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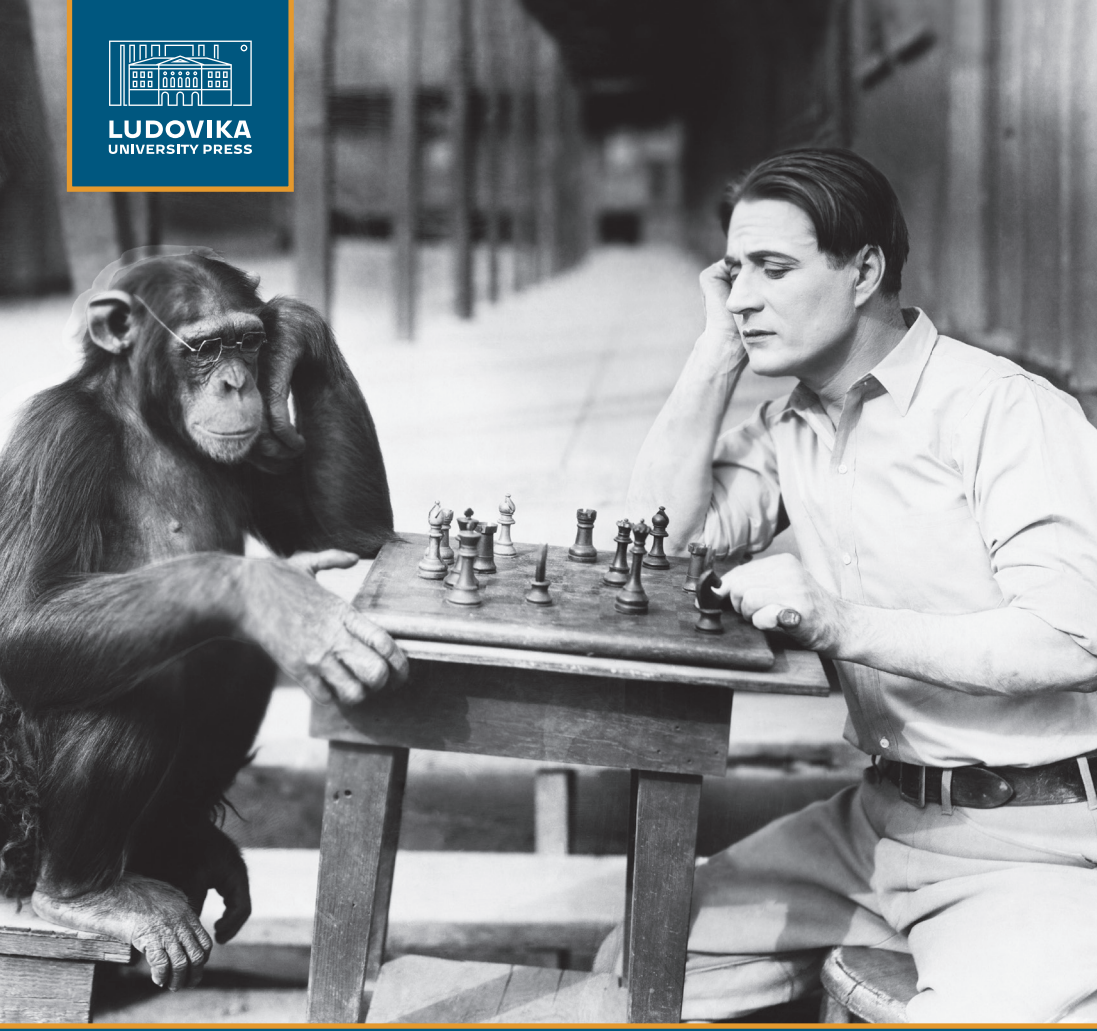

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Contents

Introduction

This book is the continuation of a book entitled *The Effects of Joint Operations* published by the author in 2019.[1] This book takes forth and expands on the ideas written down three years ago. The basic assumptions of the author regarding the effectiveness of Allied and national forces in joint operations has not changed. The effectiveness of Allied forces in peace, crisis or in conflict depends on the ability to operate together coherently, effectively and efficiently. Joint operations, be Allied, coalition-based or national, should be prepared for, planned and conducted in a manner that makes the best use of the relative strengths and capabilities of the forces offered. Joint operations demand a way of thinking and specific processes that depart from causality and embraces the presence of correlation or even covariance for the effective use of military capability in achieving objectives and attaining desired end state. There is a fashionable tendency in military writings to use the vocabulary of complexity theory and to refer to complex adaptive systems. According to the author there are many good reasons to elaborate further on insights gained from a serious study of the theories of complexity and complex adaptive systems. First, joint operations display a wide array of multi-layered problems in which an approach that is less rigid and more flexible, less artificial and more organic, less mechanistic and more living appears to be most appropriate. Second, much of contemporary Western military thinking rests on natural science and its supporting paradigms. It often ignores human attributes such as apprehensions, sensations, perceptions, impulses and emotions that constitute a very important part of the activities carried out by forces during the conduct of joint operations. Third, comprehending joint operations as a complex adaptive system can help think outside the proverbial box to foster creativity. Novel metaphors and supporting methodologies can help make the shift for a better understanding and conceptualisation. Thus the aim of the book is twofold as it both attempts to conceptualise joint operations as a complex adaptive system and examines the practical utility of focusing on causality. The planned argumentation proceeds through eight interrelated chapters. Chapter 1 sets the scene by expanding on Clausewitz's Dynamic Law in War that can be seen as a sort of precursor to the rather recent complex

[1] Jobbágy 2019.

adaptive system approach. Chapter 2 briefly delineates the traditional top-down approach of the military to strategy development and names some of the obvious shortcomings. Chapter 3 details the basic characteristics of a bottom-up strategy development based on insights coming from complexity theory. Chapter 4 suggests three possible approaches that help exploit the combined power that comes from merging the various sorts of course of action development. Chapter 5 concludes on the findings and details to what extent a causality based approach is valid for joint operations when seen from a complex adaptive system point of view. Chapter 6 details to what extent learning and adaptation in joint operations can be used as a leverage. Chapter 7 details three organic approaches to command and control. Chapter 8 details the relationship between military effectiveness and efficiency. The book thus promotes a more organic, hence biological approach to joint operations as no one would doubt that joint operations are very complex undertakings. However, one can learn a lot from knowledge accumulated in other fields of science as complexity is not a unique feature of joint operations. Complex adaptive system theory offers a biological perspective that has much to contribute to a better understanding of joint operations. Biological evolution and joint operations feature perpetual novelty and conditions far from equilibrium featuring dynamics that demand continuous adaptation. Comprehending joint operations in an evolutionary framework requires a shift from statics to dynamics, from time-free to time-prone reality, from determinism to probability and chance, and from uniformity to variation and diversity. According to the author a biological approach has much to offer for a better understanding of joint operations. Regardless whether one sees joint operations through the eyes of Clausewitz, approach it as a complex adaptive system, or examine it along attributes that display similarities with biological evolution, there are timeless and innate characteristics. It is not difficult to conclude that both biological evolution and military operations are intrinsically complex, and primordial violence is at the heart of both.[2] Joint operations indeed can be understood as a complex adaptive system in which the system properties emerge from the interactions of the many components at lower levels. The abundance of dispersed interactions indicates a mechanism that often lacks global control, but feeds from cross-cutting hierarchical setup. Similar to biological evolution, joint operations feature perpetual novelty and far from equilibrium dynamics that demand continual

[2] Goldstein 1999: 49–72.

adaptation. Interaction with the enemy means that there is a multiplicity of feedback mechanisms that affect the further dynamics by constantly changing the attributes involved.[3] Both joint operations and biological evolution are as much about selection as about transformation with the consequence that adaptation appears to be a central feature. It stands for the importance of not only how to respond to perturbations properly, but also how to maintain the capacity to respond actively.[4] Biological evolution and joint operations are full of ramifications and divergences that come as a result of the constant interaction and changing environmental conditions with various and often unexpected events as a result.[5] Clausewitz, the great Prussian theorist of war knew about the interdependence of the elements involved and concluded that scientific analysis based on logic and mathematics is of little help. Waging war was for him an art and as such requires certain skills to discriminate among an infinite multitude of objects and relations to find out which is the most important and decisive. This is in sharp contrast to a strict logical deduction and requires intuitive comparison. Remote and unimportant things and indirect relations must be set aside in order to discover the more immediate and important ones.[6] Clausewitz was also aware of the fact that war has a non-quantitative and non-predictive character, which makes it impossible for fully fledged empirical or hard sciences to offer suitable descriptions, explanations or models. War features structural unpredictability in which the distribution or dispersal of information suggests definite limits to what can be known at any given point in time. Based on Clausewitz's insights, some argued that evolutionary biology may offer a better model for a theory of war than most quantitative sciences.[7] The book can be seen as a descriptive, reflective and explanatory study of joint operations seen as a complex adaptive system. It is descriptive in a sense that it describes joint operations as a search process on an imagery landscape called joint effects landscape. It is also reflective since by approaching joint operations as a complex optimisation process that comes from population genetics, consistency and coherence is provided by the use of the respective scientific literature and Clausewitz's epic volume *On War*.

[3] Levin 1998: 431–436.
[4] Ovington 1900: 411–420.
[5] Cole 1919: 247–257.
[6] Clausewitz 1989: 607–617, 623–626, 692–693, 702–708.
[7] Watts 2004: 49–56.

It is explanatory since inconsistencies are discovered and the author identifies and explains the contributory factors in detail. The book aims at developing a coherent framework that offers a novel approach to joint operations by detailing the underlying attributes from a biological point of view.

Chapter 1
Understanding Complexity

In the structural analysis in the previous book the author depicted joint operations in a two-dimensional setting as a continuum defined by ends-means relationships.[8] Examining joint operations in terms of interactions and couplings made it possible to see the way structures are produced and dissolved. As depicted in Figure 1 the four areas thus produced (linear, complicated, complex and chaotic) pointed towards increasing unpredictability.

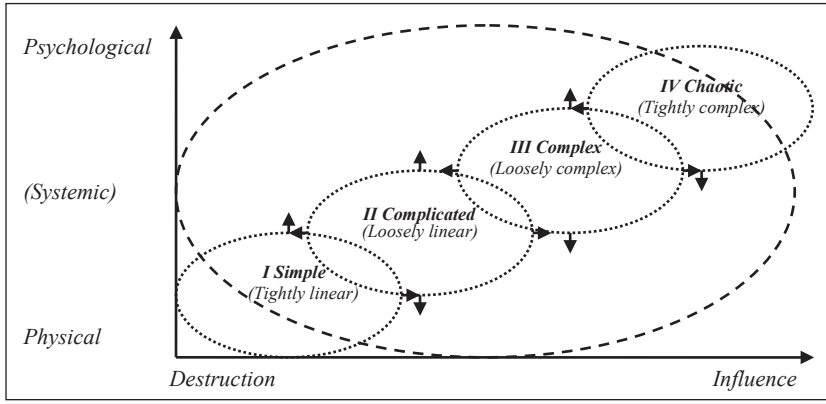

Figure 1. Four areas projected
Source: Compiled by the author

Moving towards the physical/destruction end-pole indicates direct causality and prediction, but the value of the effects achieved is normally seen as low. Although effects achieved around the psychological/influence end-pole have high values, they do not allow for predictions based on direct causality. The areas indicate that in joint operations all activities take place in an environment in which chaos constantly meets order in a disorderly way. Thus, the areas display joint operations as a phenomenon in which pre-order meets order in disorder, and occurrences move continuously back and forth in the continuum.

[8] Jobbágy 2019: 98.

Due to such attributes war can best be described by the term complexity. Similar to friction and chaos, complexity also denies the primacy of order and causality and the drive for efficiency and constant affirmation. In terms of unpredictability, complexity stands for freedom and openness that puts an emphasis on action and possibility. It is a whole in its own right in which actions complement each other when seen from the totality of the system.[9]

Multitude of layers

The structural analysis made it clear that war displays complex forms of cause and effect relationships in which one must take the various interdependences better into account. Links between causes and effects often become distant in time and space or can even disappear. In case one proceeds as if simple linear links exist even if one does not know what they are, then one is likely to undertake actions that yield unintended and surprising results.[10] As indicated by friction and by the recent concept of chaos theory, complexity can best be described as the result of many constituents that are interdependent in a non-linear way. They display a bewildering array of effects that possess a hierarchical structure spanning over several scales. Complexity appears as an emergent property in the continuum of joint operations and comes from the constant interplay of chaotic and non-chaotic forces. Simply put, complexity arises from the sheer number of the constituents and their interdependencies. Complexity also stands for a continuous evolution and adaptation containing a network of various alternatives. It cannot be represented based on reasoning and causality since the interactions and couplings of the constituents often produce unforeseeable results.[11] In order to explore complexity properly, one must acquire a pluralistic world view that accommodates all the different kinds of phenomena coexisting side-by-side. Although the simplest way to think in terms of complexity is to assume a system that involves a huge number of interacting elements, the structural analysis introduced in the previous book made clear that complex systems cannot be defined only by the quantity of the interacting components. Complexity stands for a multitude of hierarchical layers in which any exclusive focus on individual

[9] Lefebvue–Letiche 1999: 7–15; Axelrod–Cohen 1999: 28–31; Lissack 1999: 110–125.
[10] Stacey 1996: 273–276; Tasaka 1999: 115–123.
[11] Levin 2003: 3–19; Baranger s. a.: 9–11; Cilliers 1998: 2–5; Swenson–Rigoni 1999: 576–577.

agents means that important properties can easily be lost. Nevertheless, the four areas make it possible to deliver an explanatory framework that helps us better understand the consequences of our actions, and the spatial and temporal effects they generate.[12] A very important attribute of complexity can be defined as a sort of structural stability/instability. Whereas structural stability allows for analytical examination, structural instability can only be explained in a non-analytical way.[13] The laminar flow of events ceases to be stable and spontaneously turns into a turbulent flow. Structural instability stands for bifurcation in which new solutions emerge. Every such point contains an element of randomness or chance that makes impossible to predict which path the system will take. Consequently, at bifurcation points the system is beyond the threshold of stability and is under the rule of a chaotic mechanism that expresses an extraordinary sensitivity to initial conditions. Links between causes and effects can be lost and it is not possible to identify the specific consequences of a specific action or the specific cause of a specific event.[14] Any complex system can display both deterministic outcomes and random fluctuations. Around bifurcation points deterministic descriptions break down and explanations based on causal relationships do not make sense. Fluctuations completely upset the equilibrium of a system and as a result, the number of possible effects can become very high. This constant shuffling between stability and instability explains why war can display growth and decay, capture and domination, in which periods of opportunity for alternative developments are followed by solidification of existing domination structures.[15]

Emergence and environment

Joint operations stand for areas that feature different overlapping characteristics. These areas constantly influence each other, which makes attempts to identify direct causality very difficult. Linearity goes together with non-linearity and stability always coexists with complexity and chaos. Whereas stability stands

[12] Nicolis–Prigogine 1989: 5–8, 31–32; Moffat 2003: xi-xiv, 1–10; Prigogine–Stengers 1984: 131–137.

[13] Nicolis–Prigogine 1989: 93–98; Gove 1981: 213; Moffat 2003: 15; Briggs–Peat 1989: 53–65, 102; Lorenz 1993: 147.

[14] Prigogine–Stengers 1984: 140–141, 160–170, 177–179, 196–203.

