the article 'Planning and designing Smart Grids: Philosophical Considerations' in the *IEEE journal Technology and Society*.

2.2 *Designing long-term facilities for elderly with dementia*
In 2010, I was one of the members of the committee that had to judge the quality of the thesis *Aging-in-place. The integrated design of housing facilities for people with dementia* of Joost van Hoof (2010). One of the challenges of this research was to develop an integral model to design housing for elderly with dementia. The doctoral student had solved this problem by combining two existing models: the International Classification of Functioning, Disability and Health (ICF-model) and the Model of Integrated Building Design (MIBD-model). Basically, the combination of these two models was already a breakthrough in thinking: it

recognized the importance of insight in the medical background to design housing facilities for people with dementia.
Let's first review the state of art in this field. The design of buildings is a complex and dynamic process. The overall complexity is strongly increased when the design process concerns buildings for specific user groups with non-standard requirements. For example, the design of long-term facility for older adults with dementia requires an interdisciplinary dialogue involving medical disciplines, care professionals, and patient associations. In addition, the design of the building should also take into account the standard requirements of an adequate operation and cost-effective maintenance. It is a challenge for the architects and consulting engineers to capture these needs in a single design.
Ideally, the design of buildings in which care or medical treatment and interventions take place, should also be in compliance with evidence-based practice (Ulrich et al., 2008, Huisman et al., 2012). Various researchers have proposed theoretical or conceptual frameworks linking different built environment characteristics to health outcomes or to capture the current domain of evidence-based design in healthcare (Zimring and Bosch, 2008; Durmisevic et al., 2010; Ulrich et al., 2010). These models all capture a different part of the complexity and, thus, reflect a part of reality. Durmisevic and Ciftcioglu (2010, 101) acknowledge this complexity: '[N]ew knowledge in evidence-based design adds continuously to complexity (the 'information explosion'), and it becomes impossible to consider all aspects (design features) at the same time, much less their impact on final building performance.' They conclude that there is no adequate methodology to deal with different environmental aspects in a holistic way.

A couple of months after the ceremony I had an intensive discussion with Joost van Hoof about his model. I asked him two questions: 'How do you know that the combination of two models leads to an "integral model"?' and 'How exactly do you relate the medical concepts of the ICF-model to the building concepts of the MIBD-model?' His answer was as honest and as shocking: 'I don't know'. 'And', he added, 'nobody in this field has a more complete model than I have proposed.' These answers marked the start of a long term cooperation between an engineer (Van Hoof), a designer (De Koning), a geriatrician (Van der Plaats), and a philosopher (Verkerk). Also this cooperation was characterized by a catch ball process in which engineering models, neurological insights, and philosophical theories entered the arena to understand the complexity of this types of designs

and to develop philosophical tools that were understandable for non-philosopher. The first fruit of this cooperation was the article 'Developing an integrated design model incorporating technology philosophy for the design of healthcare environments: A case analysis of facilities for psycho-geriatric and psychiatric care in The Netherlands' (Van Hoof & Verkerk 2013).

2.3. *Conclusion*

Both stories have a lot in common. At first, they show that technological systems have become so complicated that engineers cannot anymore grasp the 'complexity' of their designs.**[iv]** Secondly, in the engineering practice of these scientists – both where specialists in their field – philosophy-based tools appeared not to be used. Thirdly, they support the idea that philosophical ideas and concepts have to be 'translated' into schemes, drawings, design questions, moral standards and values, check off lists, and design heuristics, in order to serve the design practice of engineers. Finally, they suggest that intensive dialogues are required to become familiar with non-technological ideas and philosophical concepts. It goes without saying that this dialogue is a challenge for all participants. On the one hand philosophical richness and strictness has to be maintained as much as possible, and on the other hand the vocabulary has to be understandable by engineers and the tools have to fit into their way of working.

3. *The Triple I Model*

The Triple I model takes the user practice as a starting point. At the first glance, this starting point seems to speak for itself. However, on further consideration this starting point cannot be taken for granted. Firstly, despite all rhetoric about customer or user orientation, the engineering perspective has dominated the design process up till now.**[v]** Secondly, this starting point invites engineers to understand the requirements of different types of users in their own organizational context.**[vi]** A part of this work has been presented elsewhere (Ribeiro et al., 2010; Hoof et al., 2013, Verkerk, 2014).

