The art of developing management support: Demands on theoretic and technologic synergy.

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Abstract

Military technical support (TS) systems are expensive, short-lived, and in a continuous need of upgrade. Insufficient knowledge of which kinds of change a social organisation has to deal with, and what these changes permit command and control (C^2) to regulate and do, is one reason for that. The continuous need of upgrade is reinforced by the self-promoting progress of technological innovations. Another reason is that the TS systems are developed with guidance of a circumstantial scenario, which is not appropriate for the variety of future threats. Lastly, the military TS are primarily algorithmic systems. As such, they disregard the demands that different changes put on the techniques by which the TS can be realised. To remain sustainable the TS systems must consist of time-less services adapted to different environmental dynamics, and hence, must be realised by different techniques.

Introduction

This paper claims that the one-sided focus on technological solutions in the development of military management (C^2) systems often results in expensive, malfunctioning, and rigid systems, that only can function if military missions and environment are stable. But, environment as well as military missions are changing. These changes mirror different dynamics and different dynamics in turn permit and demand different kinds of control and actions.

An important reason for the rigidity of military technical support (TS) systems is the one-sided focus on technological solutions of managerial problems. The more an organisation tries to solve its managerial problems by means of technology, all the more it will be aware of new and better technological solutions, and hence, the none-usability of the old ones. Nevertheless, the most serious reason to the rigidity of contemporary TS systems is the lack of analyses of what C^2 can and should control and regulate in different environmental dynamics, and by which means. Thus, there is a serious lack of theoretical understanding and knowledge of which kinds of change an organisation must cope with, which the typical characteristics of these changes are, and hence which kinds of control and action these characteristics permit.

The development of military TS systems is basically bent on identifying different C^2 functions. The functions are then realised by algorithmic techniques, which presuppose a specification of the course of events, that is, stability in environmental dynamic, tasks, and managerial goals. But none of these preconditions can be kept stable. Algorithmic and functional thinking disregard that different kinds of change demand different arts of management, and that different arts of management demand different TS service, or even functions.

To develop a C^2 system with guidance of a circumstantial scenario is a traditional procedure in a military organisation, but as much contra-intuitive. We are unable to catch all potential developments in one circumstantial scenario, because we cannot know how the future will look like. Very likely, the only way to attain an effective C^2 and TS system is to rely on theories about changes and their demands on a social organisation. Irrespective of how the future shall mould, three kinds of change: Closed, contained, and open-ended change (Stacey, 1992), will always exist as general phenomena. Each of these changes shows some general characteristics that can be used to create generic scenarios about types of situation, which an organisation always must cope with. Generic scenarios that rely on such characteristics can offer much greater confidence with respect to future developments than a circumstantial scenario ever can do. A disadvantage with generic scenarios is that they cannot predict specific events in the future. On the other hand, the circumstantial scenario cannot do this either. The advantage is that a generic scenario can catch the general processes, demands and possibilities of a particular kind of change. A circumstantial scenario cannot do that because it focuses on a specific course of events.

Since each change demands and permits different patterns of action and control, it is important that the leaders have a possibility to freely compose such TS services that match the characteristics of a particular change. The services have to be time-less, adapted to different change characteristics, and independent of what is possible to achieve in a pure technological sense today. In that way the TS systems can remain sustainable much longer than algorithmic systems containing in beforehand specified functions.

In this report, theories about change (Jantsch, 1980; Stacey, 1992; Wilden, 1980), are used to identify at least the basic time-less services a military C^2 may need in different kinds of environmental dynamic. Techniques that are most appropriate for realisation of TS services in coping with closed, contained, and open-ended change are suggested.

The importance of synergy between theoretic and technologic development

> "To be accustomed to anything
> is a terrible thing."
> Japanese Zen master

During the last decades we have learned the lesson that innovations within the field of especially information technology come to the end of usability much faster than within other fields of human activity. This phenomenon arises from the self-promoting processes in the technological progress. That is to say, the more technology we are using the faster it grows, and the more it consumes the flexibility of a system. Since technological solutions are applied to almost all problems, there is no room left for other kinds of solutions. In other words, complex systems, irrespective of whether technical or social show two vivid characteristics: They have a finite number of degrees of freedom and the degrees of freedom are consumed very quickly. In the case of military C^2systems the degrees of freedom are consumed by adoption of new technological hardware, software, or upgrades. The consumption of degrees of freedom in only one sector of a system leads with necessity to the loss of flexibility in other sectors (cf., Bateson, 1972). Hence, the organisation looses not only overall flexibility, but also creativity to come across other kinds of solution than the technological ones.