[15] Stacey 1996: 324–329.

for simplicity and linearity reflecting a tight and linear relationship between causes and effects, non-linearity points towards chaos that can be described by extreme sensitivity to initial conditions indicating a tight, but complex relationship between causes and effects. The biggest area within the continuum of war can best be described as complexity proper, which stands for non-linearity, far-from-equilibrium conditions and emergence. Although joint operations display linear properties, the underlying mechanisms are mostly defined by non-linear attributes. Consequently, one must rethink regarding the basic mechanism and shift the reasoning away from prediction aimed at identifying desired effects.[16]

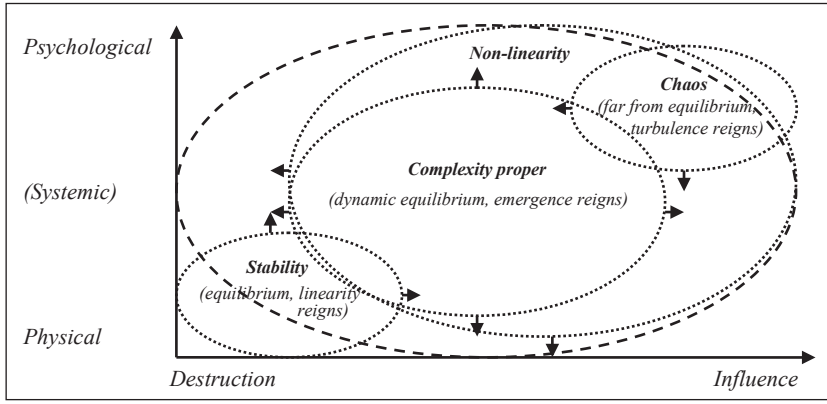

Figure 2. Overlapping characteristics of war
Source: Compiled by the author

Joint operations show emergent and interactive attributes that come as a result of structured, but non-additive interactions. Figure 2 indicates that whatever the result of joint operations it is always more than the sum of the constituents. In other words one always faces a general unpredictability in relation to the input. The various combinations in terms of interactions and couplings also mean that despite most assumptions complex systems can be surprisingly stable and resilient, too. They can continuously adjust and adapt, which ability provides them with multiple and often unexpected paths that make causal explanations

[16] Czerwinski 1998: 39–60; Briggs–Peat 1989: 174–180.

very difficult.[17] Instead of attempting to create idealised sets of problems that can be solved, joint operations require an everything-affects-everything-else mode to get a grip on the entire web of various connections. Thus conceptual elegance reflecting rational thinking, deductive logic and analytical categorisation is of little help. Novelty can come from simple properties producing emergent and unpredictable effects. Depending on the level chosen for examination, one always confronts with structures for which different laws, concepts and generalisations apply. Joint operations stand for an infinite variety of possibilities and a general unpredictability regarding causes and their likely effects.[18] Emergence is the most important attribute of complexity. It works against causality since it refers to the way novel and coherent structures arise. Emergence cannot be predicted or anticipated in its fullness beforehand since it displays features not previously observed. Emergence is a holistic configuration that offers explanation into the dynamics of the system rather than explanation based on the system's parts alone. It does not allow for predictions based on deduction and causality. Emergence does not make it possible to explain the full richness of interactions and couplings, and the resulting multitude of possibilities, either. It is not a provisional construct, since the temporal and spatial dimensions of war point towards greater and greater unpredictability. Thus emergence does not allow exact prediction of future states and cannot be handled by analytical rationality. It produces unexpected or counter-intuitive results, which indicates that causes and effects are not only separate, but often disconnected in space and time. Consequently, under emerging conditions it becomes very difficult if not impossible, to say what causes what effect or to say what will happen in a specific place at a specific time. Emergence reflects attributes such as compensation and counter-action, which make most attempts to predict and plan for desired effects impossible, as such properties cannot be added together in a simple and system-wide way.[19] Unpredictability is further exacerbated by the fact that in an open and dissipative system such as joint operations that display emergent attributes, the environment must also be taken seriously into account. War and joint operations are a social phenomena as they are linked to and interact with the surrounding social, cultural and political context. The environment is never static, but changes over time, which indicates that interactions stand more for what one does not know, and

[17] Russ–Bacon 1999: 75–79; Griffin et al. 1999: 302–304.
[18] Waldrop 1992: 38–39, 60–63, 81–83.
[19] Goldstein 1999: 49, 57–62; Stacey 1996: 296–297; Axelrod–Cohen 1999: 11–15.

less so for the possibility to make accurate predictions in terms of causality. In order to get a better insight into the causal texture of the environment a simple matrix as below might be useful.

$$L_{11}, L_{12}$$
$$L_{21}, L_{22}$$

According to the matrix emergence arises as the interplay of L_{11} that refers to the processes found within the system, L_{12} and L_{21} both referring to interactions between the system and the environment, and L_{22} referring to processes and interaction within the environment itself. The matrix indicates that environmental interdependences of social phenomena such as joint operations are often incommensurate with those connecting parts of the system. In other words, the environment is not just out there, but constantly changes in ways no one can anticipate.[20] Environmental factors also indicate that emergence stands for two sorts of unpredictability. Whereas in spatial terms it stands for the fact that properties at a certain level cannot be predicted from other level properties, in temporal terms it means unpredictability from the properties that constitute the preceding condition. Consequently, emergence creates new properties regardless of the substance involved since it relates levels to each other by denoting the very passage connecting them. In a complex phenomenon such as joint operations, several levels coexist simultaneously and interpretations based on causality can lead to mistakes. This poses a challenge to the notion of causality since it refers to something that disrupts the notion of causality and cracks the power of causal explanations. Emergence stands for qualitative changes and suggests that causality and randomness are always interwoven in an intriguing way. It also indicates novelty in the form of new and random solution paths open to chance occurrences that do not allow for mechanical explanations. Although emergence might allow for the prediction of certain structural features in general terms, it does not help predict details of the future in terms of desired effects.[21]

[20] Jobbagy 2005a: 11–23; Moffat 2003: xiii; Emery–Trist 1965: 22; Green–Newth 2001: 1–12; Jervis 1997: 20–23.

[21] Emmeche et al. 1997: 83–100; Goldstein 1996: 163–182.

Adaptation and self-organisation

Emergence opens both the door for a better understanding of unpredictability and a broader conceptualisation of joint operations as a complex adaptive system. Although the notion of a complex adaptive system generally applies to entities that show emergent properties across time and space, one must also acknowledge that not all emergent systems are adaptive. Complex adaptive systems display multiple interacting scales that mostly defy the utility of deductive and analytic categorisations. Thinking in terms of complex adaptive systems defies most assumptions regarding direct causality, identifying desired effects, and linking various levels in a direct and comprehensive manner. Retrospective analysis is feasible in a complex adaptive system, but prediction is only possible in the most general terms, which makes it very hard to see the consequences of our actions. Adaptation indicates a process that constantly changes, as the system never settles down. Although a complex adaptive system might be surprisingly stable, it is never in equilibrium.[22] Joint operations perceived as a complex adaptive system implies that the belligerents do not simply follow certain rules, but by changing those rules they create emergent futures. They are capable of learning from non-linear feedback and produce unpredictable actions. A complex adaptive system thrives best at the edge of stability and instability, which promotes creativity. A complex adaptive system stands for ambiguity, paradox and the anxiety it generates. Seeing joint operations this way is uncomfortable since a complex adaptive system cannot be planned or intended. The most important consequence of a conceptualisation based on a complex adaptive system is that long-term outcomes are unknowable since the ability to self-organise spontaneously can result in disappearing causal relationships. Emergence and adaptation explain why the general unpredictability of war takes hold if we want to get a grip on the future pattern it might display, or to reduce that pattern to its constituents.[23] Joint operations conceptualised as a complex adaptive system means that structures come from a process in which the constituents interact in an inherently complex way. These structures come as a result of self-organisation, which means that predictions based on direct causality can only be possible in the short term. The spontaneous adjustment of a complex adaptive system involves

[22] Levin 2003: 3–4, 11; Axelrod–Cohen 1999: 7–9; Gell-Mann 1994: 16–21, 54–56, 69–70, 72–74.

[23] Stacey 1996: 334–345; Coveney–Highfield 1991: 182–190.

complex interactions with so many factors that control becomes impossible. Self-organisation means that a complex adaptive system is able to dynamically adapt to changes even if those changes appear in an irregular fashion. Although self-organisation happens at all levels of the system, the components operate on local information and general principles that have only limited content for the system as a whole. Self-organisation runs against most assumptions of direct causality and indicate that joint operations are phenomena in which the operational conditions make it mostly impossible to see the output without considering the mechanism by which it is produced.[24] The internal development of joint operations might be determined by the underlying mechanisms, but cannot be predicted as the output does not make it possible to find reliable rules. One can say that a complex adaptive system displaying self-organising behaviour stands for complex and circular causality in which causes and effects cannot be mapped linearly for similar causes can have different effects and different causes similar effects. Small changes of causes can have large effects, whereas large changes can also result in only small effects. Nonetheless, small causes can have small effects and large causes large effects.[25] Self-organisation indicates that unpredictability in joint operations generally takes hold. Similar to friction and chaos, we can say that complexity in general, and the complex adaptive system and self-organisation in particular, indicate a rather low practical ceiling for prediction.

Structural instability

Although joint operations can be described in general terms using causal relationships, effects that go beyond the immediate spatial and temporal levels cannot be predicted with any accuracy. It is only possible to come to grips with some things – especially those things which are local to us both in space and time. Friction, chaos and complexity suggest that everything is interrelated and all one can attain is a temporary and partial interpretation. Humans often confuse causation with correlation, and simulation with prediction. Whereas the former refers to the preference to create retrospective validation to identify best practices, the latter points to the fact that even if it is possible to simulate

[24] Cilliers 1998: 89–95; Krohn–Küppers 1989: 155–156.
[25] Fuchs 2003: 135.

something it does not obviously mean the possibility to predict its future.[26] Joint operations are full of discontinuities and uncertainty, which indicate a general unpredictability that can make both individuals and organisations disoriented. This uncomfortable feeling explains why earlier concept such as effects-based operations appeared attractive for so many. The international arena has been a messy place in the unfolding new millennium. It should not come as a surprise that linear and causality-based concepts have gained attention in the political-military community. During turbulent times in which orientation becomes difficult, humans increasingly turn to panaceas for advice. In cases one does not understand or can cope with, humans often look for simple or simplistic solutions that promise quick help.[27]

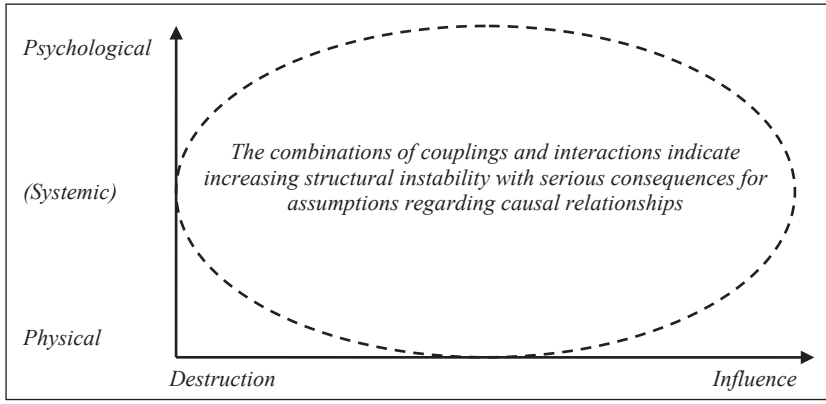

Figure 3. Predictability and causality in war
Source: Compiled by the author

As depicted in Figure 3, in the framework of the proposed and extended conceptualisation covering the full continuum of joint operations, one must constantly balance in terms of ends/means relationship. Friction, chaos and complexity indicate that one faces unpredictability both in terms of what one is trying to

[26] Flood 1999: 247–252; Kurtz–Snowden 2003: 462–463; Snowden–Stanbridge 2004: 146; Stacey 1996: 346–347.
[27] Ackoff 2001: 3–10; Christensen–Raynor 2003: 67–74; Rosenau 1999: 48–66; Mann 1997: 62–68.

achieve (effect), and in terms of how it becomes possible to achieve what one wants to (cause). The figure also indicates that joint operations stand for a general unpredictability in terms of ends and means. Several different futures are possible and there is not always time for mechanical, deductive systemic analyses aimed at detecting direct causality. The most important message of unpredictability is that instead of focusing on certain desired effects, one should rely on the ability to respond consistently to the unpredictable nature of joint operations. These operations cannot be conducted based on single and prescriptive models, but require that one evolves rapidly in order to handle dynamic and changing situations similar to the biological evolution of species.[28] The serious contradiction between the basic assumptions of causality and the unpredictable nature of joint operations naturally raises the demand for an enhanced conceptualisation. Friction, chaos and complexity indicate that one must be satisfied with understanding certain general features in terms of correlation, rather than attempting to discover a mechanism that links causes with effects directly. Thus friction, chaos and complexity should be regarded as opportunities that can explain qualitative behaviour instead of inaccurately predicting futures in terms of desired effects.[29]

[28] Snowden 1999: 16–20.
[29] Emmeche et al. 1997: 116.

Chapter 2
Organic Approach

Friction, chaos and complexity stand for a lack of accurate prediction, which indicates that joint operations require constant adaptation. Adjustment due to changing conditions does not require to know all values for all relevant variables beforehand. Similar to biological evolution, perpetual novelty must be accepted as a typical feature. Prediction is generally difficult and when the enemy learns or adapts the difficulty increases enormously. Seeing joint operations this way means that even if one was able to discern all the individual constituents, direct links in the form of causal relationships would not provide for convincing information regarding the underlying properties. The mechanism of joint operations cannot be explained as the sum of the underlying properties. Comprehending all relationships between causes and effects exceeds anything predictable. Joint operations are context-dependent and non-linear in which the whole is always more than the sum of the parts. The same phenomenon understood in a given context can often become obscure in another. Even if one detected laws applicable for any given level, they might become entirely upset at another. If one still prefers to stick to causality, the focus must shift from end-effects towards transitional effects and the means applied must equally be regarded as important as the ends sought. Whatever the effects achieved in joint operations, they reflect combinations that come from a trial-and-error mechanism rather than a careful process of optimising.[30]

Managing polarities

A causal only approach to joint operations displays major conceptual and methodological weaknesses that are dangerously disconnected from the observable characteristics. This inconsistency indicates that such concepts lack both substance and meaningful content. In an age of contingencies and desperate search for finding useful concepts for developing war-fighting capabilities, the idea of referring to effects, especially to higher order ones in the psychological domain is nothing more than a fashionable mantra. It is empty, harmful and

[30] Holland 1998: 42–45, 121–123, 185–187, 238–246.

does not take the frictional, chaotic and complex reality into account.[31] Much of the proposed continuum of war displays non-linearity that stands either for a dynamic equilibrium or far from equilibrium conditions. In contrast a causal conceptualisation of joint operations reflects an equilibrium-oriented thinking. Joint operations are addressed in natural scientific terms based on the principle of causality, which assumes that it is possible to predict end-states based on analytical rationality. Unfortunately, in the case of a complex human phenomena, analytical skills based on direct causality are valid only within a limited range. Beyond that, they are not able to deliver satisfactory descriptions as we increasingly deal with emergent and self-organising properties.[32] There is a strong preference to address joint operations mostly in a way that is closely related to the methodology found in various natural scientific fields. Even Clausewitz used the vocabulary of natural science. In order to understand this preference one must go back to the 17th century. Normal scientific thinking is based on the Newtonian world view of synthesis and emphasises actions on the environment by promising better ways to organise and exploit the world. Its biggest payoff is to arrange human natural and social life, which enabled and drove the force of industrial revolution. However, despite all the contributions to human social and economic developments, scientific homogeneity emphasising criticality and verification has never been able to get entirely rid of instability. Even abstract mathematical precision and rigour are approximate descriptions of imprecise natural processes. In a complex world and especially in the case of a complex human phenomenon such as joint operations displaying multi-layered problems, an approach is needed that is less rigid and more flexible, less artificial and more natural, less mechanistic and more organic; one that emphasises actions in the environment.[33] Natural science and its supporting paradigms also ignore most human attributes that constitute a very important part of life. Clausewitz was not short in emphasising that apprehensions, sensations, perceptions, impulses, and emotions are essential ingredients of war. Unpredictability of war also forces one to think holistically and in terms of opposites, in which one side cannot be right at the expense of the other. The interplay of opposite forces such as stability and chaos must be taken better into account in order to help redirect intuition. As the proposed continuum indicates, a complex adaptive system allows for

[31] Jobbagy 2006: 25–34.
[32] Beinhocker 1997: 25.
[33] Prigogine–Stengers 1984: 37–40.

polarities to manage rather than problems to solve. Thus, a more sober look at the real world can reveal some new insights regarding the nature of most human activities including that of war.[34] However, such an approach means less certainty and challenges the inherent preference for clear boundaries representing distinct and potentially solvable problems.