The Triple I model encourages engineers to investigate user practice from three different perspectives**[vii]** in order to understand its key characteristics, see figure 2:

1. *Identity*: identity or intrinsic values of the primary process.
2. *Interests:* inclusion of the justified interests of stakeholders.
3. *Ideals*: (hidden) ideals, dreams and values that co-shape the primary process.

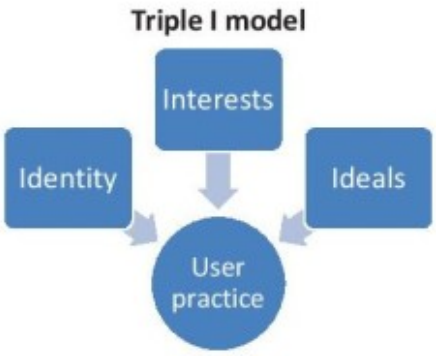


Figure 2: Graphical depiction of Triple I model

Figure 2: Graphical depiction of Triple I model

3.1 *Identity of the primary process*

The 'I' of 'Identity' or 'Intrinsic values' refers to the specific character of the primary process of the user practice. The specific character of this process is based on the idea of the qualifying function of the theory of individuality structures (Dooyeweerd 1969: vol. III). On the first sight, a 'smart grid is a smart grid'. However, from the perspective of the user this statement is too simple. After all, smart grids are used in quite different contexts, e.g. households and industrial enterprises. The theory of individuality structures (see below) shows us that the context of the household is socially qualified and the context of an industrial enterprise economically. As a consequence, the smart grid in an household has to support the social relations in that household and the smart grid in an industrial enterprise the economic functioning of that enterprise. It has to be noted that these differences in context are not primarily differences in size or something like that, but differences in the identity or nature of the user practice. Inherently, the intrinsic values of these user practices differ. The household is dominated by social values like mutual support and living as a community, and an enterprise by values like customer satisfaction, profit and sustainability. Consequently, the design of smart grids for households have to be disclosed by the values mutual support and living as a community, and the design of smart grids for industrial enterprises by an enterprise by values like customer satisfaction, profit and sustainability.

The identity of long-term homes for elderly with dementia is quite different from that of smart grids. The meaning kernel of moral aspect is 'caring for'. Therefore, the qualifying function of health care facilities is the moral aspect (Jochemsen and Glas, 1997; Jochemsen, 2006; Verkerk et al., 2007). That means, the long-term

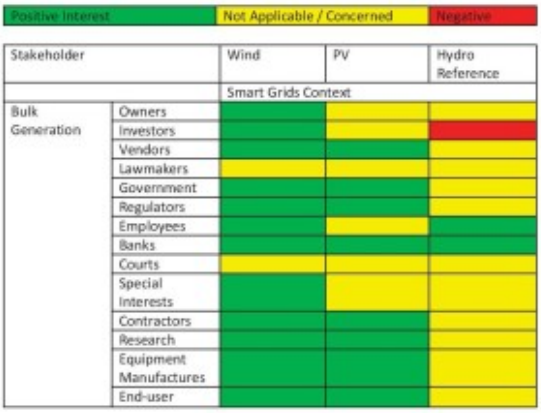
home has to be designed in such a way that it supports the care for elderly with dementia – if possible: evidence-based designs! Again, it has to be noted that the user context of long-term homes differ qualitatively from the user context of smart grids for households: morally qualified versus socially qualified. As a result, the design of long-term homes has to be disclosed by values like love, respect and closeness.

The 'I' of 'Identity' or 'Intrinsic values' is comparable with the normative principle of 'disclosure and intrinsic normativity' as developed by Strijbos (Strijbos & Basden, 2006, p245-248), and the constitutive side as defined by the practice model (e.g. Jochemsen & Glas, 1997; Hoogland & Jochemsen, 2000; Jochemsen, 2006; Verkerk et al., 2007). This 'I' is also strongly related to the ideas of 'inner goods' and 'excellence' of MacIntyre (1981). In summary, the ideas of 'identity' and 'intrinsic values' urges the engineer to identify the specific nature of user practices. It invites the designer to make the intrinsic values explicit and to 'translate' these values in design specifications (or norms).

