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"Operationalizing C2 Agility"

On Systems Complexity and Experiment Validity

Topic 5: Experimentation, Metrics, and Analysis

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Abstract

Complexity is a fundamental driver for C2 agility. This paper tries to explore the consequences of such complexity, which not only changes the rules for common wisdom about C2, but for the rules of experimentation as well. While to some extent, this may be seen as a matter of differing perspectives, agility in the performance of C2 means less predictability of organizational measures. Increased agility broadens the repertoire of action around and within the organization, hence increasing its complexity, i.e. the ability to interact internally and externally in new and unforeseen ways. While this is ultimately positive for survival and success, it also demands a rethinking on the methodological level. Historically, organizing has normally meant reducing complexity by standardizing language, behavior and expectations. Hence, organizing has resulted in reduced complexity for the sake of internal coordination. The resulting predictability of behavior has been exploited in the validation of operational and tactical concepts, at least thought to be performed more or less by the book. With agile C2 the notion of organizing changes into once again increasing complexity, thereby decreasing predictability of behavior and the appropriateness of the very *notion of validation* of operative or tactical concepts in any traditional sense. In consequence, this article draws on systems theory to discuss notions of validity.

On systems complexity and experiment validity

The aim of this paper is to discuss the methodological consequences of complexity in the wake of C2 Agility. In doing so, the discussion might reduce the risk of taking unaware risks and instead open up for new conceptions of validity in terms of responsiveness and improvisation rather than fixed structure. Without doubt, even flexibility and responsiveness may be tested and evaluated. However, qualitative uncertainty about qualitatively new phenomena can in principle not be met by pre-designed measures, which in turn cannot be validated in any traditional sense. Consequently, the ultimate validity of responsiveness in C2 Agility can only be tested in real time and in real life settings. This is not to downplay the value of organizing structures, processes or training. Rather, by discussing and developing a new *meaning* of validation under such conditions, we may improve the ways structures and processes may be enhanced, not least by training, to meet new requirements *in situ*, as new evidence provides content to notions of responsiveness. Hence, a new notion of *validity* will have the ongoing practice, rather than empty structures of organizing, as its main point of reference.

In its traditional sense, the validity of experiment results depends on the control of parameters influencing the outcome. Although simplification is typically needed to describe operational concepts i.e. in organizational processes, the description will need to either reflect or control for the complexity of human interaction as these abstractions are made into concrete experience in the experiments. In other words, the abstract design of concepts will not tell a realistic story of what actually makes a difference, unless we pay attention to the level of complexity in practice. In consequence, experiments that ignore the level of complexity of human interaction in organizations will neither be able to validate nor to falsify operational concepts. In the worst case, an operational concept that has passed the test of experimental testing will be taken as validated in the sense that it will be appropriate for meeting qualitative uncertainties through C2 Agility, without considering the

large amount of uncertainties in the execution of that doctrine. In worst case, this might lead to unaware risks and overconfidence, which in turn is a classical reason behind failure. Indeed, as experiences from NASA have shown, a culture of objectivity may feed such overconfidence.[1] The discrepancies between the normal depiction of organizational processes and the actual level of complexity in such activities can be illustrated through Von Bertalanffy and Boulding's General Hierarchy of Systems, distinguishing nine levels of complexity of systems:

General Hierarchy of Systems in order of complexity

1. Static frameworks,
2. Dynamic systems with predetermined motions,
3. Closed-loop control or cybernetic systems,
4. Homeostatic systems like biological cell,
5. The living plant,
6. The animal,
7. Man,
8. Human organizations, and
9. Transcendental systems.

(After Von Bertalanffy and Boulding[2])

Complexity should here be understood as a systemic, *interactive complexity* (as opposed to detail- or structural complexity), where the parts of a system have a greater freedom of action and more linkages between the components, giving raise to unstable, irregular and inconsistent non-linear

[1] Feldman, S.P. (2004), "The Culture of Objectivity: Quantification, Uncertainty, and the Evaluation or Risk at NASA", *Human Relations*, Vol. 57, No. 6, pp. 691-718.
[2] in Hofstaede, G. (1978) "The Poverty of Management Control Philosophy", *Academy of Management Review*, July 1978, pp.450-461.

effects.[3] Such a system is also capable of finding new ways of interacting internally and with the outside world.