Boxes and boundaries

Any analysis regarding the relationship between certainty and uncertainty, stability and chaos can easily end with the conclusion that the emphasis on the former has always been dominant in thinking. However, focusing on certainty only is analogous with a life spent in the box. It excludes the different and includes the similar without questioning the latter. An exclusive focus on certainty means that nothing is tolerated beyond its contours. In contrast, joint operations feature evidence that certainty and uncertainty always mix and are separated only by boundaries in human thinking.[35]

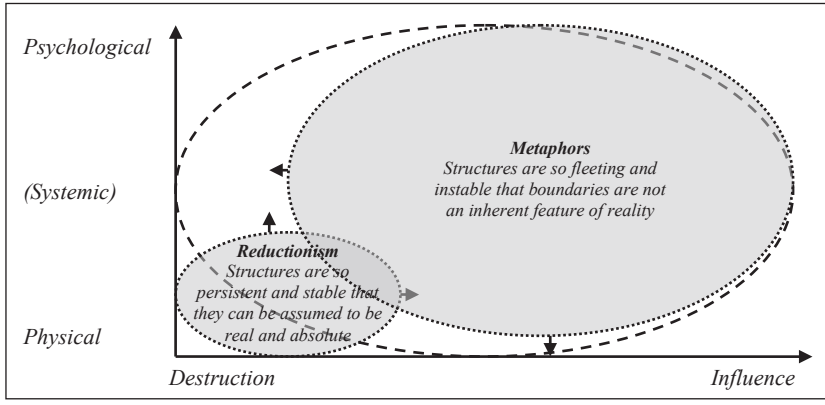

Figure 4. Boundaries and the continuum of war
Source: Compiled by the author

[34] Dent 1999: 10–13.
[35] Molderez 1999: 84–91.

As displayed in Figure 4, much of joint operations is non-linear and composed of waxing and waning structures that constantly emerge and change. They always display qualitatively different behaviours. Emergent and self-organising attributes with changing and evolving boundaries mean that knowledge gained is always limited and provisional. Boundaries depend on the level of aggregation chosen, reflect the limitations of human cognitive resources, and the inherent need to reduce complexity. Unfortunately, since a holistic description of the world is impossible, all descriptions must be essentially metaphoric in order to comprehend the complex relationship between various natural and social boundaries.[36] Boundaries are reminders that coping is often possible, but control is not. Issues such as global warming together with various environmental disasters painfully display that boundaries are not there to separate. Boundaries connect, and the bulk of human actions only disturb complex adaptive systems on various scales. Solving problems in a given area can cause new and unexpected problems in others, often in fields that are not directly related. Due to the intricate relationship of interactions and couplings, desired effects always induce unexpected, unwanted and uncontrollable consequences. Thus modelling the world and a complex human phenomenon such as joint operations, based on a logical framework focusing on direct causality, is inappropriate. As modern science evolved it produced ever-increasing specialisations. The disciplines moved deeper and deeper into their respective fields resulting in high and impenetrable walls that divided up sources and targets of their efforts. In contrast conceptualising war as a complex adaptive system means that we appreciate it as an organic whole and not as dissected entities. This approach shows similarities with the idea of a war-fighting ecosystem as coined in some military publications.[37]

Metaphorical explanations

Taking full advantage of metaphors requires to first clarify the term. Thus, a metaphor is an implied comparison or a figure of speech in which a word denoting a certain object or action is used for another in order to suggest an analogy. The very strength of metaphors is that they involve both sources and targets surrounded by an aura of meanings and associations. Metaphors enlarge

[36] Richardson–Lissack 2001: 40–49.
[37] Levin 2003: 4; Alberts et al. 2002: 83.

our perception by producing insightful connections and interpretations. They offer a conjunction by activating a train of associations. Metaphors place the target in a new light, which might lead to a profound re-conception. Powerful metaphors offer more than a list of associations by emphasising some aspects whilst diminishing others. They enable the individual to see and experience new connections. In sum, metaphors are comparisons that can give shape and form to abstractions through images not dependent on the weaker like or as foundations of the simile.[38] Metaphors are figurative expressions in which a word or phrase designating one thing is used to designate another in the form of an implicit comparison. Metaphors make a qualitative leap from reasonable, prosaic comparison to identification or fusion of two objects as the resulting new entity possesses the characteristics of both. The military has always loved metaphors as military writings are full of them acting as frames of reference for facilitating discussion and developing ideas.[39] Metaphors can be extremely powerful and much more significant than normally considered. Although metaphors are usually paradoxical statements, they can be very robust. They are literally false according to abstract rationality, but true according to imaginative rationality. Metaphors form essential as-gates in the human cognitive process since they enable the understanding of one thing in terms of another. Metaphors are indicators of a network of meanings that all affect the processes of perception and conception. As evolving things, they are open to novelty even mutation. They are able to capture the underlying processes of other evolving entities surprisingly well. Metaphors can help us explore an interesting possibility space characterised by contingency and feedback. Metaphors can also be superior to analytical models when the phenomena of interest are impossible to control or the necessary assumptions unsure.[40] Thus metaphors appear to be helpful aids when dealing with a complex adaptive system such as war. Four general levels of metaphors can be differentiated such as transfer, construction, unification and merger. Transfer as level one and means the transfer of a single term into another context in order to create new meaning. Construction as level two and stands for the construction of analogies as part of a specific theory or a general and systematic inquiry to elucidate phenomena. Unification as level three stands for a unifying view of an entire paradigm, often symbolised by a specific term that refers to the whole

[38] Gove 1981: 1420; Holland 1998: 202–210; Saperstein 1997: 44–61; Jablonsky 1997: 4.
[39] Ilachinski 1996a: 44–45; Durham 1997: 38–40.
[40] Beyerchen 1997: 70–77.

frame of understanding under a given paradigm. Merger as level four can be seen as the most comprehensive in which science itself is understood as an irreducible metaphor.[41] Based on the idea of the evolving biosphere the author proposes the *Organic Strategic Ecosystem* metaphor. Organic since it is born out of complex adaptive systems theory that emphasises joint operations as a conflict between two self-organising, living and fluid-like entities. Strategic since the many mutually interacting and coevolving parts form emergent possibilities that have relevance on the strategic level in the form of victory and defeat. Ecosystem since biological evolution serves as the basis for conceptualising joint operations as an open ended and dynamic system.

Fitness and coevolution

Conceptualising joint operations as an Organic Strategic Ecosystem resembles similarities with processes found in biological evolution. Emergence and self-organisation represent non-linear attributes pointing towards spontaneous order rather than a gradual process. The continuum of joint operations refers to an area that can be characterised by two end-poles such as stability and chaos. Whereas chaos is a randomising force that points towards a disordered state, stability stands for equilibrium and represents spontaneous crystallisation and a high degree of order.[42] Minor changes can sometimes cause catastrophic outcomes in such a system's behaviour. It appears naturally that selection as a steady optimising force alone cannot drive evolution. Selection is powerful, but not too powerful, which indicates evolution to be an unpredictable process consisting of detailed bits of selection and improbable ad-hoc events. As a consequence, biological evolution exhibits spontaneous order even in the absence of any selective force. Understanding this mechanism requires the introduction of two interrelated attributes such as fitness and coevolution, both indicating simultaneous adaptation and change.[43] Biological evolution can be depicted in the form of a landscape, also called the fitness landscape. Its surface is continually evolving and changing due to the action/reaction cycles of the species inhabiting them. Similar to the unpredictability of joint operations dynamic and deforming

[41] Ilachinski 1996a: 45–49.
[42] Kauffman 1991: 64.
[43] Kauffman 1995a: 151–152; Waldrop 1992: 102–110; Kauffman 1989: 527.

fitness landscapes also defy clear causality. They imply the impossibility of continuing and exploiting current capabilities through constant refinements. There is no guarantee that current locations of high fitness symbolised by high peaks remain unchanged over time since their values can alter significantly. Thus the challenge is to strike an appropriate balance between exploiting locations of high fitness and constantly exploring new locations that might have an even higher value. Conceptualising joint operations this way means that similar to biological species one moves along an evolutionary path or trajectory representing effects-based operations.[44] The proposed metaphor of the Organic Strategic Ecosystem makes it possible to take the frictional, chaotic and complex reality of war better into account. The inherent and age-old relationship between the military and landscapes supports such an approach in many respects. The literal interpretation understands landscape as terrain with its geographical features that have always been influential for the conduct of war and warfare. The first level of abstraction is embodied by the topographical map that directly refers to geography since it depicts the physical landscape in standard symbols. The second level of abstraction is representation by metaphor and indicates political, economic and cultural landscapes that have no physical basis. The third level of abstraction allows us to understand landscapes as tools for analysing and modelling complex problems.[45] The proposed conceptualisation relies on the second level. Fitness originally described the relative success of a species in relation to others in its environment. No fitness landscape is fixed, but changes in response to the actions of other species with which it coevolves. A species tries to optimise its fitness by getting onto a peak that symbolises a relative competitive advantage. Similar to the unpredictable mechanism of joint operations, fitness emphasises a constantly changing environment in which a species' suitability to the circumstances often alters in a subtle and dramatic way.[46] Since such attributes resemble situations found in war, the notion of an effects landscape in which peaks stand for effects, is extremely suited for a conceptualisation. Similar to fitness landscapes also effects landscapes do differ from each other as they show a number of properties and structures. In most cases heights of different peaks are correlated in such a way that peaks differing slightly are near each other. As the environment and the enemy change, the value attributable

[44] Brabazon–Matthews s. a.: 3–5.
[45] Dockery–Woodcock 1993: xiv–xv.
[46] Glenn 2012: 40–41; Osinga 2005: 140–142.

to any given effect will also change. Consequently, the heights of the peaks in the landscape move constantly up and down over time indicating that one effect regarded as valuable today might probably be of little help tomorrow.[47] If one can better understand the underlying properties of such an imaginary landscape it becomes possible to think of joint operations as a search process to find high peaks. This powerful metaphor helps conceptualise joint operations in a way that not only acknowledges the frictional, chaotic and complex reality of war, but also takes full advantage of it.

[47] Jobbagy 2004: 183–184.

Chapter 3
Shifting Balance Theory

Organic Strategic Ecosystem as metaphor allows to conceptualise war as a complex adaptive system in which joint operations represent an approach that aims at finding an appropriate combination of effects. Thus joint operations is seen as a complex optimisation process. Effects form a large pool of possibilities in which the combination of effects achieved decides over victory and defeat.

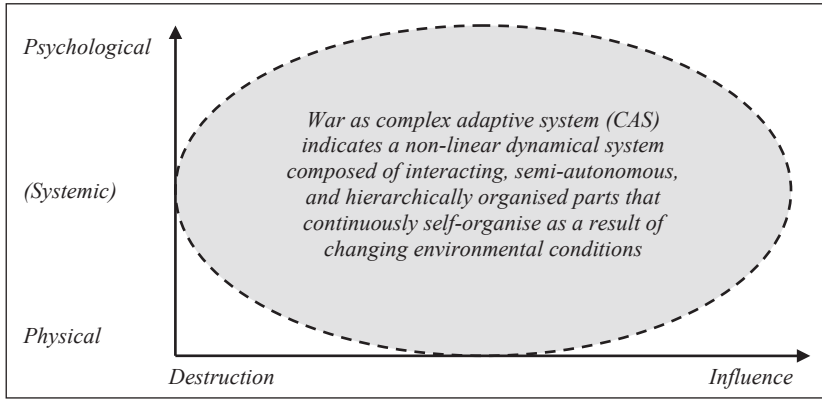

Figure 5. Continuum of war perceived as complex adaptive system
Source: Compiled by the author

As the actions of the antagonists develop, high value effects can become obsolete and effects originally with low significance can turn increasingly powerful. In this dynamic give-and-take process, similarly to biological evolution, the antagonists continuously adapt by means of compensation and substitution. As indicated by the proposed continuum of joint operations and depicted in Figure 5, the conflict shuffles back and forth between orderly and chaotic regions. This is very much in accordance with the Clausewitzian observation that every "action in war is not continuous, but spasmodic. Violent clashes are interrupted by periods of observation, during which both sides are on the defensive".[48] He defined this

[48] Clausewitz 1989: 257.

attribute the Dynamic Law in War as in campaigns, periods of inaction and response change with periods of action as "periods of active warfare [would] always be interspersed with greater or smaller periods of rest".[49] The period of rest meant for him stability and equilibrium including phenomena such as physical and psychological forces, circumstances and motives. Although this continuous cycle defined war fully, Clausewitz emphasised that the "state of crisis is the real war; the equilibrium is nothing, but its reflex".[50]

Similar observations

Due to the frictional, chaotic and complex reality of joint operations, prediction is generally limited. There are so many variables that must be taken into account that the combination of effects reflects a distribution of potential outcomes rather than a unique outcome. Moreover, distributions overlap so that approaches attempting to optimise make more sense than those attempting to maximise. Consequently, success and victory can be seen as a realised positive outcome rather than a maximum one. The greater the uncertainty the greater the possibility that success is a combination of relative superiority and fortuitous circumstances. Chance in the form of trial-and-error also limits the selection of any meaningful criteria for achieving maximum effects. There is no guarantee that a particular outcome in the form of desired effects is really the best one. Once chance forces select a particular path, it often locks in regardless the quality of other possibilities. There are many possible solutions to the same problem and sometimes small, fortuitous and trivial events determine the one event that becomes dominant.[51] Darwin recognised in his book *On the Origins of Species* that genetic usurpation and endemic warfare share similarities as both are important forces in evolution and human history. In chapter three he drew an analogy between war, battle and natural selection and saw evolution as a "[b]attle within battle [that] must ever be recurring with varying success". This analogy made him conclude that "from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows". Biological evolution was

[49] Clausewitz 1989: 260.
[50] Clausewitz 1989: 262.
[51] Alchian 1950: 211–214; Arthur 1990: 92–94.

for him a "great and complex battle of life", which together with the Law of Battle for survival formed a recurrent pattern also in his second epic work *The Decent of Man*.[52] Effects as interrelated phenomena, which also mean that in biological terms they interact. Like living species effects may gain strength or lose momentum thus resembling attributes of the organic world. Consequently, joint operations can be interpreted as a process of filling niches with a combination of effects that are fitter than those of the enemy.[53] Darwin made clear that soldiers might share similar problems with ecologists as both try to find a function that matches the crude reality of life. The American military thinker John Boyd also advocated that evolution by natural selection and the conduct of war are intimately related. Both reflect conflict, survival, and conquest in a very similar and fundamental way. Stability and chaos mark the two end-poles in which the degree of non-linearity defines both the quantity and quality of the outcome. By finding small areas of order sometimes it is possible to achieve equilibrium, but occasionally no equilibrium can be reached at all. When one understands joint operations as a process that includes a trial-and-error mechanism, insights coming from evolutionary biology are very helpful as even a modest pool of effects can show an enormous amount of possible combinations. Clausewitz pointed out that "the vast, the almost infinite distance […] between cause and its effect, and the countless ways in which these elements can be combined" demand things to be seen in a comprehensive fashion.[54] T. E. Lawrence, the author of *Seven Pillars of Wisdom* and leader of the Arab Revolt in 1916–1918 also found a biological element in warfare that was inexpressible with hard or quantitative sciences. This element was for him not subject to the laws of mathematics as it dealt with unknown variables, unfixed conditions and organic things. Its focus was the individual without artificial aids, an intangible that drifts about like gas. This element, he stated, does not live on any material and does not offer any material to the killing. The biological element appeared for him messy and slow like eating soup with a knife. Lawrence regarded this element the breaking-point, which decided on life and death. The biological element was humanity in battle, the personal experience. It was the very war with a line of variability running

[52] Crook 1994: 20; Darwin 1859: 73–88, 490 (quotations: 73, 80, 490); Darwin 1871: 40–51, 98, 102, 123, 238, 239–315, 323–326, 403.