3.2 *Inclusion of justified interests*

The 'I' of 'Inclusion of justified interests of stakeholders' refers to an approach in which the interests of the different stakeholders are identified and included in the design process. This stakeholder approach is based on Freeman (2001) while the concept of justified interests follows from the concept of qualifying function of individuality structures (Dooyeweerd 1969:vol. III). For example, the most important stakeholders of smart grids are governments, local authorities, bulk producers of electricity, local producers of electricity, transmission companies, and so on. Each of these parties have justified interests. The justified interest of governments and local authorities are mainly legal or juridical: compliance with national and local legislation. Another justified interest is economical: the influence on the national (and local) economy and employment. The justified interest of bulk producers of electricity is that the smart grid can handle variations in demand so that they can produce at a stable and predictable way. The justified interests of local producers of electricity is that micro-grids will balance as much as possible production and consumption on a local level, and that excess of energy can be delivered to the network at a good price. The stakeholders configuration of smart grids appears to be very complex. Figure 3 presents a more detailed analysis showing that the stakeholders differ for different 'components' of smart grids and different sources of renewable energy. It goes without saying that managing of justified interests of stakeholders in large

smart grid projects is extremely important and failures in managing these interests are very costly. For example, in Brasil problems arose in the construction of the transmission lines. As a result, the wind energy park was finalized but the connection to the national electrical network was not yet finalized!**[viii]**



Positive Interest		Not Applicable / Concerned		Negative
Stakeholder		Wind	PV	Hydro Reference
		Smart Grids Context		
Bulk Generation	Owners			
	Investors			
	Vendors			
	Lawmakers			
	Government			
	Regulators			
	Employees			
	Banks			
	Courts			
	Special Interests			
	Contractors			
	Research			
	Equipment Manufactures			
	End-user			

Figure 3a: Detailed stakeholder analysis for smart grids

The most important stakeholders of long-term housing for elderly with dementia are family, nurses, doctors, neighbourhood, owners, banks, insurance companies, local and national authorities. Also in this case, every stakeholders has its own justified interests. The idea of justified interests can be illustrated clearly in discussing the aesthetic aspects of the building. Who's justified interests are at stake? Who decides? The architect? The owner? The patients? The family of the patients? The local neighbourhood? To answer this question I would like to return to the ideas of 'identity' and 'intrinsic values'. The qualifying function of a long-term facility for elderly with dementia is the moral one. It is about 'caring for'. That means, the aesthetic aspects has been designed in such a way that the care for the patients is supported as much as possible by the aesthetic design (disclosure). The building has to be – to use a buzz word – a healing environment. What about the owner? Isn't his or her money? The justified interest of the owners is the return on investment over the lifetime of building and not whether or not 'they like the building'. On top of that, when the aesthetic appearance strongly supports the way of living of elderly with dementia, the building will have a competitive advantage over other long-term facilities so that the risks of 'empty beds' and less income will be reduced. Finally, it is often claimed that one of the justified interests of an architect is the aesthetic appearance of the building. After

all, it is an expression of his or her creativity. In addition, in architecture the judgments of peers about the design and the beauty of the building are considered to be very important. Based the idea of the identity of the facility and the intrinsic values I would argue that the justified interest of an architect is not in the beauty of the building but in designing a housing that supports elderly with dementia in their daily activities.

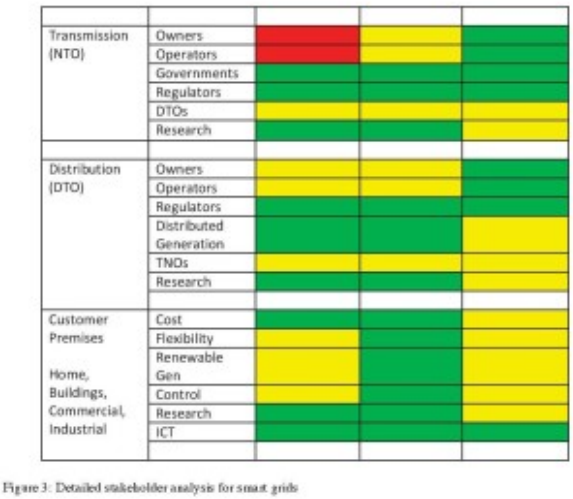


Figure 3: Detailed stakeholder analysis for smart grids

Figure 3b: Detailed stakeholder analysis for smart grids

Strijbos (Strijbos & Basden, 2006, p252-254) has developed the idea of 'multi-actor activity'. It is not clear to me to what extent this idea corresponds with the proposed stakeholder approach that has an organisational background. In the early formulations of the practice model the idea of justified interests of stakeholders was not present (Jochemsen & Glas, 1997; Hoogland & Jochemsen, 2000; Jochemsen, 2006). Later on, Verkerk et al. (2007) tried to incorporate these ideas in this model. In summary, the idea of 'inclusion of justified interests of stakeholders' opens the eyes of engineers for the diversity of stakeholders, makes them sensible for the their different interests, and offers arguments to judge their interests.