According to the above classification, human organizations (level 8) are among the most complex phenomena we know of. At the same time, organizations are normally depicted through static frameworks such as organization charts (level 1) or in the best case as flow-charts of value-creating processes (level 2). Traditional C2 systems operating as cybernetic systems (level 3) typically preserve internal equilibrium at the cost of external adaptability (i.e. closed systems). In contrast, thanks to their instability, living cells have the capacity for homeostasis (level 4), i.e. self-development according to new requirements or possibilities in the environment. Plants (level 5) are more complex than single cells, but less complex than animals (level 6). In force of our imagination and capacity for self-reflection, humans as cultural, sense-making creatures (level 7) are more complex than (other) animals. Human interaction give rise to even higher levels of complexity, with uncertainty of outcomes as a result (level 8). On the top of the hierarchy (level 9), transcendental or symbolic systems such as language, logic and mathematics exceeds other systems in terms of complexity.

The practical consequence of this is the need to balance the urge for simplification with insights of its limitations: we may reduce complexity of organizations (as natural systems) by emphasizing their deliberate process design (as rational systems). However, if we do so without paying attention to the actual or potential level of complexity of organizational life, we will not only miss the point of the character of the system, but may also lose the entire validity of experiments designed to validate operational concepts. Hence, looking away from the character of human organization will not prevent these factors to influence the outcomes of experiments: either we include them in the

[3] TRADOC Pamphlet 525-5-500, ”Commander’s Appreciation and Campaign Design”, version 1.0, 28 January 2008, The United States Army.

operational concepts or control for them in the experiment design, theories highlighting the character of systems on complexity levels 7 and 8 could demonstrate the validity of operational concepts.

Principles on lower levels (e.g. level 6) may apply also to humans, such as strictly behaviouristic studies of humans' immediate reaction to certain stimuli, such as Pavlov's studies of involuntary reflexes. However, human behaviour (level 7) cannot be explained by conceptualizing it as a mere response to external stimuli: these are relevant, but the same stimuli may provoke very different reactions depending on how people *understand* the situation, i.e. as an outcome of interpretive *sensemaking*[4] processes. Furthermore, when people act in groups (level 8) more complexity is added as behaviour becomes interactive, forming patterns on a structural or societal level both influencing and growing out of emergent actions: systems of meaning, moral, norms and culture *partly* govern the available legitimate repertoire of action without fully determining it or ruling out reflective and purposeful individual action.[5]

To grasp the intelligibility of human action, the repertoire of theoretical perspectives needs to be extended beyond the rational design of organizations. The law a *requisite variety* states that for purposeful control, only variety can neutralize variety: the control mechanism which is employed to

4 Weick, K.E. (1995), Sensemaking in Organizations, SAGE, Thousand Oaks.

5 In relation to C2, in practice this means that organization and process design is immune of neither cultural phenomena, nor of individual reflection. Furthermore, this logic is not only relevant to own forces, but also to the behaviour of opposing forces or societies at large. Hence, the very dimensions which condition our own organization and process design also set a limit to analysis of opponents and societies: as much as we are capable of rational thinking, it will be conditioned by cultural influences, and as much as opponents' actions are conditioned by cultural influences, they are capable of rational thinking. Hence, human capacity for reflection and self-reflection both makes possible and sets the limits to intelligence analysis and optimal C2.

control a complex system must have at least as much variety as the system it is intended to control.[6] This is the case as much for the situation of experiment control, as for C2 in practice. Hence, to understand the outcome of any situation, it is also necessary to, as far as possible, control for the actual level of variety, i.e. the delicate nuances of the interaction and conditions influencing decision and action during the experiments.

In order to understand human individual behaviour (level 7), it is necessary to grasp the aspect of symbolism; i.e. what things *mean* from the individual's perspective. What goes on is interpreted as an episode in between the past and the future, the self and the world and is guided by the self-awareness suggested by the situation. As later years' empirical research has shown, processes of *sensemaking* and *situated cognition* are much more momentary and temporally bounded than earlier believed.[7] Hence, personal psychological profiles or cultural background counts only for a smaller part of the factors influencing how a situation is understood. Rather, to understand the action of a player in a practical experiment, one needs to understand how the actor understands the (point of the) concept, the role and the actual situation. *In consequence, any specific situation must be interpreted from the subjective standpoint of the individual, i.e. by applying interpretive approaches to e.g. individual psychology or pedagogy.*

Human organizations are here treated as the entire range from small groups to entire societies. Although there are obvious differences in complexity between them, it's a matter of degree rather than of kind. The law of requisite variety can also be stated as that a system of lower degree of complexity cannot "understand" a system on a higher level of complexity. Hence, a dog simply