[53] De Greene 1997: 275–277, 288.

[54] Gleick 1987: 59–80; Williams 1997: 229–235; Byrne 1998: 32–33; Alchian 1950: 217; Boyd 1986: 11; Clausewitz 1989: 698.

through all its aspects. Its components were sensitive and illogical with always the possibility of accidents and flaws. The biological element was not expressible in troops or figures, but existed as intuitions. He reasoned that even if nine-tenths of warfare was certain and could be taught in books the irrational rest could be ensured only by instinct. Due to this biological element he stated that amateur control, experimental councils, ad-hoc divisions, and all sorts of whimsicality are inherent features of war.[55]

Humans and hominids

In biological terms war is an expression of intraspecific aggression for which there are countless examples in the animal kingdom. However, due to the long lasting influence of the famous Austrian etymologist Konrad Lorenz, until the early 1970s it was assumed that not much is going on in evolution in terms of intraspecific aggression. This long lasting scientific illusion, the desire to pacify biological processes is similar to other fields of science when it comes to war. Anthropology is a good example for this tendency.[56] In his seminal book *On Aggression* Lorenz concluded that aggressive behaviour has the function to maintain the existence of individuals and species in two ways. First, aggression regulates the density of a species in a given habitat thus preventing the exhaustion of food resources. Second, aggression is linked to sexuality and has the function to pass on of own genes. Aggression did not have the function for him to kill other individuals belonging to the same species. Ending in certain rituals, it can make the bonds between individuals even stronger.[57] This illusion was smashed by later research. Intraspecific aggression and death as a result of it is pretty much everyday reality for many members of a wide array of species in the animal kingdom. It became also clear that the level of intraspecific aggression in the animal kingdom very much surpasses the level of aggression found even in the most violent human societies. The only thing that limits the level of intraspecific aggression is the desire of the involved to avoid serious injuries and wounds. An injured or wounded animal may face decreasing chance to get access to food and as a result of it most serious consequences. There is no social security, no

[55] Lawrence 1997: 101.
[56] Keeley 1996: 3–8; Eibl-Eibesfeldt 1979: 20–26.
[57] Lorenz 2002: 21–45, 54–81.

medical or health institutions in the animal kingdom. One consequence of it is that the bulk of intraspecific killing is aimed against the weaker and the defenceless. Observations prove that most such killings occur against cubs of others within the same species. Thus intraspecific aggression found in the animal kingdom is essentially asymmetric and has the function to avoid injuries and wounds.[58] Biologically modern humans *(Homo sapiens)* belong to the family of Hominidae. Relatives are the chimpanzees *(Pan troglodytes),* the bonobos *(Pan paniscus),* the gorilla *(Gorilla gorilla)* and the orangutan *(Pongo pygmaeus).* The closest relative is the chimpanzee.[59] There are three scientific discoveries that support this very close relationship. The discoveries point five million years ago when there existed a common origin of the two species. One discovery is those 4.5 million years old fossils found in Ethiopia that prove the existence of a bipedal human ancestor with a chimpanzee-like head. The second discovery is those laboratory tests that prove a strong genetic similarity between humans and chimpanzees. In fact, humans are genetically closer to chimpanzees than to gorillas. Even though recent research suggests the gap might be rather 6%, the originally identified 1–2% genetic difference might be small enough to place both species within the same genus. The third discovery is those field and laboratory observations that found striking behavioural, social and other similarities between chimpanzees and humans. Similarities in intergroup encounters of chimpanzees and human wars are among the most interesting.[60] Wars of humans in all ages featured disciplined soldiers, organised warriors and coldblooded killers. Aggressive intergroup encounters of chimpanzees provide all this. Chimpanzees do hunt and eat meat. On occasion they become cannibals. It appears that chimpanzees are anything else then just funny caricatures of humans.[61] Primitive wars of human societies and intergroup encounters of chimpanzees display remarkable similarities when it comes to dynamics. Both contain surprise attacks, the application of overwhelming force, the commitment to kill, intimidation of individuals belonging to the other group. Aggressive and violent behaviour can be observed both in chimpanzee intergroup encounters and human warfare.[62] Groups of male chimpanzees conduct patrols every three to five days.

[58] Gat 2006: 3–10, 36–113, 114–132.
[59] Wrangham–Peterson 1996: 35–40.
[60] Wrangham–Peterson 1996: 23; Gyrus 2010: 35.
[61] Ghiglieri 1987: 68.
[62] LeBlanc–Register 2003: 78; Jones 2008: 514.

They move towards the borders of their territory. Since chimpanzee territories overlap, this activity is very dangerous for them. Here they become silent and cautious, sniff the vegetation, climb high into the trees to observe the area of the other group. The encounter of different chimpanzee groups of similar size ends up with loud hooting, mock charges, throwing stones and sticks of various sizes. After a while, the groups retreat towards the centre of their territory. However, should the encounter become asymmetric in number or situation, another scenario unfolds. In case a lone chimpanzee is located, they chase it and as soon as it becomes possible, attack it ferociously. In these cases death and cannibalism can happen.[63] Jane Goodall, one of the world's foremost experts on chimpanzees could personally observe aggression, violence and brutality that go together when encounters of chimpanzees belonging to different groups become asymmetric. In the 1970s she witnessed the unfolding intergroup dynamics of two chimpanzee groups, the Kasakela and the Kahama. In relation to what she saw, she explicitly used the term *warfare.*[64] Others too, observed similar intergroup dynamics of chimpanzees featuring war-like attributes. Toshida Nishida in Tanzania, Stella Brewer in Senegal, Christophe and Hedwig Boesch in Ivory Coast observed similar consequences of asymmetric chimpanzee encounters. Observations recorded the extinction of two entire chimpanzee groups for which another groups of chimpanzees were named.[65] Jane Goodall thinks that the behaviour of chimpanzees may be to a great extent similar to that of proto and early humans. Simple patterns of chimpanzee thinking and violence turned over millions of years into human love and hate, mercy and cruelty, harmony and – war. In military terminology, chimpanzee intergroup encounters are of low intensity, irregular in appearance and asymmetric in nature. Their attributes include the commitment to achieve numerical superiority or situational advantage with consequences of serious injuries and occasional deaths on the side of the receiving end.[66] This very much accords with certain attributes of the primitive wars waged by humans. These wars do not involve many casualties; therefore, participation is, at first glance, not very dangerous. Their level is below the military horizon of advanced societies, their dynamics is half-hearted and floppy. These wars do not require much logistic support, and there is no need for

[63] Goodall 1988: 10–11; Mitani et al. 2002: 18–21.
[64] Mitani et al. 2002: 12–13.
[65] Wrangham–Peterson 1996: 19–21.
[66] Goodall 1988: 8–10.

organised training and elaborate fortifications. They feature lack of discipline, command-and-control, specialisation and principles. Primitive wars are over long time thought to be inefficient undertakings waged by volunteers and part-timers.[67] Nothing is farther on in reality. The low intensity, irregular and asymmetric conflicts of the unfolding 21st century of Iraq and Afghanistan featured attributes common with the wars of primitive humans and the intergroup encounters of chimpanzees. This form of war can have serious consequences on the lives of both individuals and groups. Since it is not waged by an institution, it penetrates into all aspects of the society involved. It destroys social structures, does not make distinctions between war and peace, soldier and civilian, enemy and criminal. It features a poisonous cocktail of subversive warfare, psychological activities, terror and counter-terror, and absolute enmity leading to genocide.[68] This form of war can be very bloody, cause the death of many, and result in serious consequences. On occasion it can come closest to the apocalyptic or absolute war Goodall observed between the Kasakela and the Kahama groups. The encounters of the two groups went until the end of 1977 when the Kahama was no more. Goodall witnessed the clear evidence of chimpanzee genocide.[69] Observing chimpanzee intergroup encounters makes it possible to understand war not just as a political phenomenon spanning over some hundreds of years, a cultural phenomenon spanning over some thousands of years, or an anthropological phenomenon spanning over some tens of thousands of years. The comparison with chimpanzee intergroup encounters makes it possible to see war as a natural phenomenon spanning over millions of years.[70] The significant genetic and morphological similarity between humans and chimpanzees, the evidence of aggression and violence in both species suggest that certain dynamics and attributes of war, especially when it comes to asymmetric ones, is the result of the evolutionary process. Wars waged by the Yanomamö of the Amazonas observed and recorded by Chagnon show clear similarity with the intergroup encounter of chimpanzee groups as detailed by Goodall and others. Their social setup is also similar as both form patrilineal groups ranging from some dozen to some hundreds. Raiding is the most dominant form of intergroup encounters. A small party of males deliberately intrudes into the area of the other group and

[67] Harris–Johnson 2003: 164–165; Gardner–Heider 1968: 135–144.
[68] Schmitt 2004: 6–7, 10–55.
[69] Creveld 1991: 21–22; Trinquier 2006: 44–52; Wrangham–Peterson 1996: 18.
[70] Keegan 1994: 128–134; Ferguson 1984: 44–50; Wrangham–Peterson 1996: 43–47.

as soon as asymmetric opportunity occurs they stalk to the victim, charge it brutally and kill on the spot or wound fatally. They commit nasty things that would be named war crimes in advanced human societies.[71] Long-term observations of wild chimpanzees make their intergroup aggression even more similar to wars of humans. Over a period of ten years ranging from 1999 to 2008, Mitani et al. observed a chimpanzee group called Ngogo in Kibale National Park, Uganda. During the ten years, the group killed or wounded fatally 21 chimpanzees belonging to other groups. The researchers concluded that due to the killings the Ngogo chimpanzees expanded their territory considerably, from 28.76 km^2 to 35.16 km^2 by annexing an area previously occupied by their neighbours. Thus territorial expansion followed a series of lethal asymmetric attacks. The findings are consistent with the hypothesis that lethal intergroup aggression of chimpanzees can lead to territorial expansion. In this process, chimpanzees increase their access to resources that are then available to other group members, too.[72] The observation of Mitani et al. come very close to what Hobbes described as absolute war in which the meaning of right and wrong, justice and injustice becomes empty. There is no common power, no law and no injustice. Force and fraud go together with continual fear and danger of violent death. In absolute war life is solitary, poor, nasty, brutish and short.[73] Conducting raids and fighting from ambushes promote an approach that is essentially defensive. Schmitt called the approach that combines strategic defence with tactical offence telluric. It should not come as a surprise that also Clausewitz, who addressed asymmetric warfare waged by the people only shortly, did this in his book on defence.[74] Aggression and violence are, according to Clausewitz, inherent features of war and can also be found in the intraspecific group aggression of chimpanzees living across Africa. Among chimpanzees most serious attempts at killing and the killings themselves are done when the victim can be caught helpless and relatively defenceless, and is little capable of effectively harming the attacker. These occasions of deadly fighting are asymmetrical in which casualties overwhelmingly concentrate on the receiving end. This pattern is remarkably uniform

[71] Chagnon 1992: 182–241; Gardner–Heider 1968: 135–144; Wrangham–Peterson 1996: 63–70; Gabsis–Shaw 2017.

[72] Mitani et al. 2010: R507–508.

[73] Hobbes 1965: 78.

[74] Schmitt 2004: 6–7, 10–55.

also among humans in the primitive warfare of any society of hunter-gatherers and primitive agriculturalists. It was observable regularly in the asymmetric warfare waged in various areas of operations ranging from Iraq to Afghanistan, too. Raiding chimps and insurgents fighting for non-state actors appear to have similar motivations. Members of both species avoid serious, deadly, face-to-face confrontations to avoid the risk to oneself and to one's close kin. Wounds gained in symmetric confrontations may be most dangerous and can reduce the chance to get to resources to sustain one's living. The life of raiding chimpanzees and of insurgents is highly insecure and fraught with violent death. For chimpanzees there is no social security in nature and wounds might mean starvation, which is also true for humans living in the unfortunate parts of the world.

Properties of gene mutation

Biologist Sewell Wright wanted to understand the properties of gene mutation and, similarly to Clausewitz, concluded that under biparental reproduction even a limited number of mutations can result in an almost infinite field of variants. In order to handle this problem, he introduced the idea of shifting balance, which is less a rigorous and strict theory, but more a picturesque metaphor.[75] Wright constructed a graphic representation, which he understood as a short and non-mathematical approach to biological evolution resembling a certain similarity with a topographical map known by the military. Although he emphasised that references to geography are of secondary importance, the result was map-like and contained multiple peaks surrounded by circular contours. The map was defined by two axes representing the dimensions along which possible combinations can be arranged. Every combination had a certain value and by connecting the points of equal value contours of peaks and valleys arose.[76] Wright assumed that evolutionary selection could carry the species to the top of the nearest peak, but could not cross valleys that separate the current peak from other, probably higher ones. However, should the species be able to cross valleys then it is not under the exclusive control of natural selection, but of a certain trial-and-error

[75] Wright 1932: 356; Joshi 1999: 66.
[76] Wright 1988: 115–116; Wright 1967: 165–172; Joshi 1999: 67–68.

mechanism. An indefinitely large species that lives under constant environmental conditions and is exposed only to natural selection can reach equilibrium by occupying a certain peak. The population either grows through an increase in mutation rate or a decrease in mass selection, or it decreases through the opposite process as depicted in Figures 6a, and 6b. In both cases evolutionary selection alone does not seem to be sufficiently strong to push the species towards another and possibly higher peak (from peak D to peak E).[77]

Wright assumed that the environment is never static, but changes continuously. The landscape constantly deforms by depressing high places and elevating low ones. According to him, if a species is not extremely specialised and occupies a wide field on the landscape, by moving constantly it could find higher general regions. Such a trial-and-error mechanism can shuffle the species about by means of change without advance in adaptation. As a solution he proposed a large species to be subdivided into many local races that shift continually in a non-adaptive fashion on the landscape as depicted in Figure 6c. Although this exploratory process could result in a decrease of fitness as an immediate effect, this way it would become possible that at least one local race finds a higher peak and pulls the entire species towards this better position. Wright emphasised as depicted in Figure 6 that a subdivision of a species into local races provides the most effective mechanism for trial and error in gene combinations.[78] Evolutionary adaptation involves differentiation in which the principal mechanism is essentially non-adaptive. Although he was not explicit, Wright regarded the species themselves as complex adaptive systems that depend on the balance of certain factors controlled by a trial-and-error mechanism. In his attempt to see evolution as a dynamic process, he regarded adaptation as a balance between natural selection and random genetic drift with each having a varying contribution to the survival and extinction of species over time and space. He proved that adaptation and chance events play an important role in biological evolution.[79]

[77] Wright 1932: 360–362; Wright 1988: 117.

[78] Wright 1932: 363.

[79] Wright 1932: 362–366; Joshi 1999: 68–72; Wright 1988: 118.