3.3. *Ideals, dreams, and values*

The 'I' of 'Ideals, dreams and values' expresses basic beliefs about the good life; this 'I' is inspired by the theory of ground motives (Dooyeweerd 1969:vol I). These basic beliefs are intricately present in every user practice and co-shape technological designs. Generally, engineers are not aware of the presence of

ideals, dreams and values. In their view, designing complex systems is a *technological* challenge. In the field of smart grids and renewable energy different basic beliefs play a role. At first, there is the ideal of *freedom*. Unlimited access to energy makes people free to live their own life. Secondly, the dream of *control* is present. People want to control nature so that energy is available at every time and every place when they need it. Finally, the value of *sustainability* is promoted. This value can have an economic motivation (to guarantee the free market), an ethical motivation (responsibility to next generations) and a religious motivation (stewardship). These ideals, dreams and values are intricately present in developing renewable energy and designing smart grids. They *motivate* engineers to do their job and *influence* the design.

In the field of building long-term facilities for elderly with dementia values also play a very important role. The most important question is: What's a good life for these patients? It goes without saying that an univocal answer on this question is not possible. It requires an in-depth insight in the perception of the environment of elderly with dementia. This perception is influenced by the phase of the illness, the personality of the patient and his or her religion or philosophy of life. Additionally, this 'I' also refers to ideals, dreams, and values that are brought in by different stakeholders. For example, health care institutions that commission a builder to build the housing, want to realize their mission and values also through the quality of their facilities. Insurance companies also want to have a say in the construction of long-term facilities. They are driven by both economic values as well as care values.

source	examples
individual	self development, meaningful life, changing the world, sustainable future
organisation	add value to society, serving the customer, develop ICT solutions for the industry, inventing the future
culture	Christian thinking: serving God, serving fellowman, stewardship
	Modern thinking: equality, freedom, free market, solidarity
	Postmodern thinking: self expression, authenticity, designing your own future, individual development
Note: stakeholders that are strongly involved in a user practice also will 'bring in' their own ideals, dreams, and values.	

Figure 4: Sources of ideals, dreams or values

This short analysis shows that there are different sources for ideals, dreams, and values, see figure 4. All these ideals, dreams, and values influence the design in one or another way. This analysis shows that values intricately present in

practices; both interwoven with each other as well as layered.

The ‘I’ of ‘Ideals, dreams, and values’ is present in the systems approach, namely in the principle of the critical awareness of the socio-cultural context (Strijbos in Strijbos & Basden, 2006, p254-255). It is also present in the practice model, i.e. the directional component (Jochemsen & Glas, 1997; Hoogland & Jochemsen, 2000; Jochemsen, 2006; Verkerk et al., 2007). The Triple I model explicitly takes the organization context as a starting point and distinguishes between different sources (individual, organisation, culture).

4. *Supporting Tools*

The Triple I model is intrinsically related to and supported by a couple tools:

1. Theory of the many aspects.**[ix]** This theory reveals the different aspects of technological designs. It prevents engineers to reduce the user practice to technological categories and urges them to ask new questions.
2. Theory of individuality structures. This theory supports engineers in understanding the identity and intrinsic values of the user practice.
3. Additional tools. These tools support engineers in investigating specific aspects of the user practice, designing new products, and evaluating different designs.

Figure 5: Application of the theory of many aspects to develop multi-aspectual design specifications

4.1 *Theory of many aspects*

This theory offers another perspective to draw up the design specifications for complicated designs. Figure 5 shows how such an analysis can be done for building long-term facilities for elderly with dementia. The first step is to gain insight in the neurological processes of the brains of older persons with dementia. After that, these insights have to be related to the experience and behaviour of older persons with dementia. Then, the question has to be asked how the different aspects of a building have to be developed in order to support the daily living of

these patients. Finally, this results in a multi-aspectual design specification.