In the run-a-way progress of technology we have to reflect about the conditions we are creating for ourselves in high-tech environments. We also should think of whether technological solutions can serve humans in all cases, or whether we are creating a world in which humans serve technology. The probably only way to liberate some degrees of freedom of a system for other kinds of solution and to create a bridge between technological and human resources is to develop theories of change and their demands on actions and control. Without such knowledge, we cannot know how to act and what to control in the future or whether humans or technology are best at acting or controlling in a particular environmental dynamic.

Thus, theories are roads to our understanding of what is happening now and what can happen in the future. Therefore, a theory is a precondition for the development of C^2 and TS models. Theory based models make it possible to test and improve both C^2 and TS systems systematically. With the guidance of models we can then develop adequate methods to study the behaviour of a system, because the theories from which the models were derived ought to indicate what we are able to study, observe, alter, and make statements about.

The art of developing C^2 and an adequate technical support

> "A clash of doctrines is not a disaster, it is an opportunity."
>
> Whitehead

The basic prerequisite for all biological and social survival is to preserve the ability to be informed about environmental changes, and to communicate the nature of the changes to others. This is above all important for a military organisation, since an enemy is forcing rapid and surprising changes upon it. These changes and the new non-traditional missions attributed to the military community stresses the need of sustainable TS systems that can handle rapid changes in the environment.

Since majority of contemporary military TS systems are non-intentionally constructed to work in stable environmental dynamic, they will be inadequate at the moment environmental dynamics, missions, organisational structure, or military tactics change. Nevertheless, the entire C^2 system is designed and constructed by means of technological possibilities of yesterday. That is, the preparation for developing and implementing of a new management and TS system into an organisation is going on for years, and is thus by necessity determined by the knowledge and technical possibilities of yesterday. But, as the self-promoting progress of technology more or less continuously offers new faster and better solutions on old problems, the TS system is in a continuous need of upgrade. This results in expensive, many times malfunctioning, and non-interoperable systems. The non-interoperability is most obvious when military systems are to be connected to civilian systems, which are upgraded in a faster pace than the military ones. Consequently, the need of a service based TS system is urgent, and must be developed with guidance of the demands of actions, and the possibilities of control that each kind of change permits. From that, we have to extract services (e.g., plan implementation, data registration, matching patterns of the course of event and plans, warning, etc.) that can support humans in all kinds of dynamics.

C^2 functions

In ordinary cases, a military C^2 system consists of a specified list of functions, tasks, and/or activities that a commander shall devote his time to. Since such a list is assumed to be valid in all cases and situations, the specification works as a normative model of what kind of behaviour an organisation is supposed to show, and what the commander is supposed to achieve. It can happen very easily that organisational attention will be locked to the control of that the normative model is followed rather than to a reflection about what is productive to do in a particular situation. Or, which consequences will emerge if a general model would be used on specific events. Stated differently, a normative model takes no consideration to three qualitative aspects in the art of C^2. These aspects are specificity of events, variety of events, and context-tied behaviour.

The specificity of events means that each event is unique and demands a particular approach. Thus, it is impossible to apply a general model on specific events. With the variety of events is meant that nobody is capable to either predict phenomena that will emerge in the future or the relationship between them. Nobody is capable to control the variability of phenomena. The context-tied behaviour implies that components of a system (particularly humans) do not stay in a mechanical permanent relationship to each other. Rather an individual is aware of the kind and degree of supports an environment offers at any given time. That is, single members of an organisation are contextually tied to each other in both a physical and mental sense (Vaill, 1989). Therefore, the effectiveness of C^2 depends more on the interaction between people, than on a complete list of tasks and activities to be performed. The qualitative aspects of C^2 vary in strength depending on what kind of change the organisation is coping with at present. Consequently, the art of C^2, tasks, control, and activities will vary as well. This means that TS services also must be adapted to the characteristics of a particular change to support human beings adequately.

Technical support for C^2

Also military TS systems consist of a number in detail specified functions. These are algorithmic functions related to the tasks of commanders. Both the list of tasks and the TS functions are supposed to be universal. But, a particular task or function can be a key function, not needed at all (cf., Vaill, 1989), or even be contra-productive depending on the environmental dynamics since the art of C^2 varies in different kinds of dynamic. To be valid in general, each function specified on the list should therefore be made universal in some way. But, it is impossible to make algorithmic functions universal for all kinds of dynamic simultaneously, because at least in chaotic dynamics the use of algorithmic techniques can be deceptive.