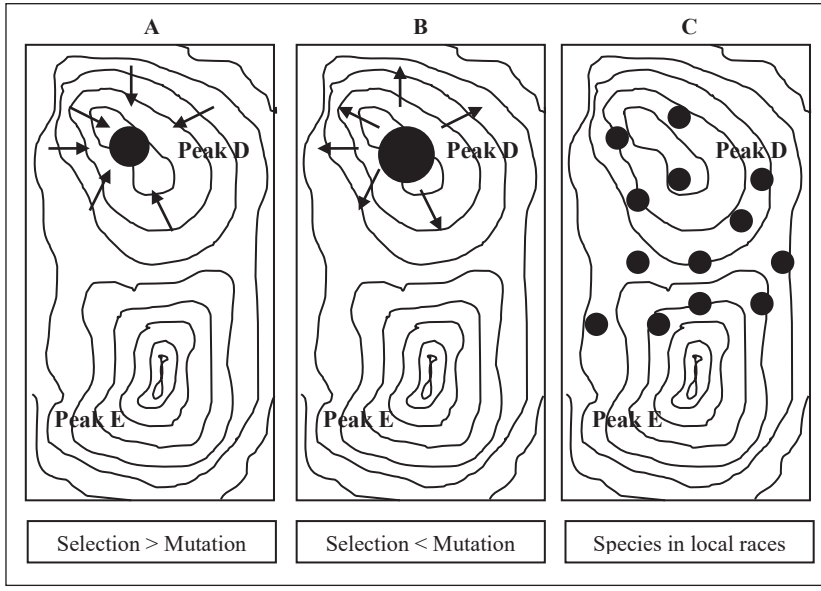

Figure 6. Trial-and-error mechanism by Wright
Source: Compiled by the author

From a contemporary military point of view, Wright's idea resembles clear similarities with the network-centric genre of military writings that are characterised by factors such as the re-focus from the sum of individual platforms to the network of possibilities they provide for, and the gains that can be exploited. The re-focus from mostly isolated and homogenous actors to the various interdependencies smaller and more specified players stand for. The re-focus from strategy development in traditional terms to issues such as adaptation, learning and coping under continuously changing conditions.[80]

[80] Cebrowski–Garstka 1998: 28–35.

General landscape features

Wright's idea applies to many phenomena in which outputs depend on several inputs. Although he referred to the space of possible genotypes, the concept can be extended to model various complex problems ranging from combinatorial chemistry, physics, computer sciences and various social disciplines. It is also very valuable for joint operations since no comprehensive list of desired effects can reveal the countless possibilities in which individual effects interact or provide useful information regarding the underlying mechanism.[81] Some critics question the meaningfulness of fitness as a unit of measure and regard the theory a crude metaphor that has heuristic, rather than analytical values. However, they cannot deny that Wright's idea is a fascinating approach towards visualising real-world problems by means of statistical features. In fact, critics acknowledge that despite objections, problems and limitations, a discussion of biological evolution based on the idea of fitness can be helpful as it reveals insightful guidelines that may be generalisable to more intricate relations of evolutionary mechanisms.[82] The fitness landscape is a beautiful idea that helps us think about effects-based operations differently by offering some advantages. It helps conceptualise effects-based operations as an emergent and self-organising process. It forces one to differentiate better between two basic aspects of adaptation such as efficiency and effectiveness. It can give impetus for a different and more sophisticated understanding of course of action development especially in a constantly changing and dynamic environment. It can contribute to a meaningful discussion regarding issues such as command and control, and military effectiveness. The suggested biological analogy and the idea of fitness make it possible to see joint operations as a process, which is not always causally connected. Joint operations stands for a temporal sequence of aggregates rather than a linear process in which earlier events simply cause later ones.[83] This framework helps conceptualise joint operations as a migratory process on an imaginary or joint landscape that resembles topographical features. Consequently, the goal is to find and occupy regions that contain high peaks representing high value effects and deny the enemy doing the same. Kauffman and Levin picked-up Wright's idea and stated that evolutionary

[81] Brabazon–Matthews s. a.: 2; Merry 1999: 257–258; Kauffman 1989: 529; McKelvey 1999: 298.

[82] Gell-Mann 1994: 247–255; Cruzan 2001: 5; Holland 1995: 65–80; Mitchell 1995: 47–50.

[83] Matthen–Ariew 2002: 79–83.

adaptation is composed of small changes. Its mechanism resembles similarities with a local search process in the form of an adaptive walk, which is always constrained. Evolutionary adaptation deals with conflicting requirements that limit the end result. Adaptive walks proceed along a path characterised by fitter variants leading to attainable local or global optima as both adaptation and fitness come from the environmental context. Real life displays an extended web of relationships and conflicting constraints; therefore, they assumed a landscape featuring many peaks and valleys. Kauffman and Levin regarded adaptation the simplest form of optimisation and also the simplest form of the trial-and-error mechanism. Similarly to Wright, they saw evolutionary change as a novel and creative process that may or may not be accompanied by adaptation to the constantly changing conditions of the environment.[84] As a baseline case, they first examined adaptation on uncorrelated fitness landscapes. In such landscapes they suggested to draw the fitness value of each entity randomly from a given, but fixed underlying distribution. Kauffman and Levin used N genes where each gene could have only two values, 1 standing for gene activated and 0 for not activated. The number of possible combinations is 2^N with 1 being the lowest value and 2^N the highest. Connecting the 2^N points with lines results a landscape-like surface, which is very rich in peaks or local optima. According to them, the number of such local optima increases almost exponentially to N resulting that on an uncorrelated landscape the expected lengths of adaptive walks are generally very short. Each successive step on average moves halfway from the current point, towards the point with the maximum value. After each step the expected number of fitter points is halved on average. The result being that the stopping times are distributed very tightly. In such a setting the great majority of adaptive walks stop within one or two steps. The number of alternative pathways leading to optima with higher fitness values decreases linearly with the rank order of the points. Consequently, with an adaptive walk from any single starting point via a 1-mutant fitter variant only a small fraction of the true local optima is accessible.[85] Kauffman and Levin argued that the success of an adaptive walk depends on the correlation structure of the landscape. A point with an initially low fitness has many fitter neighbours, a point with high fitness has just few and a point that is a local optimum has none. In such a landscape, an adaptive walk can branch into many alternatives early in the process, but the number of

[84] Kauffman–Levin 1987: 12–15; Kauffman 1995a: 163–166; Capra 1997: 222–230, 245–254.
[85] Kauffman–Levin 1987: 19–24; Kauffman 1995a: 167–169.

alternatives slows down as fitness becomes higher. Their conclusion was that adaptation on an uncorrelated fitness landscape favours branching radiation that slows ultimately to stasis.[86] Kauffman and Levin argued that most fitness landscapes are correlated in which points with similar values are closer to each other. The result is that neighbouring points or 1-mutant fitter variants show similar properties. Correlated fitness landscapes can also be rugged and make for long-jump adaptation via J-mutant fitter variants. In this case the importance of a local optimum disappears since all points become accessible. As a result, the correlation structure becomes weaker and weaker, and the number of local optima diminishes. On such landscapes, the importance of the expected waiting time increases as jumps sufficiently far represent adaptation that experiences an uncorrelated landscape. Similarly to an adaptive walk, they assumed that if more than one J-mutant fitter variant is found the fittest is chosen. Thus on average, a single J-mutant fitter variant lies halfway between the least fit and the fittest, which means that the waiting time to find the next fitter variant doubles with each successive step almost independently of the population's size. Adaptation via J-mutant fitter variants is rapid at the beginning, then slows down and after a modest number of steps stasis sets in. Similarly to adaptation via 1-mutant fitter variants branching into alternatives is more common initially, but progressively harder later. Adaptation via J-mutant fitter variants also tends to prefer branching radiation that eventually quiets to stasis.[87] Later Kauffman assumed that correlated landscapes might exhibit self-similar, fractal-like characteristics resulting that small hills nestle into the sides of larger hills which again nestle into the sides of much larger hills. Consequently, landscapes can be correlated, but rugged. After a jump with a distance shorter than the maximum, the species may land on an uncorrelated landscape when measured on a shorter length scale, but on a correlated landscape when measured on a longer length scale.[88]

Evolutionary landscapes

Using the insights coming from the two baseline landscapes and the two sorts of adaptation, it became possible to derive some generalisations for adaptation

[86] Kauffman 1989: 619–622; Kauffman–Levin 1987: 26.
[87] Kauffman 1987: 27–29.
[88] Kauffman 1989: 572–577; Kauffman 1995a: 171–175.

on correlated landscapes. They argued that it makes sense to marry the local and global search in adaptation depending on the time scale of the process. Most statistically rugged landscapes are correlated, and adaptation via J-mutant fitter variants may possibly escape the correlation structure, which is not possible with adaptation via 1-mutant fitter variants. Given a randomly chosen point on the landscape with an average fitness, early in the process the population would sample both in the vicinity via 1-mutant fitter variants and further away via J-mutant fitter variants. Since the fitness is average, half of the points sampled will be fitter and half less so. Due to the correlation structure, points sampled nearby will be only slightly fitter, whereas points further away and not constrained by the power of correlation could reveal much higher fitness levels. Early in the process long jumps trying to find J-mutant fitter variants would become dominant and result in a branching radiation. However, as more J-mutant fitter variants are encountered, the chance of finding J-mutant fitter variants will be less than finding nearby and only slightly fitter 1-mutant variants. Consequently, in the mid-term adaptation via 1-mutant fitter variants in the form of an adaptive walk or local hill climbing will dominate the process. However, as the process goes towards the peak, the rate of finding 1-mutant fitter variants decreases and the danger of ending up in stasis grows. Therefore, in the long term, adaptation via J-mutant fitter variants will again make sense, since only with long jumps is it possible to land in the vicinity of a fitter point that can again be climbed.[89] Although evolution can be understood as a process composed of long jumps and walks uphill, after each long jump and hill climbing the time requirement for finding the J-mutant fitter variant is typically more than double. Radiation and stasis are inherent features of the evolutionary process. Early in the process many different pathways branch upward. As time passes fewer alternatives will emerge until single lineages get trapped on local optima. As local optima are approached, the number of ways leading uphill decreases. On rugged landscapes radiation and stasis are utterly generic. In other words, adaptation stands for branching lineages that surf on a turbulent fitness sea with both divergence and convergence occurring at wave-tops.[90] Although in reality the contours of fitness landscapes remain unknown, they can be reconstructed in order to make them knowable. Based on the general insights gained above, Kauffman developed a model, which is defined both by the variable N and another

[89] Kauffman 1987: 33–35.
[90] Kauffman 1989: 577–580.

variable K. The number of genes N, and the average number of epistatic interactions K stand for conflicting constraints within N that profoundly influence the fitness of any combination. Since K can be tuned from zero to a maximum value, it basically defines the ruggedness of the landscape. As K increases, the landscape changes from smooth to very rugged, or from statistically correlated to statistically uncorrelated.[91] K = 0 means that there are no epistatic interactions, no conflicting constraints and no cross-connections. The structure of the landscape contains only one global optimum, which makes an adaptive walk via 1-mutant fitter variants possible. This landscape is the simplest possible in which all points are on a connected pathway leading to the top. The surface is smooth with neighbouring points having nearly the same fitness value. Thus, knowing the fitness value of one point provides significant information about the fitness value of neighbouring points. On such landscapes for very large N, the fitness values of 1-mutant fitter variants are very similar. In that case, walk lengths to the global optimum increase linearly with N resulting that the pace of such a walk is very slow. This smooth landscape perfectly reflects the ideal gradualism of evolution as outlined by Darwin. K = N-1 means that the amount of conflicting constraints is maximum and each point is affected by all other points. The result is an entirely uncorrelated and extremely rugged fitness landscape. The fitness value of any given point does not give information about the fitness value of neighbouring points. On such landscapes, the number of local optima is very large and the rate of finding better optima via 1-mutant fitter variants decreases at every step. Thus the lengths of adaptive walks to local optima are generally very short and the expected time to find a local optimum is proportional to N. Only a small fraction of the local optima is accessible from any given point. As the number of points increases, the fitness value of local optima falls towards the average fitness of the space, which limits the force of selection and the success of an adaptive walk. The fitness values of accessible optima become poorer as the peaks themselves decrease.[92] As Kauffman argued, between the two end-poles there is an infinite variety of potential surfaces. Should K and N increase proportionately, the fitness of accessible optima becomes an ever poorer compromise and hardly better than mere chance. Such landscapes resemble isotropic features as high peaks move apart from each other in the landscape. Consequently, any one area looks roughly as any other area.

[91] Kauffman 1989: 540–543; Kauffman 1995a: 169–171; McKelvey 1999: 301–302.

[92] Kauffman 1989: 544–547; Kauffman 1995a: 173–175.

Good peaks do not exist since it is not possible to climb higher peaks than afforded by the landscape itself. However, if K is small and fixed whilst N increases the landscapes display non-isotropic features and contain special regions in which high peaks cluster. The location of one high optimum gives information about the location of other good local optima. In this case it is reasonable to search for peaks that lie between two higher peaks that contain mutual information about possible good regions of the landscape. Originally, the concept of NK landscapes was developed to understand evolutionary migration of haploid gene combinations that do not involve sexual recombination, but happen if advantageous point mutations accumulate. However, sexual recombination of diploid gene combinations helps improve the mostly myopic search process of an adaptive walk guided only by the local features of the terrain. Although through sexual recombination it becomes possible for a species to get a bird's-eye view on the landscape, in this case success depends on the correlation structure. On random landscapes recombination is useless and does not make any sense since it suffers the problems of long-jump adaptation. However, on correlated landscapes in which the highest optima are close to each other and peaks are largest, the location of any given high optimum carries information about other optima. Peaks contain mutual information about the good regions in which recombination can be compared with the effect of repeated long jumps. Thus, recombination is a very powerful form of adaptation on very rugged, but correlated fitness landscapes. The only critical requirement is that local optima must carry mutual information about the location of other good or better optima.[93] NK landscapes can have two baseline cases. Whereas the first equals K = 0 and indicates an entirely smooth surface, the other equals K = N-1 and stands for an entirely rugged surface.[94] By approaching one of these two end-poles, evolution suffers from two limits of complexity in the form of catastrophes. The first extreme refers to K = 0 in which the gradient leading to the single optimum is shallow. In this case, selection is not always able to hold the population at the peak and can become too weak compared with mutation. The adapting population cannot stay at the top of the peak, but flows down mostly in the form of quasi-species into the lower regions of the landscape. This phenomenon stands for large mutation rates that lead to a sudden breakdown of stability. Such a case

[93] Kauffman 1992: 112–120; Kauffman 1995a: 180–183; Kauffman 1989: 583–592; Coveney–Highfield 1995: 227–228.

[94] Kauffman 1989: 569, 611.

is called the error catastrophe. The other extreme refers to K = N-1, which indicates a very rugged landscape containing a huge number of peaks. Here, local optima fall towards the mean of the space. Consequently, walks are locked into typical local regions that have an average fitness value. In this case, selection affords only poor peaks to be climbed. A shift towards this extreme results in a complexity catastrophe.[95] Given these two limitations, Kauffman assumed that early in the evolutionary process adaptation occurs on a highly uncorrelated fitness landscape with a subsequent adaptation happening on a rather well-correlated landscape. Adaptation on a correlated landscape means that the rate of finding fitter variants can either stay constant as the fitness increases or decreases slower than on uncorrelated landscapes. In other words, history does matter since early development always locks in.[96]

Importance of coevolution

In real life species live in niches afforded by other species, with the result that fitness landscapes are not fixed, but evolve due to interactions with other species. As Kauffman argued, real evolution is a coevolutionary process that happens on coupled landscapes in which adaptive moves deform the landscapes of respective partners. This implies epistatic interactions between the landscapes themselves, since in reality the fitness of each species depends both on the environment and other species. Consequently, landscapes of coevolving species show a very dynamic surface that trembles, waves and heaves. In such a situation all bets are off since attempts of one species to improve its own fitness may deform the landscape of the other species to which it is coupled. Although the fitness landscape of any given species is a function of the adaptive moves of other species since they correspond to the changes, it cannot be excluded that certain aspects of fitness might be independent from interactions. In order to catch the essence of coevolution he introduced two new variables, C and S. Variable C describes the epistatic interactions between the landscapes and represents those external constraints that influence a species' fitness. Increased C shows how the adaptive moves of species deform the landscapes of their partners.