Information processing of older persons with dementia is quite different from healthy adults. The most important difference is that the capacity to process complex stimuli decreases in course of the disease. Schematically, the human brain consists out of an emotional and a cognitive layer. Neuroscience has shown that the cognitive layer is necessary to analyse complex situations and to evaluate behavioural alternatives. People with dementia, however, are mainly dependent on processing of the emotional brain. They cannot analyse complex situations and cannot evaluate behavioural alternatives. Therefore, the whole environment has to be designed in a such a way that complex situations do not arise and an evaluation of behavioural alternatives is not required. However, when these conditions are not met, the emotional brain cannot handle the larger number of stimuli and 'orders' the body to fight or to flight. These fight or flight reactions are interpreted by the environment as 'problematic behaviour'. These types of insights influences every aspect of the building and its furnishing: from the arithmetic aspect up to the pistical aspect.

I would like to give one example. How to design a chapel for patients with dementia? How can the construction and its furnishing support spiritual experiences of elderly with dementia? Two insights from the neurosciences are very important. First, patients have to be brought in a relaxed state. At a low level of stress, it is possible to use the cognitive brain to support higher functions, e.g. spiritual experiences. A relaxed state only can be realized when the design of the chapel is simple and surveyable, and gives of a low level of stimuli. Note: a low level of stimuli is required to prevent fight of flight behaviour. Second, patients with dementia can only handle dynamic stimuli. Therefore, dynamic stimuli have to be introduced that stimulate spiritual experiences. Examples of dynamic stimuli are a moving cross, a flickering candle, or religious music. All these stimuli have to be given 'one at a time' to prevent overload of the emotional brain that results in fight of flight behaviour. Third, the memory 'reverses' to his or her youth and early adulthood. As a consequence, the choice of the design, attributes and music has to be in agreement with the religious culture of the youth and early adulthood of the patients. In summary, the theory of the many aspects urges engineers to go beyond the technological aspects of their designs and to broaden their outlook to all (relevant) non-technological aspects. Especially, this theory can be used as a 'check off list' to ask questions and to address all aspects in the specification of a

new design. This idea many aspects and their normativity is also present in the systems approach in the principle of 'simultaneous realization of norms led by a qualifying norm'(Strijbos in Strijbos & Basden, 2006, p248-252).

4.2 *Theory of individuality structures*

The Triple I model also presupposed the theory of individuality structures (Dooyeweerd 1969:vol. III). The theory of the modal aspects describe the different aspects in which things, wholes or concrete structures function. The theory of individuality structures describe the own nature or identity of these structures. Typical societal structures in which humans function and develop themselves are families, schools, labour, politics, entertainment, and churches. All these structures have an own identity or individuality as expressed by the so-called qualifying function: social, formative, economical, juridical, social, and pistical, respectively. In all these societal structures technology only will function adequately when is it disclosed under the guidance of the quality function of this structure. For example, smart grids have to be disclosed under guidance of the social qualifying function for households and the economic qualifying function for industrial enterprises. Long-term homes for elderly with dementia have to be disclosed under the guidance of the moral qualifying function. The theory of the individuality structures is required to understand the nature and character of the context in which technology is used. It is also required to understand that the identity of technology is not determined by technology itself but by the nature of the societal structure in which it functions. (Verkerk et al, 2007, p118-122).

4.3 *Additional tools*

In recent years, a number of general tools are developed that support designers. For example, User Driven Innovation presents theories and approaches to invite users as co-designers (Abel et al. 2011, Dijk et al. 2011), Social Return on Investment maps the societal business case of new innovations (www.socialevaluator.eu), and the Canvas model supports the development of new business models (Osterwalder & Peigner 2010). In addition, every discipline has its own methods and techniques for designing technology. All these methods and techniques can be used in close connection to the philosophical tools presented in this paper.