[6] Daft, R.L. and Wiginton, J.C. (1979) "Language and organization", *Academy of Management Review*, Vol. 4., No. 2, 179-191.
[7] Elsbach, K.D., Barr, P.S. and Hargadon, A.B. (2005) "Identifying Situated Cognition in Organizations", *Organization Science*, Vol. 16, No. 4, pp.422-433.

doesn't get why a man might starve himself to death because of ideological reasons, as little as one single individual can understand the width of complexity of human interaction within even the smallest organization. In consequence of the high degree of complexity in organizations and societies and individual humans' limited capability to understand such complexity, a large number of parallel theories have developed to understand human collective behaviour.

There are at least two major complications for formulating general theories about collective human behaviour. First, there is a conflict between *micro* (where individual action sums up to societal patterns) and *macro* perspectives (where societal patterns guides individual action) for explaining human action. Second, there is a conflict between the assumed predictability of action following general (scientific) *laws* on the one hand the assumption about the human capacity for intelligent, self-reflective and creative *rationality* (denying predictability) on the other hand. Hence, it is an open question to what extent there can be any science of social phenomena in a traditional sense. One might argue that the failure of social science to find general laws with predictive power might be seen as its greatest achievements; namely to highlight the intelligibility of human action as active and reflective behaviour within the restraints suggested by the situational context.[8]

Although neither economics nor traditional macro-structuralist approaches to sociology should be excluded per default, traditions highlighting society as ***socio-cultural systems***, such as through the notion of ***communities of practice***[9], should be especially relevant for C2 studies. Furthermore, it can be argued that although there might be social structures on a macro-level, they will always manifest themselves empirically in local micro-practices. Hence, concrete practices in everyday life will tell not only the story of the locally and temporally bounded actions, but also about how they are related to

[8] Czarniawska, B. (2004) "Narratives in Social Science Research", Sage, London.
[9] Lave, J. and Wenger, E. (1991) *Situated Learning. Legitimate peripheral participation*, Cambridge: University of Cambridge Press

larger societal structures or phenomena. Among the many possible approaches that could be considered a few may be especially relevant. *Phenomenological* approaches taking the local life-world of actors, as exemplified by *ethnographical* culture-studies, emphasize the active and central role of interpretation. *Socialpsycological* approaches and *symbolic interactionism* highlight the role-playing character of everyday life, as well as the story-telling logic of cognition. In the attempts to understand the essence of certain ways of being and behaving, *Bourdieu's notion of social fields of practice* may inspire multi-dimensional analysis of social behaviour.

Methodological issues in social sciences go further than only following the method-manual. Rather what is required to gain credibility is reflectivity in relation to a number of issues.[10] The view of human knowledge as socially constructed and maintained addresses its relation to truth as well as its social function. Hence, Habermas questioned the character of *rationality*, Foucault addressed the mutual relation between *knowledge and power*, and in Marx's tradition of seeing *knowledge and identities as constructed*, feminism and other approaches speaking the voice of the underprivileged are all significant contributions addressing the power aspect of knowledge production. Likewise, how we name and frame phenomena is not neutral or for ever given. Rather, in line with Gidden's structuration view of societal development as interaction between the micro and macro-levels, the *emergent character* of both *knowledge and society* should be addressed. Hence, ultimately, social science raises perhaps more questions than it answers. However, if objectivity cannot be obtained, self-reflection may be the only warrant for *a more conscious and less culture-bound research effort*.

[10] Alvesson, M. and Sköldberg, K. (2000) "Reflexive Methodology, New Vistas for Qualitative Research", Sage, London.

As later contributions have shown, C2 theory and practice are not immune from these influences, raising fundamental questions about its task and scope.[11] Similar revisions have also appeared in civilian management control theory, emphasizing its attention-directing rather than truth-telling function, hence balancing the norms of science with the demands of practice.[12]

Summing up, insights about the level of complexity of social systems both calls for a more rigorous experiment design as well as it addresses the limits to the "science" in social science. However, ignorance will not improve validity of experiments and the best way of making C2 studies more rigorous is by a thorough reflection upon its possibilities and limits also reflected in research design and in the presentation of research results.

What would it mean to validate a concept like C2?