[95] Kamp–Bornholdt 2002; Franz–Peliti 1997: 4481–4487; Kauffman 1989: 552–558, 580–583, 587–592.

[96] Kauffman 1995a: 177.

Variable S stands for the number of interacting species, hence the number of different fitness landscapes. Thus the variables tune the landscape's ruggedness and also model the richness of external conflicting constraints.[97] Similarly to fixed NK landscapes, on coevolutionary landscapes there are also two end-poles. Whereas the one end-pole is called evolutionary stable strategy, the other is called evolutionary unstable strategy or the Red Queen. In an evolutionary stable strategy each species climbs to a peak that is consistent with the peaks on the other species' fitness landscape. Under this condition the species stop coevolving because each is better off not changing as long as the others do not change.[98] At the other extreme the species never settle down, but keep chasing peaks forever. Their effort to deform and lower the peaks on the other species' landscape also alters indirectly their own. Consequently, the behaviour lies in the chaotic domain in which the species run ever faster in order to stay in the same place. For cases in between Kauffman found that species can coevolve well. The speed at which species move depends on their current fitness and the ruggedness of the respective landscapes. If species are on landscapes of different ruggedness the rate at which they move uphill depends on their joint fitness and landscape ruggedness. When the amount of coupling between the landscapes is high, by increasing the number of conflicting constraints internally, a species can reach equilibrium faster and gain higher fitness.[99] In general, Kauffman concluded that for $K > C$ equilibrium is encountered more rapidly than for $K < C$ where the waiting time can become very long. For coevolving species $K = C$ is a crude dividing line for the time requirement to encounter equilibrium. In the case $K > CxS$ the coevolving partners all get to equilibrium rapidly; in the case $K < CxS$ equilibrium can only set in after a long period of time. Thus, the fitness in coevolving systems increases when a species can adjust its K to C with $K = CxS$ being a rough guide.[100]

97 Kauffman 1989: 675–688; Kauffman 1995a: 215–222; Kauffman–Johnsen 1991: 325–369.
98 Beckerman 1999.
99 Kauffman 1989: 689–702; Kauffman 1995a: 223–225.
100 Kauffman–Johnsen 1991: 334–343; Hordijk–Kauffman 2005: 41–49.

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Chapter 4
Joint Effects Landscape

The evolution of species is manifest in their migratory process chasing high peaks and comes as the result of various genetic combinations. An effect (E) can be seen as the function (f) of an action (a) on an object (o) and be depicted in the form of a simple equation

$$E = f(\text{a}, \text{o})$$

This approach very much corresponds with the official NATO definition of an effect, which is "a change in the state of a system (or system element), that results from one or more actions, or other causes". Thus an effect bridges the gap between objectives and actions by describing what changes in a system are required. This can affect changes in capabilities, behaviour or opinions (perceptions) of actors within the environment. Effects provide a focus for actions and contribute to the achievement of objectives and the end state. Effects must be measurable and should be limited in number.[101] The equation makes it possible to conceptualise effects, similar to living species, in terms of genotypes. For this reason, it is important to clarify what the term genotype stands for. The genotype of an organism can be defined as "the class to which that organism belongs as determined by the description of the actual physical material made up of DNA that was passed to the organism by its parents at the organism's conception".[102] In a similar fashion genotype can be understood as the specific makeup of an effect that refers to certain composition of objects as outlined in the equation above. However, before going further it is important to make a distinction between an object and an objective. Whereas in terms of effects an object forms the focus of an action as it sets the boundaries between phenomena, an objective exists only as a specific state regardless of whether an action was taken or not.[103] In common NATO terminology an objective is defined as "[a] clearly defined and attainable goal or aim to be achieved". In the spirit of mission command, objectives are assigned to a commander by the next higher level. The North Atlantic Council

[101] Supreme Headquarters Allied Powers Europe – Allied Command Operations 2021.
[102] Stanford Encyclopedia of Philosophy s. a.
[103] McCrabb 2001: 7–12; Jobbagy 2005a: 54; Vego 2006: 45.

promulgates strategic objectives, military strategic objectives and non-military strategic objectives to prescribe the 'ends' to be achieved by NATO military and non-military efforts in support of the achievement of the NATO end state.[104]

Effect-genotype

The first part of the equation refers to actions and can be grouped in many ways. Well-known terms such as divert, delay, disrupt, destroy, and demoralise can describe actions needed to achieve effects as well. Another more comprehensive and extended listing can include deter, destroy, disrupt, degrade, decapitate, divert, dislocate, delay, deny, deceive and defend.[105] The listings provide for a vast array of options. However, the author suggests a simplification in which an action is limited to two alternative states such as action taken standing for 1 or action not taken standing for 0. The second part of the equation refers to the object and is equivalent to the number of genes N. In a military conflict, similar to living organisms the number of objects that must be considered is normally very large. According to Kauffman, an organism such as the eukaryote has 20,000–100,000 structural genes and a variety of other control points. In order to interdict enemy ground units, the Air Campaign during Operation Iraqi Freedom identified and struck approximately 19,900 aim points or objects.[106] Thus, each effect has genes represented by bits composed of binary numbers. Pairing objects with actions means that an object can either be targeted in the form of action taken or not targeted in the form of action not taken. Consequently, the effect-genotype represents a given combination of effects and takes the simple form of a binary string with 2^N possibilities.[107] For example in case of ten objects (N = 10) and the two sorts of actions, the effect-genotypes can have 2^{10} or 1,024 various possible states ranging from 0000000000 to 1111111111. These possibilities can be depicted in the form of a joint effects landscape that contains various peaks representing the different values of the effect-genotypes. Similarly to Kauffman's NK model, the value of any combination can be defined as the average of the contribution of the individual objects, each in its own context and

[104] Allied Command Operations 2021: 3–41 (footnote).
[105] Walker 1998: 28, 73; McCrabb 2002: 11; Wagenhals–Levis 2002.
[106] Kauffman 1992: 427; Conetta 2003.
[107] Rinaldi 1995: 53; Kauffman 1989: 540; Levinthal 1997: 936–937; Ramsey s. a.

the K other objects in the form of functional couplings or epistatic interactions. The joint effects landscape is defined by effect-genotypes consisting of a given number (N) of objects (o) with two possible states at each object (o_i) and can be expressed as follows

$$F(o) = \frac{1}{n}\sum_{i=1}^{n} F_i^{(\alpha)}(O_{1i}, O_{i1}, O_{i2}, O_{i3}, ...O_{ik})$$

Whereas for K = 0, each object is independent of all other objects, for K = N-1 each object depends upon itself and all other objects. Thus each object's fitness contribution depends on the choice between the two different binary states at each of the K other objects that impinge upon it.[108] The joint effects landscape reminds us that effects are highly complex phenomena. There is no single dimension along which it becomes possible to search and find combinations that possess good or high value. Hence predefining desired effects often do not make sense. Joint operations represent a high-dimensional search process that aims at finding an optimum combination of effects with the goal to occupy high spots on the joint effects landscape in which a given combination of effects influences battlefield performance and as a consequence the outcome on higher levels.[109] Before detailing the implications of such a conceptualisation of joint operations some limitations must be acknowledged. Despite similarities with Kauffman's model the joint effects landscape is a heuristic approach that do not attempt to quantify the search process more precisely. Consequently, one must acknowledge that it might not always be possible to find a search process that guarantees a good optimum, and similar to biological evolution in war one has to accept mostly sub-optimal solutions. Whereas in the NK model the search process is driven by an algorithm that always chooses the fittest option, it is not always possible to do that in reality. Much of real-life problems are NP complete and intractable to analytical solutions in the form of algorithms.[110] A further limitation is due to the fact that cultural imprints and past experience always distort perception. For example the same phenomenon or even a simple symbol can have a different meaning for people with different political, military, economic, social and other background. Reality is not directly comprehensible

[108] Kauffman–Macready 1995: 28; Levinthal 1997: 936–937; Hordijk 1994: 10–11; Altenberg 1997: 2; Goertzel 1996.

[109] Rivkin 2000: 827; Ilachinski 1996b: 136–137.

[110] Weinberger 1990: 326; Rivkin 2000: 826, 831–832.

and the joint effects landscape represents a specific mapping of reality. Identity can limit the search process by excluding certain areas that may contain good peaks, but cannot be explored or climbed. Due to the existence of different blinders, the joint effects landscape is always a compressed and distorted form of reality that puts limitation on the search potential. A further reason why the search process is suboptimal comes from the fact that it is not the peaks sought, but the landscape's ruggedness that determines the success of any given search. The joint effects landscape exists only in our representation, which means that the search process is typically constrained and appears mostly in the form of a biased walk. In other words, this specific imaginary landscape has no objective reality separable from the autonomous agents inhibiting it. Although this sort of bias sometimes eases the search process, it always limits the search potential. Thus, any problem decomposition in the form of a joint effects landscape only coincides with the reality as it may or may not correspond to the true or real decomposition structure.[111] An utterly false representation can induce additional and lasting interactions, which influence the way alternatives are generated and evaluated. Consequently, the joint effects landscape refers to unique and private mappings of the actors involved.[112] This however, indicates that there will never be perfect battlespace knowledge or transparent battlefield available, only approximations with a certain error value. Due to such less-than-perfect descriptions generating wrong predictions, as time passes the desired peaks on the landscape might differ from the expected peaks, which again might differ from the actual peaks found and explored. One must always assume that very good strategies might often become hidden for long periods of time, but can also emerge occasionally.[113] Whereas joint operations exist in a high-dimensional space, the joint effects landscape can only provide for certain statistical characterisations of the space of possibilities. Thus, the search space is explored in one particular direction, which always implies a biased characterisation. The way effects are constructed also does not provide clear and attainable information on the genotype/phenotype mapping. The way effects are generated and perceived can differ significantly. Despite its power to deliver helpful and valid statistical insights regarding the possibility space, the predictive power of the joint effects

[111] Brabazon–Matthews s. a.: 6–18; Beckerman 1999; Smith 2006: 142–148; Dosi et al. 2003: 418–422.

[112] Roos–Oliver 1999: 284.

[113] Sakulich 2001: 15–18; Dawen 2004: 21–27; Beinhocker 1999a: 98–99; Rivkin 2000: 833.

landscape is limited and has more to do with landscape statistics than landscape reality. It allows for analysing the search space only along a single fitness function and if the problem is multi-objective it cannot provide for further and broader generalisations. Despite all its utility, even the joint effects landscape is unable to capture the true nature of emergence with all its self-organising attributes.[114] Nevertheless, the joint effects landscape is a powerful aid in conceptualising war in a novel way. Joint operations are seen as a process that rests on adaptation and mutation in which one attempts to offset changing conditions coming both from the environment and interaction with the enemy. Conceptualising joint operations this way also has the advantage that the emerging search process can be defined by the network of effects and not exclusively by desired effects. Regardless of the approach and methodology chosen it will never be possible to explore the vast space of possibilities. However, the joint effects landscape can give the chance to understand the complexity of joint operations and framing it as a complex optimisation problem that includes approximations and estimations regarding optimal values. Furthermore, the joint effects landscape can also give the chance to assess the benefits of further optimisation or to define termination criteria.[115]

Efficiency and effectiveness

The joint effects landscape shows that it is often more important to gain insight into the mechanism of how effects interrelate rather than to define desired effects. The frictional, chaotic and complex reality of joint operations indicates that the combination of effects often counts more than certain desired individual effects. Conceptualising war and joint operations in the framework of a complex adaptive system requires the ability to manage polarities rather than solving problems. Evolution comes as the result of two search mechanisms such as adaptation via 1-mutant fitter variant and J-mutant fitter variant. In a similar fashion, in the framework of the joint effects landscape, joint operations can be seen as a combination of two different, but interrelated processes such as being effective and efficient. Although in normal English usage both refer to effects, there is a significant difference between them. Effectiveness stands for the quality of being able to achieve an effect or the ability of becoming effective. It has a general

[114] Teo 2003: 84–85.
[115] Rosé 1997.

meaning since it describes only the power to carry out an act that has a certain result. Effectiveness suggests the accomplishment of a desired result especially as viewed after the fact. Efficiency stands for the capacity to produce a certain desired result with a minimum expenditure of resources. It has a more specific meaning and describes the suitability of a given procedure. Thus efficiency is being the immediate agent in producing an effect. It suggests an action or a potential for an action in such a way as to avoid loss or waste of energy in producing a result.[116]

$$\textbf{Effectiveness} = \frac{\textit{Realised output}}{\textit{Desired output}}$$

$$\textbf{Efficiency} = \frac{\textit{Realised output}}{\textit{(Desired) input}}$$

The biggest difference between the two is that whereas effective stands for the power to produce an effect, efficient describes the process of producing an effect. The following simple comparison may explain the fundamental difference between the two:[117] In the framework of the equations above, effectiveness gives information about what kind of end-state is achieved and forces to think more precisely about what one wants to achieve. Efficiency can be regarded as the relation between input and output, representing how the end-state is achieved. The difference between effectiveness and efficiency can be conceptualised in the framework of the proposed joint effects landscape. Whereas efficiency means climbing discovered peaks and is analogous with adaptation via 1-mutant fitter variants, effectiveness stands for searching for good peaks and is analogous with adaptation via J-mutant fitter variants. Consequently, efficiency stands for exploiting or making incremental improvements in the form of adaptive walks. Effectiveness stands for exploring new areas in order to detect opportunities as a result of long jumps that can be exploited. Climbing peaks in the joint effects landscape can be understood as increasing efficiency, exploring new and potentially high peaks as an attempt to increase effectiveness. Searching for efficiency means a process of climbing higher on a discovered hill until the peak representing maximum effect is reached. Being on the top indicates that one has achieved an effect with the minimum use of resources. Efficiency presupposes that the hill has a clearly defined and hardly changing shape, which

[116] Gove 1981: 725.
[117] Snowden 2005.

makes both path and peak visible. Efficiency contains a high degree of certainty and predictability with the chance to define desired effects and develop plans to realise them. Efficiency allows for a classical problem solving approach in which it is possible to know where one is relative to the peak, and know how to get to it. Exploiting a peak means doing things the right way or doing things better. Once a peak is climbed it makes sense to stay there since it represents a potential function that can be exploited.[118] However, the surface of the joint effects landscape always changes, which demands a constant discovery of new and higher peaks. Due to the inherent dynamics, there is always chance that a peak can become a valley and a valley a peak. Although there might be some correlation between nearby peaks, it is often very difficult to see the contours of the landscape. Uncertainty and unpredictability dominate as the joint effects landscape turns increasingly complex. These features require a reorientation based on effectiveness and flexibility, which shift the premium towards searching and discovering new peaks. Being effective means doing better things, which often includes being efficient since the effects landscape contains many different peaks that may offer the potential for climbing uphill. Whereas efficiency means climbing, improving and doing things better, effectiveness stands for searching, exploring and being innovative. In a rough and constantly changing joint effects landscape one specific approach can become disadvantageous regardless of how excellent the planning and execution. Flexibility and adaptive ability offer more potential since they indicate the importance of learning and innovative skills. Effectiveness emphasises possibilities rather than prediction and points towards compromise solutions that make it possible to address the conflicting constraints of various sub-problems since rugged landscapes contain many more low than high peaks.[119] The joint effects landscape indicates that one should become able to find a balance between exploration and exploitation. Exploration to the exclusion of exploitation represents experimentation with alternatives that involve uncertainty and distance, but no potential for gaining benefits. Exploitation to the exclusion of exploration represents refinement and is mostly associated with being proximate and predictable. However, the peaks to climb might easily be poor local optima. Whereas efficiency in the form of exploitation represents an internally focused approach, effectiveness stands for an external focus and new connections that allow for a "jump clear across the landscape to a new distant