4.5. *Use of toolbox*

The toolbox presented in this paper is the result an organizational analysis of institutionalized practices and a number of dialogues with engineers in different

fields: the electrical infrastructure of the future, long term homes for elderly with dementia, internet portals in health care, orthopaedics, and applied gaming for health care. These dialogues are continuing; so, the toolbox is 'under construction'. What is the effect of the use of this box on engineers? I would like to present some experiences:

1. Engineers experience that the complexity of designs can be unravelled by using these tools.
2. Engineers learn that complex design never can be grasped in simple models. As a result, they have resigned themselves in the fact that it takes time to understand the tools and to learn how to apply them.
3. Engineers experience that the identity of technology is not determined by technology itself but by the nature of the user practice. For most of them, this experience is an eye-opener.
4. Engineers experience the idea of the many aspects as a breakthrough in thinking. Intuitively, they analyze some aspects but forget others.
5. Engineers experience the distinction between justified and not-justified interests as a revelation. In practice, they base their decisions on intuition and not on philosophical analysis.
6. Finally, engineers get the feeling that they get more grip on ideals, dreams, and values and their influence on designs.

To illustrate these findings I like to tell a short story. This model has been presented by Paulo Ribeiro to a committee of the European Union about smart grids. The leader of this committee complimented Ribeiro with the words: 'Now I understand a bit more the implications of complexity of smart grids and why the design of these systems is such a challenging job'.

5. *Conclusion*

The paper started with the observation that nowadays engineers often cannot oversee the complexity of their designs. Better tools are needed to cope with this situation. The Triple I model presented in this article has demonstrated its value in different technological contexts: health care, internet portals, architecture, and smart grids. The model addresses the challenges formulated in the introduction. Firstly, the name 'Triple I' sounds right, expresses simplicity, and arouses curiosity. The model easily can be visualised in figures and tables. The next step is to make the visual representations perfect by professional designers. Secondly, it guides engineers through the complexity of design processes by distinguishing

three different perspectives: Identity, Interests, and Ideals. Additionally, it proposes a number of tools to support the design process. Finally, it opens the eyes of engineers for the existence different user contexts and the influence on the design process. It also invites the engineer to pay attention to the organizational embedding of the user.

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NOTES

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ii. *Maarten J. Verkerk* – Department of Arts and Social Sciences, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands, m.verkerk@maastrichtuniversity.nl
iii. Philosophers easily undervalue the importance of an appealing model. The main reason is that they concentrate on the content and forget that their ideas only will have impact when they are marketed well. Marketers, on the other hand, focus on selling ideas. They believe that good products need an appropriate imago and well-designed packaging.
iv. It has to be noted that engineers use the word 'complexity' in different ways. On the one hand, they use this word for existing knowledge in their own field, like the interaction of different components, modules, and technologies. On the other hand, they use this word for knowledge of other disciplines that is not (yet) available, like ethics and marketing.
v. In certain engineering quarters the perspective of the user has recently been (re)discovered as a key factor in the design process (Buxton, 2007; Abel et al., 2011; Dijk et al., 2011).
vi. It has to be noted that the practice model focuses on the characteristics of professional practices and does not address explicitly the different types of users. In addition, it does not take into account the organisational context of these different users. For example, internet portals in health care are used by different kinds of users, e.g. patients, professional, and (administrative) staff. Each of these users have specific requirements and operate in different organisational contexts. Engineers that design internet health care portals have to cope with these specific requirements and different contexts. In systems thinking, 'customers' and

'actors' are explicitly identified (the 'C' and 'A' of 'CATWOE'). Rightly, Strijbos (Strijbos & Basden, 2006, p252) points out that disclosure of new possibilities in developing technology is a multi-actor activity.

vii. I prefer to use the word 'perspective' to indicate that a certain point of view is chosen to investigate the practice. Each perspective reveals a different type of 'complexity' that strongly determines or has to determine the design process.

viii. Personal communication Paulo Ribeiro.

ix. The Triple I model presupposed the theory of modal aspects (Dooyeweerd 1969:vol. II). In communication with engineers the word 'modal' raises too many questions, therefore the expression 'theory of many aspects' is used.

REFERENCES

Abel, B. van, Evers, L., Klaassen, R. & Troxler, P. (2011). *Open Design Now: Why Design Cannot Remain Exclusive.* Amsterdam: BIS Publishers.

Basden, A. (2008). *Philosophical Frameworks for Understanding Information Systems*, Hershey PA: IGI Publishing.

Burken, C. van, & Vries, M.J. de (2012). Extending the theory of normative practices: an application to two cases of networked military operations. *Philosophia Reformata*, 77, 135-154.

Buxton, B. (2007). Sketching User Experiences. Getting the design right and the right design. New York: Kaufmann.