To use algorithmic techniques on complex and ambiguous phenomena can very easily lead to a confusion of cause and effect. Partly because such techniques ignore a radical conversion of a situation, that is, that the definition of a problem, and hence, the possible solutions can change radically. Partly because they ignore the mechanisms of sluggishness that can force an organisation to act in contra-intuitive, and/or contra-productive way (Rrigogine, & Stengers, 1984).

In addition, majority of contemporary TS systems are short-lived, due to the methodology applied in their realisation (circumstantial scenario, specifications of function, and algorithmic techniques). Such systems work as intended when the environmental dynamic is stable or in all essential aspects similar to the circumstantial scenario. But, the systems would be inefficient as soon as the circumstances on the political, technological, or military tactical arena change.

The difficulty of preserving military TS system sustainable lies in the lack of knowledge of what TS can, should, and cannot support C^2 with in different kinds of dynamic. Because the environmental demands on an organisation vary depending on which kind of change is vivid, the services that TS should provide humans with must vary as well. Some constructors and users of military TS are trying to solve the insufficient sustainability of TS systems in a structural way by suggesting an evolutionary module-based system capable of adaptation to alternating circumstances in the environment. Yet, structural solutions cannot guarantee that a system remains sustainable. Wilden (1980), pointed at that all systems produced by an evolutionary process are:

1) Reproductive (capable of duplication with or without error)
2) Adaptive (they have memory and are capable of learning)

All evolutionary systems show two emergent phenomena:

a) Emergence of new system characteristics despite the fact that the system is following the instructions of its original "program".
b) Discontinuous evolution to such a complexity or organisation that goes beyond the original program of the system.

Yet, each discontinuous jump in the organisation of a system leads to a change of its goal, and hence, to a tension between the old goal and the new one. This tension will be intensified due to the system ability to adapt to adaptation. Since every new adaptation is costly somehow, the system will "hunt" for homeostasis. Stated differently, the system will try to hinder the oscillations inherent to it, to pass the limits of its control, that is, not to oscillate itself into destruction. To "hunt" for homeostasis is one way of engendering positive feedback and the system must therefore adapt to noise in order to survive at least in a short-term perspective. Thus, adaptation in homeostasis is an essential product of noise in the system-environment relationship (Wilden, 1980). But, growth or evolution of a system is the product of the relationship between the internal program of the system following its developmental pathway, and the external constraints on the positive feedback that is engendered by the internal program (Wilden, 1980). All growth or evolution leads to an increased organisation, or to an adaptation through changes in the system's structure.

Applying that reasoning on an evolutionary module-based TS system, we should expect that it also would hunt for homeostasis. That is, adapt to noise in the environment. But, as the system can only operate within the boundaries of its internal program (at least during some period of time), it cannot evolve or adapt as complex social systems by changing the structure. Being unable to increase its own organisation, the risk of system destruction is obvious due to the pressure of negative feedback that demands adaptation (another structure). In other words, a relationship between a system and its environment that goes beyond the homeostatic plateau will very likely lead to a destruction of the system, unless it could be able to adapt by changing its physical structure. Human beings are unable to do that. The question is whether a technical system would be able to do that and still remain the support to humans as intended.

Changes in the environment

Neither a social organisation nor an individual can avoid to cope with three kinds of change: Closed, contained, and open-ended change (Stacey, 1992). These changes can be understood in terms of stable, ultra-stable, and chaotic dynamics.

- <u>A closed change (stable dynamic</u>) is characterised by the possibility to make short-term predictions and to control events, processes, and consequences in a short-term perspective. Stable dynamics permit a repetition of previously acquired behavioural and action patterns, because the actual events and circumstances are in all essential aspects similar to the situation in which the patterns have been developed. This kind of change permits automation of a large part of a decision process as short-term predictions of the course of events are relatively confident due to the mechanisms of sluggishness. Algorithmic techniques can match this kind of change, and are therefore applicable to the construction of TS systems.

- A contained change (ultra-stable dynamics) is characterised by a larger uncertainty in predictions than closed change. In dealing with contained changes, a social organisation can rely on probability measures in decision making. Because, the probabilities are counted on a large number of similar events. This kind of change processes extends the time-horizon in planning, lowers the accuracy in predictions, and increases the frequency of errors in decision making. A module-based TS system that permits a composition of time-less services supporting decision making and actions in the same pace as new experiences are made are best suitable to the demands and possibilities of contained change processes.