[118] Merry 1999: 257–259; Kauffman 1995b: 222; Kauffman 1989: 625.
[119] Merry 1999: 260–262.

hill".[120] In general, efficiency and effectiveness are interconnected phenomena and mean that the emphasis should rely less on reducing environmental uncertainty or simply waiting for structural inertia and more on appreciating the power of simultaneous selection and adaptation. Thus efficiency and effectiveness are not mutually exclusive alternatives that can be treated only within their own domain of applicability, but fundamentally interdependent. Consequently, they are not conflicting perspectives or complementary views, but two interrelated processes of change.[121]

General topography

The central element of the joint effects landscape is fitness, which describes the relative value of a certain effect-genotype. Before detailing the consequences of the joint effects landscape it is important to compare Wright's original shifting balance theory with Kauffman's NK model. The original theory is rather static as it emphasises the importance of height difference between peaks, assumes subdivision of a species into local races that move around in a non-adaptive fashion either to find higher peaks or just to be in the right place by chance in case the environment changes. Climbing is the only form of moving uphill and attention is paid exclusively to environmental changes as the major reason for topographical consequences. In other words, the importance of time is not of first consideration. For Kauffman both the height differences between peaks are important, and the way those peaks are located in the landscape is a result of various internal and external conflicting constraints. His model also allows for the possibility of jumping long distances in the landscape in order to escape the correlation strength. Furthermore, he assumes that given an average fitness both the number of steps and the time requirement needed to find a higher position increase after each subsequent step. Thus time plays an important role since the process of evolution is examined in more detail. It is faster in the beginning, but eventually slows down. In general, Kauffman regards fitness as a function of various more or less favourable environmental changes and a dynamic coevolutionary process. The space of possibilities in the joint effects landscape is N-dimensional. For a better understanding it is suggested to imagine a large

[120] March 1991: 71–73, 85; quotation Beckerman 1999; Meyer 2002: 96.
[121] Roos–Oliver 1999: 289; Levinthal 1991: 140–145; Courtney 2001: 38–42.

two-dimensional grid in which N defines the size. Each grid represents a certain effect-genotype with a given value. The topographical features of a landscape arise when heights of nearby grids are connected that turn the two-dimensional sheet into a mountainous three-dimensional joint effects landscape.[122] Due to differences in their respective values, effect-genotypes emerge in the form of hills and valleys of various sizes and shapes. The surface of the joint effects landscape can range from entirely correlated to entirely uncorrelated resulting in a smooth or rugged surface. Between these two extremes there are landscapes that are correlated, but rugged. The way topographical features are located is influenced by the interactions and coupling of the constituents that refer to epistasis or conflicting constraints as outlined by Kauffman. Thus equilibrium expressed in K = 0 and chaos in K = N-1 form the two end-poles within which effects landscapes exist. Consequently, most effects landscapes are rugged, but correlated. They display many peaks of various heights even in the form of peaks within peaks indicating that the joint effects landscape contains many more lower peaks than higher ones.[123] Similar to biological evolution, in the framework of the effects landscape it is impossible to predict when transitions will occur or what the resulting pattern in terms of peaks will be. However, effect-genotypes with similar values might often be close to each other and as a simple analogy we suggest a subdivision into three different regions. The first region is low and equivalent to physical effects. This region contains only peaks of low heights in the form of hills that can easily be climbed. It indicates a simple foresight horizon that comes as a result of tightly linear attributes. The second region is medium and more mountainous that refers to systemic effects. This region stands for a complicated/complex foresight horizon that comes as a result of loosely linear and loosely complex attributes. The third region is high and equivalent to psychological effects. It is the most multi-peaked region indicating a chaotic foresight horizon that comes as a result of tightly complex attributes.[124] A further important aspect of the effects landscape is the frequency with which the surface changes. In general one can say that the surface of lower regions change more often and dynamically than that of higher regions, as it is relatively easy both to achieve and compensate for physical effects. The higher the region, the more static is the surface. Although low peaks can be discovered with relative ease,

[122] Beinhocker 1999a: 98; Beinhocker 1999b: 50; Rivkin 2000: 827.
[123] Waldrop 1992: 102–105; Kauffman–Johnsen 1991: 64–67; Merry 1999: 265.
[124] Maxfield 1997: 78–98.

the peaks themselves have a low value. Unfortunately, higher peaks are not only more difficult to find as they are scattered over the joint effects landscape in relatively small regions, but also most paths leading to the top remain hidden. This characteristic explains why it is more difficult to achieve psychological than physical effects and why psychological effects have a longer temporal horizon indicating strategic value. Even successful exploration of a given region does not yield information regarding where to search further. Thus, the exploration of one region does not always give sufficient knowledge on other and preferably higher regions. The only certainty is that moving from the lower regions of the joint effects landscape to higher ones has the consequence that the higher the peaks the higher the possibility that they offer only potential value.[125]

Searching for peaks

Effect-genotypes indicate joint operations as a search process on an imaginary landscape called joint effects landscape. The number of objects N can be very large, the result being that the length of an effect-genotype can be enormous with values ranging from 1 to 2^N. Earlier it became clear that effects are located on a continuum characterised by physical and psychological effects as end-poles.[126] As one moves from physical towards psychological effects, their value increases, which explains joint operations to be a process that chases high peaks on the joint effects landscape. However, one must take equally into account that the more one moves towards psychological effects, the more complex they become as both the amount of objects involved and the number of conflicting constraints increase. In other words, the average height of the peaks we encounter might be lower than expected. A simple physical effect such as destroying a tank, an airplane or a bunker does not include many conflicting constraints that must be taken into account. A systemic effect such as shutting down a power plant in a given area can have the consequence that the enemy cannot operate his military arsenal properly. However, hospitals or critical water supply facilities may also suffer a shortage in energy thus causing innocent civilians to starve and die. A psychological effect can suffer from even more conflicting constraints that may run through various ethnic, religious, social and political dividing lines in any

[125] Roos–Oliver 1999: 284.
[126] Jobbagy 2005a: 55–57.

given society. As the example in Iraq shows, the population is mostly Muslim, but the non-Arabic Kurdish minority makes up a large part of its territory and lives in a separated region in the North. Political and religious differences between the two ethnically Arab groups of Shi'as and Sunnis are also large.[127] Moving from physical towards psychological effects, the joint effects landscape turns increasingly rugged and contain many uncorrelated peaks that often jeopardise a successful search process and decrease the prospect of finding good peaks. Thus, there are certain common sense elements that must always be taken into account when conceptualising joint operations this way.[128] Instead of focusing exclusively on the upper right area of the continuum of war, the author proposes reconsideration in terms of the probable. This can help find the ideal mixture of available means and achievable ends. The more one adheres to what is probable the better and easier to combine effectiveness and efficiency. Although this means that one lowers the ambition in terms of desired effects, but can take better advantage of available means as the situation unfolds and address the proposed coherency of effects. Thus, one sacrifices focus to gain flexibility. However, then the question arises naturally: why is achieving psychological effects in joint operations understood as something more desirable than achieving physical or systemic effects? John Warden, one of the founding fathers of effects-based operations, suggested the opposite by arguing that one should focus more on the physical side of the enemy.[129] In terms of the joint effects landscape, two processes explain this phenomenon. Although on average the value of local peaks declines slightly with K, the number of such peaks increases. Moving into the more rugged regions of the landscape has the consequence that the number of true local optima decreases, but their value increases with the result that the expected value of the maximum fitness level certainly increases.[130] In such a landscape it is very difficult to find high value effects since the area from which to start is essentially smaller. Approaching joint operations from the psychological end-pole has the consequence that the joint effects landscape becomes very rugged in which high peaks spread apart, and even if one is detected, its location carries only a very limited amount of information regarding the location of other high peaks. Due to their distance, peaks often represent different and unrelated psychological effects

[127] Central Intelligence Agency 2004.
[128] Davis 2001: 21.
[129] Jobbagy 2005b: 46–48.
[130] Levinthal 1997: 942–943; Kauffman 1989: 546.

rather than variations.[131] Joint operations are mainly associated with achieving psychological effects on the enemy thus causing a behavioural change despite the fact that such effects are generally very difficult to achieve. It appears that humans intentionally focus on the assumed height of the maximum peak rather than on the landscape's ruggedness, which profoundly influences the topographical features. Obviously, conducting joint operations and mountaineering practices share at least one common element. Both soldiers and alpinists are equally enthusiastic about finding and climbing the highest possible peak. In their effort to reach new heights, they often disregard reality in terms of what can and cannot be achieved.

Recombination and occupation

The surface of the joint effects landscape is not fixed, but coupled to the joint effects landscape of the enemy. The way these landscapes are coupled bears consequences for possible catastrophes mostly in the form of long, protracted and indecisive campaigns based on attrition and annihilation. The only thing possible in such cases is to decouple the landscapes as shown by the American example in Vietnam in 1975, in Afghanistan in 2021 and the Soviet experience in Afghanistan in 1989. According to Kauffman, in the case of coupled landscapes the fitness of coevolving species becomes higher when they are able to adjust their conflicting constraints to the level of their external couplings. K = C was regarded as a rough dividing line for the time needed to achieve mutual equilibrium. In a similar fashion joint operations can be understood as a contest between two belligerents in which each wants to maximise survival chances by forcing the other into regions of lower fitness. The course of activities proceeds from an evolutionary stable situation towards an evolutionary unstable state as the belligerents act, react and interact. Based on Hobbes's discussion of war, the temporal aspect can be seen as the very enabler of other advantages such as limited casualty, destruction and low cost. Consequently, one should go back as fast as possible to another and more preferable stable situation. Only this way is it possible to achieve a better state of peace in the form of a new equilibrium. Otherwise, as war unfolds the chance to be dragged into a Red Queen race, in which the belligerents run ever faster just to stay in the same place, grows. However, if one can control internal couplings and achieve

[131] USJFCOM JED 2005: 3–4; Rivkin 2000: 834, 838.

a rough K = C situation faster, the chance of victory grows. Raising K above C temporarily means gaining flexibility. Although this goes together with an increase of conflicting constraints, only this way becomes it possible to induce a multitude of options that can be exploited. One must take into account that it is not possible to entirely harmonise internal and external couplings, but this sort of parallelism gives the chance to become as rugged as the environment. The overall result is that the complexity profile internally mirrors the external complexity, which resembles a clear similarity with Ashby's law of requisite variety. In other words, one becomes able to track and climb those peaks that offer the best effects and come as a result of dynamic and constantly changing interactions with the enemy. The frictional, chaotic and complex reality of war demands that we maximise our internal diversity so as to be optimally prepared for any foreseeable or unforeseeable contingency, which comes from the interplay with an intelligent enemy.[132] Ashby's law indicates that if one can find the narrow edge of chaos, it becomes possible to push the enemy towards one of the two end-poles. Should this area not found, there is a chance that to drift either towards panaceas believing that through simple destruction one can generate desired psychological effects, or towards attrition and annihilation in which regardless of the means applied the best one can achieve are mostly scattered physical effects. Both options can be labelled as joint operations, but the effects achieved might be less than optimal. The recent history of warfare is rich in examples of this kind. Most strategic bombing campaigns of World War II point towards the former, the trenches of World War I represent the latter. However, one should not forget that even if it is possible to act within the area of the possible no one can ever reach maximal fitness, only relative fitness, for which the other must be taken into account.[133]

Coevolution tells that as time passes competitive advantages always tend to diminish. If one belligerent is pushed towards K=0 paralysis is the result and no adaptation to changing circumstances occur. The inability to react properly is the consequence since the pace of change is quicker than the ability to adapt successfully. In the effort to offset the growing disadvantage, the enemy constantly mutates and can probably achieve lower level physical effects, but does not possess the ability to capitalise on any sort of synergy among them.

[132] Beinhocker 1999a: 100; Ashby 1957: 202–218; Beinhocker 1999a: 105; Pascale 1999: 86; Markides 1999a: 62.

[133] Merry 1999: 272; Beinhocker 1997: 35; Arthur 1989: 116.

The result is some sort of pseudo-effects that come from destruction. Actions can inflict damage by sporadically killing friendly forces personnel or destroying friendly assets, but these activities cannot spill over into coherent joint operations. Although effects achieved can be distributed uniformly over the space, the overall situation represents the error catastrophe. The enemy climbs desperately uphill without realising that the peak he occupies has already started to shrink. Instead of exploring new alternatives he clings either to a particular region or a hill thus getting the false impression of potential success.[134] The other extreme is when one belligerent is driven towards a chaotic situation K = N-1 and gets dragged so deep into the conflict that the effects achieved suffer from an increasing amount of conflicting constraints. In this case complexity catastrophe sets in. The consequence is the inability to take hold of the peaks explored, and wanders around the joint effects landscape desperately chasing high peaks. Due to the amount of conflicting constraints, the effects achieved instantly reduce the potential and value of other effects. Thus, the belligerent constantly explores the landscape without finding exploitable peaks. Consequently, he suffers only a loss and not a gain in fitness. A further interesting feature of the joint effects landscape is the issue of recombination as it became clear that in evolutionary terms diploid organisms offer more potential for finding new peaks on correlated landscapes. Sexual recombination is equivalent to many long jumps and provides an aerial view of the landscape. Thus, the question regarding recombination in joint operations arises naturally. In biological organisms, the issue of sex is an implicit part of the fitness function, whereas in joint operations it is explicit.[135] As outlined earlier, one assumed advantage of joint operations is that the concept relies on the parallel and comprehensive application of all elements of military and non-military power.[136] By capitalising on the power of these many elements, it is possible to lift the position from which the joint effects landscape can be observed, and find better regions which offset the typical shortcomings of long jumps. Recombination as manifest in the comprehensive approach makes it possible to jump farther away and reduces the time requirement of finding high value effects. Unfortunately, similar to biological evolution, if the joint effects landscape is very rugged also recombination in the form of integrating all elements of power suffers from serious limitations. Another no less important issue

[134] Franz–Peliti 1997: 4481; Merry 1999: 261.
[135] Hordijk 1994: 7.
[136] Jobbagy 2005a: 51.

concerns whether one should stay or move once a peak is occupied. In Wright's original landscape, the species moved in a non-adaptive fashion subdivided into many local races that nested around a given peak. They detected new peaks either by chance or just happened to be at the right spot when the environment changed. In either case, through cross-breeding the lucky genotype pulled the entire species uphill. Kauffman's model allows for a much more dynamic process that rests both on adaptation via 1-mutant fitter variants or adaptation proper in a Darwinian sense, and on adaptation via J-mutant fitter variants. The question of moving or staying on a peak in the joint effects landscape depends on the fitness difference between the potential of the effect that can be exploited and the dynamics that can suppress or elevate the peak already explored. Due to the unpredictability of joint operations, it makes sense to stick to, and exploit peaks already found, which seems to be a good hedge against possible unsuccessful jumps. Such a pre-cautionary measure is even more important, as long-jump adaptation means that only one peak is examined out of a large pool of possibilities. Since the evaluation of distant peaks is always difficult and equals a real value plus an error term, sticking to peaks already achieved can be a good measure if the landscape changes.[137]

Clausewitz reloaded

This chapter is the heart of the book and proves the assumption that various biological perspectives on human behaviour have very much to offer in the search for a better understanding of conflict and war.[138] Regardless whether one sees war through the eyes of Clausewitz, approaches it as a complex adaptive system, or examines it along attributes that display similarities with biological evolution, there are timeless and innate characteristics. Joint operations stand for primordial violence, which is intrinsically complex and comes as the clash of physical and psychological forces.[139] In the framework of biological evolution, the author treated joint operations as a complex adaptive system in which the system properties emerge from the interactions of the many components on lower levels. Joint operations contain an abundance of dispersed interactions. The underlying