Although often presented as separate entities, theoretical choices do have *methodological implications*. As communities of practice renders a somewhat self-referring picture of cognition as a social and collective phenomenon, researchers and their work cannot be totally immune of such tendencies. In other words, *facts are hybrid entities*: given by pure and brute forces of the environment, however also more or less arbitrarily classified and interpreted through the collective social experience within a community (Rorty 1991). This gives a stance of relativism to studies of practice, which may however also be seen as a way of qualifying rather than rejecting ideals of objectivity. Hence, giving up the assumption that I with my tools evidently am reaching truth doesn't mean giving up the notion of "justified true belief". Instead, the relativism suggested by the theory of

[11] Osinga, F.P.B. (2007) "Science, Strategy and War – The Strategic Theory of John Boyd", Routledge, New York.
[12] Bjurström, E. (2007) "Creating New Attention in Management Control", Doctoral thesis, Uppsala University, Department of Business Studies, Uppsala, Sweden. Fulltext PDF available at: http://publications.uu.se/abstract.xsql?dbid=8234

communities of practice just suggests that *the process of justification should be problemized, debated and seen also as a social phenomenon*.

While method can be described and debated in technical terms, it can also be argued that methodological issues mainly concern two fundamental aspects, namely *ontology* or what the world looks like and *epistemology* how we get knowledge about it. Since the Enlightenment the scientific impulse has been to look for general patterns, explaining phenomena and making the world *predictable* and thereby easier to exploit for human needs. However, the idea of the world as being *highly lawful* is not entirely built on empirical evidence, but just as much an assumption and an expectation that has more to do with faith and the human weakness for *ruthless generalizations*. Hence, much of expectations and views on methodology regarding social phenomena are rather based on a generalization from natural sciences and logic rather than on a reflection over empirical experience in the social domain. In other words, there is a tendency to *generalize far beyond what's warranted* by experience.

The problem of excessive generalization is also connected with defining the proper level of analysis. With an over-simplified view on what mechanisms that govern organizations and societies, it may seem tempting to only look for the stable, general and abstract patterns rather than for the many little everyday doings that make up social structures. All these tendencies can be traced back to ontological assumptions of orderliness, predictability and generalized rules. In consequence, metaphorical understandings of "the-world-as-a-machine" guides the arguing about validity and generalization. As counterweight, communities of practice suggests another ontology of "the-world-as-not-such-a-tidy-place", hence fostering a more sceptical attitude towards generalization. It also speaks a warning of complexity: - Do not handle high-level complexity issues with low-level complexity theories and methods! Instead, rather than denying complexity and uncertainty, we

should look for theories problemizing how such an environment may be handled and even exploited for human needs. Hence, out of a practice ontology, *discussing the limits of validity and generalization is seen as a greater virtue than over-estimating the reach of past and limited experience*.

Practice *epistemology* suggests that we learn and understand by our everyday doings within a social community. This also means that scientific method will not allow us to reach out beyond the somewhat arbitrary cognitive patters suggested by the environment. The only way to balance this self-referring tendency is to expose oneself to new experience, diversity of interpretations and active reflection upon own assumptions. This also sheds new light on what validation can be: as we don't really reach out to a pure reality as soon as we start classifying and naming things, validation doesn't have phenomena themselves as only point of reference, but also the social community judging *what* is seen and how it matches the belief system of the community. Hence, *validation and justification are social phenomena*, guided by social rules.

The point of this view is not to create unnecessary uncertainty, but to *avoid taking unaware risks*. Rather than clinging to established and taken-for-granted assumptions of organizing, method, what the world looks like and how we get knowledge about it, these things should be problemized and reflected upon. Hence, the *warnings* of students of military theory should be taken *seriously*: not to underestimate the variety and creative potential of individuals, not to generalize without considering the power of context, not to simplify and underestimate complexity in theory and method.

Developing a new understanding of validity in CD&E on C2 Agility

As little as Rome was built in one day, so was the understanding of military and scientific endeavours. It will take time to realize C2 Agility. And it will take time to realize what it is. It will take even more time to find out how it can be validated or what a meaningful notion of validation of such a concept might be. Nevertheless, C2 Agility is needed and to proceed in a controlled manner, we also need concept development and experimentation methods to question and promote concepts for further development. However, a potentially even more dangerous phenomenon than future adversaries may be the very belief that we would be able to *validate* operational concepts in any traditional sense in an environment characterized by qualitative uncertainty, i.e. the lack of knowledge about *what* kind of measures an adversary could take or what effects could be invoked. This simple insight might be the most important vehicle for a secure future. The very point is that we cannot yet know where we will end up, without referring to future, unknown events. And exactly this insight is at heart of C2 Agility.