- An open-ended change (chaotic dynamics) is characterised by the impossibility to predict which events will emerge, how they will emerge, and which consequences they can lead to. This kind of change differs in a radical way from the two other ones as it usually starts as a tiny deviation from a normal pattern. Yet, every tiny deviation can suddenly escalate to big, unexpected, and unpredicted events and consequences. It is usually contra-productive to try to control the open-ended change by for instance statistic or algorithmic techniques as it is impossible to predict when these changes emerge and which consequences they will lead to. This change requires an ability to appreciate uncertainty and ambiguity as well as an ability to do something constructive of it. It needs sensitivity for anomalies, fluctuations, and pattern recognition. So far, human beings are superior in that respect.

Hence, there is a need of TS systems having potential to support management in all these kinds of dynamics. To develop such TS systems we have to:

1) Develop theories about the relationship between different kinds of change, tasks, missions, and organisational structure.
2) Apply and develop techniques that can handle the characteristics of each change.
3) Develop C^2 models on basis of 1).

To ensure that the development of theories and models can handle as much variety of the real word as possible, a cross-disciplinary group should be engaged for that purpose. A cross-disciplinary group can supply with a manifold of perspectives to the problem that a homogeneous group hardly can do.

Thus, manifold is determining the development of future C^2 activities, and for coping with future uncertainties and varieties of military missions. The demands to quickly adapt to varying missions and circumstances need not only different C^2 activities, but also multifaceted TS services that are able to:

- Adapt to varying missions and dynamics
- Facilitate and support C^2 in accordance with the need of single individuals
- Compensate for human weaknesses
- Warn of changes in the organisation or the environment

Contemporary TS systems

Development of TS systems as an aid to C^2 is basically guided by a specification of the course of events or action steps that are supposed to result in some intended effects or results. The logic behind a sequence specification is always depending of a particular goal and the context within which the events are supposed to occur. If, for instance, the context would change, the specified course of events will be inadequate (Vaill, 1989). This logic takes no consideration to the interdependence between various missions, tasks, organisational structures, and different kinds of change. A specification of the course of events can work if we would be able to keep the context and the problem stable during a period of time. But, we cannot do that. Unpredictable changes in the environment emerge continuously, and determine our action possibilities. Partly due to the fast pace of technological progress in general, and partly due to the run-a-way development of software. Both conditions take up our time, as we have to learn the new applications and struggle with the defective interoperability between the old and the new software.

Besides, majority of the military software is developed for particular military purposes, and hence, only a small part of commercial software can be used. The consequence is that the military software is expensive, difficult to replace, and becomes very quickly antiquated since it is developed with guidance of knowledge and techniques of yesterday. To remain up-to-date the military TS have to be developed in terms of time-less services rather than in terms of software performing particular functions. Only time-less services can effectively serve C^2 in all kinds of dynamics.

The superstition or the engagement to mere technological solutions leads to decreased action freedom by a system rather than to an increased action freedom. The superstition, the technological progress, and the development of software are moving in a clockwise direction, that indicate autocatalytic or self-promoting phenomena. These three self-promoting phenomena form three pairs of corners that also move in a clockwise direction, and mould into three self-promoting sub-systems: Superstition - technological progress, technological progress - development of software, and superstition - development of software. These sub-systems spur on technological complexity. That is, the more complex a system, the faster it grows; the more technology we have the faster pace of software development, and the more we believe in technological solutions, the more we also believe in our ability to solve our problems by means of technology.

We cannot stop the technological progress, and we should not endeavour to do that either, but we have to introduce some anti-clockwise processes to increase our freedom to decide when to use technological solutions and when to refrain from them.

Time-less services

The TS systems should make it possible for human beings to detect changes, choose between action patterns, and act in all kinds of environmental dynamics. Because different kinds of dynamics put different demands on an organisation and permit varying degrees of control of the course of events, the TS systems must offer services that match those demands and possibilities. The basic time-less services needed in three kinds of dynamics are described below.

Stable environmental dynamics or closed change

This kind of dynamics needs services that perform a formal scanning, surveillance, and identification of single events and objects. A user should be able to choose focus in scanning and surveillance, decide a goal, formulate plans, and make short-term predictions about the course of events. Stable dynamics permit short-term predictions and control of the course of events due to the mechanisms of sluggishness in complex systems. A large part of the decision process can be automated, and hence, the use of algorithmic techniques is quite appropriate. Moreover, a user should be supported in the implementation of plans, and correction of action errors. In any way, the most important service is warning. Such service should warn of structural changes in the environment or in the organisation itself as well as for deviations from the decision model at use. It should also be possible to register all essential input data and the course of event.