Dooyeweerd, H. (1969). *A New Critique of Theoretical Thought.* The Presbyterian and Reformed Publishing Company.

Durmisevic, S., & Ciftcioglu, Ö. (2010). Knowledge modelling tool for evidence-based design. *Health Environments Research and Design Journal,* 3(3), 101-123.

Dijk, D. van, Kresin, F., Reitenbach, M., Rennen, E. & Wildevuur, S. (2011). *Users as Designers A hands-on approach to Creative Research*. Amsterdam: Waag Society.

European Commission (2010). *Energy 2020: A strategy for competitive, sustainable and secure energy.* COM(2010) 639 final.

European Commission (2011). *Smart Grid Projects in Europe: Lessons Learned and Current Developments.* The Hague: Institute of Energy.

European Electricity Grids Initiative (2010). *Roadmap 2010-18 and detailed implementation plan 2010-2012*.

Freeman, R.E. (2001). The Stakeholder Theory of the Modern Corporation. In Beauchamp, T.L. & Bowie, N.E., 6th ed., *Ethical Theory and Business,* pp56-65. New Jersey: Prentice Hall.

Hoof, J. van (2010). Aging-in-place. The integrated design of housing facilities for people with dementia. Thesis. Technical University Eindhoven.
Hoof, J. van & Verkerk, M.J. (2013). Developing an integrated design model incorporating technology philosophy for the design of healthcare environments: A case analysis of facilities for psychogeriatric and psychiatric care in The Netherlands. *Technology in Society*, 35(1), 1–13.
Hoogland, J. & Jochemsen, H. (2000). Professional autonomy and the normative structure of medical practice. *Theoretical Medicine and Bioethics*, 12, 457-475.
Huisman, E.R.C.M., Morales, E., Hoof, J. van, and Kort, H.S.M. (2012). Healing environments: a systematic review. *Building and Environment*, 58, 70-80.
Jochemsen, H. & Glas, G. (1997). *Responsible medical care* (in Dutch). Amsterdam: Buijten & Schipperheijn.
Jochemsen, H. (2006). Normative Practices as an Intermediate between Theoretical Ethics and Morality. *Philosophia Reformata*, 71, 96-112.
MacIntyre, A.C. (1981). *After Virtue. A Study in Moral Theory*. London: Duckworth.
Monsma, S.V., Christians, C., Dykema, E.R., Leegwater, A., Schuurman, E. & Van Poolen, L. (1986). *Responsible Technology. A Dooyeweerdian Perspective.* Grand Rapids: William B. Eerdmans.
Osterwalder, A. & Peigner, Y. (2010). *Business model generation*. New York: Wiley.
Pike Research (2011). Smart Grids in Europe. Available at: http://www.pikeresearch.com/research/smart-grids-in-europe, accessed February 2011.
Ribeiro, P.F., Polinder, H. & Verkerk, M.J. (2012). Planning and designing Smart Grids: Philosophical Considerations. *IEEE Technology and Society*, 31(3), 34-43.
Strijbos, S. & Basden, A. (eds) (2006). *In search of an Integrative Vision of Technology.* Interdisciplinary Studies in Information Systems. New York: Springer.
Ulrich, R.S., Zimring, C., Barch, X.Z., Dubose, J., Seo, H-B., Choi, Y-S., Quan, X., and Joseph, A. (2008). A review of the research literature on evidence-based healthcare design. *Health Environments Research and Design Journal*, 1(3), 61-125.
Ulrich, R.S., Berry, L.L., Quan, X., & Parish, J.T. (2010). A conceptual framework for the domain of evidence-based design. *Health Environments Research and Design Journal*, 4(1), 95-114.
Verkerk, M. J., Hoogland, J., Stoep, J. van der & Vries, M.J. de (2007). *Thinking,*

Designing, Making. Philosophy of Technology (in Dutch). Amsterdam: Boom.
Verkerk, M.J. (2014). *A philosophy-based 'toolbox' for designing technology. The Conceptual Power of Dooyeweerdian Philosophy*. Accepted for publication, Koers. Bulletin for Christian scholarship.
Vries, M.J. de (2006). Ethics and the Complexity of Technology: a Design Approach. *Philosophia Reformata,* 71(2), 118-131.
Zimring, C., Bosch, S. (2008). Building the evidence base for evidence-based design. Editors' introduction. *Environment and Behavior*, 40(2), 147-150.