Ultra-stable environmental dynamics or contained change

In ultra-stable dynamics, the TS should offer in principle the same services as in stable dynamics, but the time-horizon in the execution of decisions will be prolonged. Since C^2 cannot choose exact goals of action, the goals will be expressed in terms of commissions or wide qualitative purposes. The reason is that the detection of important changes occurs indirectly either as a qualitative analysis or scanning of anomalies from the "normal" pattern. Thus, the most important service C^2 should be provided with is matching the pattern of the course of events with the characteristics of a particular mission. The C^2 also need support to plan actions in a longer perspective using probability measures of potential developments of the course of events. However, such probability measures presuppose access to data from a large number of similar cases. This dynamic cannot be mere described algorithmically, and hence, TS services cannot be based on algorithms only. Combining techniques such as fuzzy logic, heuristics, and statistics that permit both/and assumptions, and also allow working with qualitative purposes should be used for the development of software. TS services should also register deviations from the expected pattern in ongoing events, and the kind of and the qualitative purpose of each mission. The warning service should be more sophisticated than in stable dynamics, and hence, related to deviations from the particular decision-making model at use.

Chaotic environmental dynamics or open-ended change

When the environment shows this kind of dynamic, the C^2 cannot distinguish the discovery of single changes from the choices of action. A particular choice of action gives rise to new discoveries, and the focus on one of many changes may permit only some particular actions. In this case, C^2 cannot do anything else than to interpret, reflect, associate, and look for anomalies in the course of events, and try to identify a behavioural pattern by enemy and own units. The choice of action cannot be about anything else than about clarifying preferences, intentions, ambitions, and purposes. The most effective action patterns in chaotic dynamic are to back momentary successes, to take up explorative actions, and quickly end failures. Hence, TS services should register anomalies, behavioural patterns, and the effects of successful and erroneous actions. Such services cannot be developed by algorithmic or statistical techniques because there is a lack of adequate data. Services based on genetic algorithms and intelligent agents can partly support C^2 in this dynamic. But most times we have to rely on human ability to cope with uncertainty, that is, to intuitively prioritise focus and action.

Each of these dynamics permits different action strategies, decisions, and control. Consequently, TS systems that are constructed by guidance of algorithmic techniques can support C^2 effectively only in situations that are characterised by stable dynamics. Their support to C^2 will be inadequate as soon as the environmental dynamic changes.

Conclusion

One of the most important conclusions is that the methodology applied for construction of contemporary military C^2 and TS systems can hardly result in sustainable systems. New military missions, tasks, and the uncertainty about future threats will demand quite different military structures, C^2, and TS than today. The pace of change on the political and military arena can indicate faster throw in environmental dynamics. Considering that dynamics can be expressed in terms of different changes that demand various approaches we can also expect that each dynamic will require and permit different actions and control.

Thus, it is impossible to construct a TS system that is suitable for one particular kind of dynamics and expect that it will work in all kinds of dynamics. The reliance on a circumstantial scenario when constructing C^2 and TS systems is not always appropriate since it urges on algorithmic solutions. It is easy to use algorithms when conditions for performing a particular function are specified in a circumstantial scenario. But the real world is seldom algorithmic. In some situations it is impossible to specify tasks or missions and/or to keep the context constant over time. What is needed in reality is a TS system that is sustainable and usable even if the dynamics or the missions would change dramatically. To reach that, the TS system must consist of time-less services that can handle demands of stable, ultra-stable, and chaotic dynamics. C^2 must also have the possibility to compose appropriate services to cope with actual missions in existing environmental dynamics. The time-less services cannot be algorithmic only, but should also use techniques that can encounter the characteristics of each dynamic.

Another conclusion is that the balance and coupling between theoretical knowledge, development of C^2 models, and the use of technology is defective. The one-sided focus on technological solutions results more and more in technical systems that are difficult to understand and handle. They require too much of human attention and cognitive abilities only for the purpose of keeping the systems work as intended. Consequently, it can happen that during decisive circumstances that demand full mental capacity, the capacity will be occupied with mastering the system more than with the task to be performed. That of course would be devastating for a military organisation, especially if a situation would demand speedy reflections or decisions.

Even though the primary purpose of constructing TS systems is to liberate human mental resources, the effects are many times quite opposite. Mental resources are often tied to system management and fulfilment of norms and functions. Time for reflection is practically missing. Yet, it is exactly reflection we need to deal with ultra-stable and chaotic dynamics. Thus, the dominating idea of our culture "Technology will do it for us", is not always well advised.

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