[137] Levinthal 1997: 947.
[138] Goldstein 1987: 33.
[139] Australian Government 2005.

mechanism lacks global controller, but feeds from cross-cutting hierarchical interactions. There is perpetual novelty, which is far from equilibrium dynamics that demand continual adaptation. Similarly to biological evolution, the composition of joint operations change constantly. The coevolution of the belligerents means that the components feed back and affect their further dynamics and change the attributes of the players involved.[140] Joint operations and biological evolution are as much about selection as about transformation; therefore, adaptation appears to be at the heart of both. Transformation emphasises the process character and stands for the importance of not only how to respond to perturbations properly, but also how to maintain the capacity to respond adaptively.[141] The complexity inherent in joint operations and biological evolution can be modelled in similar ways. Although the attributes of the underlying mechanisms of the similarity is obvious, one should bear in mind that the approach taken in the chapter of this book can only give insights, but never definite answers. Despite the underlying mathematics, the joint effects landscape is rather qualitative and descriptive in nature as it guides the thinking increasingly towards adaptation, evolution, behaviour, metaphors and models.[142] Certainly, from a biological point of view joint operations can be seen as a struggle for existence in which success stands for survival of the fittest. However, unlike in the case of the exact natural sciences there is no biological law of nature and joint operations cannot be expressed as a mathematical function of the variables. This was the very reason for introducing the Organic Strategic Ecosystem metaphor in order to discuss the intricate mechanism of joint operations and its restricting influence on causal assumptions. However, this way it became possible to grasp the complex web of relations inherent in joint operations and see it as an interdependent whole.[143] Darwin himself used the expression struggle for existence "in a large and metaphorical sense including dependence of one being on another".[144] An evolutionary approach to joint operations emphasises variations and diversity in order to comprehend a rapidly and dynamically changing character. Both biological evolution and joint operations display selection pressures that point as much towards co-operation as competition. The resulting synergy employs

[140] Levin 1998: 431–434.
[141] Ovington 1900: 414; Vayda 1974: 183–193.
[142] Drapeau et al. 2008: 1–8.
[143] Loeb 1917: 73–76; Mitman 1997: 260; Vergata 1994: 145.
[144] Quotation Bailey 1915: 54.

information and displays innovation. The obvious similarities do not mean that joint operations and biological evolution can be equated with war in a direct fashion. They do share certain general properties, which allows for a careful application of the same scientific language. Consequently, the author applied evolutionary biology to joint operations as a specific scientific method but without the specific meanings. The metaphor is well suited to approach joint operations both at macro and micro levels, especially in tracing and explaining change. It helps one assume that evolution equals joint operations, mutation stands for achieving an effect, species represent armed forces and genes stand for individual soldiers.[145] In any case, joint operations stand for a struggle in which on occasion the correct route is discovered, but often it is not, and more often only partially. Friction as outlined by Clausewitz emphasises a constant trial and error process, which plays an important role in the final outcome. There is no straight genetic line in evolution, and also joint operations are full with ramifications and divergences. This requires continuous adaptation, which comes as a result of changing environmental conditions and the unexpected moves of the enemy.[146]

[145] Modelski–Poznanski 1996: 315–319.
[146] Cole 1919: 247–253.

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Chapter 5
Course of Action Development

Comprehending joint operations as a complex optimisation problem in an evolutionary framework requires a shift from mechanics to biology, which emphasises dynamics over statics, time-prone over time-free reality, probabilities and chance over determinism, and variation and diversity over uniformity. The effect-genotype is the foundation for this analogy as biological evolution and joint operations share similarities. Although they cannot be equated with each other, in an evolutionary framework joint operations can be seen as a transforming large-scale system for which biology is uniquely appropriate to trace and explain its bewildering attributes as "men and animals successful in the struggle succeed because they happen to be best suited to their surrounding conditions, whether those conditions are simple or complex, high or low".[147]

Mixing principles

The joint effects landscape has far reaching consequences on course of action development, too. In order to improve fitness there are two generic mechanisms such as adaptive walk representing efficiency and random jumps representing effectiveness. Both refer to effects and indicate that effects can basically be achieved through two different, but interrelated ways. Due to dynamically changing circumstances, the conduct of joint operations demands the application of both processes in parallel. Consequently, one has to mix them not only to gain, but also to maintain high fitness. Whereas efficiency means climbing and proceeds through adjacent neighbourhoods, effectiveness stands for exploring neighbourhoods sampled far away. Due to the dynamic surface of the joint effects landscape, the exclusion of one process at the expense of the other can easily result in disadvantages negating the prospect for success. The mechanism applied must always correlate with the characteristics of the surface.

Early in the process, the landscape appears to be uncorrelated and displays a surface that mostly denies the advantages of climbing. In order to escape the

[147] Modelski–Poznanski 1996: 315–319; Andreski 1971: 89–92; quotation Ovington 1900: 414; Armstrong–Warner 2003: 1–8.

correlation structure and avoid being trapped on poor local optima, one must jump until a good peak is found and the process of climbing can start again. In other words, one must generate feedback that can be harvested. Thus it is important to act first or do something, then identify and select what works and finally retain only those actions that appear desirable.[148] Only then does an optimisation conducted along some selected dimensions aimed at improving efficiency make sense. However, as one approaches the peak, further climbing becomes increasingly unattractive since the potential benefit to can gain yields less and less in terms of fitness. Sooner or later it is better to jump again until another suitable and exploitable peak is discovered. Much of joint operations is non-linear and as depicted in Figure 7, achieving effects always comes as a combination of effectiveness and efficiency. In joint operations, efficiency means an emphasis on comprehensiveness and not dynamism, in which every move can be planned in advance and in detail.

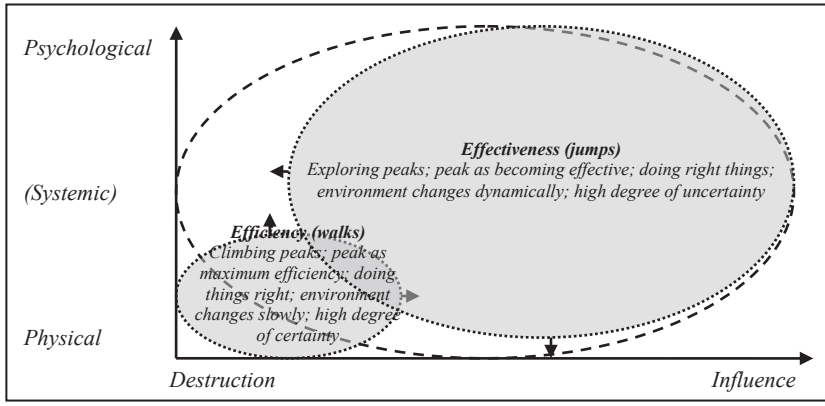

Figure 7. Adaptation in terms of efficiency and effectiveness
Source: Compiled by the author

Flexibility is sacrificed in order to achieve certain desired effects that make the actions focused, streamlined and unified. This is the domain that makes an exclusive top-down deductive approach, attempting to link the strategic and the

[148] Mintzberg et al. 1998: 198.

tactical levels by means of direct causality, possible. Unfortunately, in a constantly changing environment optimisation based narrowing options often do not make sense. In this case, one is better off to seek for exploitable opportunities and is always ready to change and adjust. Instead of relying exclusively on adaptive walks, one must also have the courage to jump right across the landscape to find good peaks. This way no one attempts to impose order, but takes disorder inevitable and assumes that it also affects the enemy. Consequently, there is a great reliance on bottom-up initiatives based on local information, which is in sharp contrast to the traditional mechanical and deductive approach to course of action development. The two processes can be described by two principles. The maximum principle is an approach that allows for reductionism and stands for efficiency. It assumes that peaks can be defined and solutions come as a result of engineering solutions. Optimisation and the drive for perfection make sense since it is possible to focus on single dimensions in order to make things better. Planning and execution are the best means to achieve desired effects. The minimum principle is an approach that attempts to exploit the power of metaphors and stands for effectiveness. It indicates that peaks have to be found first to achieve useful or good enough effects. Solutions mostly come as a result of a messy trial-and-error mechanism. Not control, but coping is possible, which emphasises satisfying and acceptance. Here the focus is on relationships and the way they develop over time and space as a result of adaptation and learning. Armed forces normally put unilateral emphasis on the maximum principle as they mostly employ a one-dimensional approach to course of action development. They see it as an adaptive walk despite the fact that this only reveals narrowing options. The attempt is to realise predefined objectives at every stage and at every level of war.

Meaning of strategy

In order to understand this preference, one must first look at the meaning of the term strategy that is defined in normal English as follows. The rather general version describes it as the science and art of employing political, economic, psychological and military resources in order to achieve maximum support to adopted policies. The more particular and military oriented version describes strategy as the science and art of military command in order to meet the enemy

in combat under advantageous circumstances.[149] For Clausewitz strategy meant nothing more than "the use of an engagement for the purpose of the war".[150] He lived in an age in which the aim of war equalled with a clearly expressed political purpose. However, this rational causal construct with a clear and concise subdivision of military means to political ends did not hinder Clausewitz to emphasise that in strategy "everything [had] to be guessed at and presumed".[151] For him, strategy meant a unifying structure to the entire military activity that decided on the time, place and forces of the enemy with whom the battle had to be fought. Consequently, its importance came as a result of "numerous possibilities, each of which [would] have a different effect on the outcome of the engagement".[152] The sheer number of possibilities explains why he equated strategy with surprise and argued that "no human characteristic appears so suited to the task of directing and inspiring strategy as the gift of cunning".[153] Although Clausewitz regarded the political aim the ultimate goal of war, he equally argued that the multitude of conditions and considerations prohibits its realisation through a single act. As a result, the political end must be decomposed into military means of different importance and purpose. This instrumental focus explains his conviction that "only great tactical successes [could] lead to great strategic ones" and his claim that in strategy "there [was] no such thing as victory".[154] Political results on the strategic level could only come from victories fought on the military tactical level. The more the politics on the strategic level is able to exploit military victories gained on the tactical level, the greater the success. This was the very reason for him to claim that in strategy "the significance of an engagement is what really matters".[155] Despite all the merits and contribution of Clausewitz to the theory of war, in terms of the joint effects landscape his rather narrow approach to strategy and course of action development to realise it appears to be too narrow for the unfolding 21st century. Being a theorist of the early 19th century, he regarded politics as the supreme reason which tamed and canalised the conduct of war. However, his strong influence on Western military thinking resulted that the common understanding of strategy locked in as a link between military means

[149] Gove 1981: 2256; Brodie 1949: 475–478.
[150] Clausewitz 1989: 207.
[151] Clausewitz 1989: 211.
[152] Clausewitz 1989: 228.
[153] Clausewitz 1989: 238–239 (quotation 238).
[154] Clausewitz 1989: 242, 247, 268–271, 434–462 (quotations 270, 434).
[155] Clausewitz 1989: 617–638 (quotation 617).

and political ends, or in a more generalised version between cause and its effect. Strategy in general stands for a scheme for making one to produce the other. It is understood as a plan that rests on clear cause-and-effect relationships to use available military means in order to achieve certain political ends. It provides a rationale for those actions that help realise political goals. Strategy is seen as a rational or planning activity that relates means to ends in a focused and rigid manner despite the fact that in most cases strategy might change in case new means become available or different ends appear to be preferable.[156] Non-linearity stands for the brake-down of ends-means rationality. As an example, irregular, low intensity and asymmetric warfare such as counterinsurgencies are inherently non-linear phenomena, in which both the formulation of political goals and the application of military means are influenced by the interplay of so many factors that an approach based on rational planning has limited utility. In these cases strategy does not resemble similarity with an elegant forced march, but appears as a messy and painful trial-and-error process in the form of muddling through. The joint effects landscape also indicates a dynamic process in which military means and political ends of the participants can become confused. The result is that the means employed and the ends achieved cannot always be delineated sufficiently. The constantly changing surface of the joint effects landscape best addresses the increasing complexity and challenges posed by various irregular forces such as globally networked terrorist organisations not possessing traditional boundaries. Thus, a more organic approach is needed that takes emergent and self-organising attributes better into account.[157] Despite the non-linear character of joint operations, the traditional military approach to course of action development can be best described as engineering. It is seen as a rigid model that rests on ends-means calculation in which one attempts to synchronise between ends sought and means applied. A clear definition of ends is followed by a proper organisation of available means for which objectives are set, options narrowed and choices made. Thus course of action development is appraised in terms of ends rather than means and assumes deliberate, rational and goal-attaining entities. Goals are articulated as objectives and come as a result of a general consensus. They are assumed to be ultimate, identified, well-defined and sufficiently few to make them both manageable and measurable. The focus is on how well those specific and established objectives are achieved at every

[156] Betts 2000: 5–6; Builder 1989: 47–52.
[157] Mintzberg–McHugh 1985: 160–162.

level of military operations.[158] Course of action development is objectives-based that emphasises a calculated relationship between ends, ways and means in which ends represent the objectives sought, means the available resources and ways the concepts that attempt to organise and apply resources in a skilful way. As Clausewitz stated "the subjugation of the enemy is the end, and the destruction of his fighting forces the means".[159] It fits very well into the traditional strategy equation below.

Strategy = Ends + Ways + Means

Ends are equivalent to military objectives, ways to military force employment concepts and means to military resources. Strategy focuses on ways in order to employ means to achieve ends. It is a plan of actions in a synchronised and integrated framework that helps achieve various objectives on theatre, national, multinational and Alliance levels.[160] This framework indicates the military as a self-sufficient system that contains the necessary means both to determine and attain objectives. Planning is seen as a balancing act between the two, enemy opposition is often regarded as something that falls outside the system. It is seen as an environmental peculiarity that can be overcome. The enemy is simply not allowed to affect clear reasoning, drawing up and pursuit of objectives. Joint operations are often subdivided into various headings such as strategy, operations and tactics, and often competence in one area does not mean competence in the other. The military is seen as a rational machine in which decisions are governed by prediction and control. High degree of stability and calm is required in order to provide a basis for the rational patterns of orders as the total body of available information is analysed and reduced. Joint operations are a series of discrete actions in which events come in a visible and serial sequence. Strict military discipline makes it possible that "nothing occurring in the course of its execution should in any way affect the determination to carry it out".[161]

[158] Feld 1959: 15; Beinhocker 1999b: 53; Robbins 1987: 31–32; Pirnie–Gardiner 1996: 3.
[159] Clausewitz 1989: 637, 697 (quotation 637).
[160] Dorff 2001: 11; Lykke 2001: 179–180; NSO 2017: 3-1–3-2.
[161] Warden 1989: 1–6; Wylie 1967: 24, 84; Feld 1959: 16–21 (quotation 21).

Promoting inflexibility

The fundamental design of this approach contains neatly delineated steps with objectives placed at the front end and operational plans at the rear. The process of planning starts normally with setting objectives as quantified goals, followed by the audit stage in which a set of predictions about the future is made. Predictions delineate alternative states for upcoming situations, which are also extended by various checklists. In the subsequent evaluation stage the underlying assumption is that similar to firms that make money by managing money, armed forces can make war by managing war. Several possible courses of action are outlined and evaluated in order to select one. The following operationalisation stage gives rise to a whole set of different hierarchies, levels and time perspectives. The overall result is a vertical set of plans containing objectives, allocation of resources, diverse sub- and supporting plans and various action programs. The last stage of scheduling is equivalent to the establishment of a programmed timetable in which objectives drive evaluation in a highly formal way as everything is decomposed into distinct and specified elements. The basic assumption is that once the objectives are assembled strategy as end-product will result. This approach rests on decomposition and formalisation in which course of action development often resembles a strong similarity with mechanical programming.[162] However, due to its linear design this approach can also promote inflexibility through clear directions since it attempts to impose stability. Although everything is built around existing categories emphasising a planned, structured and formalised process, it contains two possible pitfalls. The first is predictability as it presupposes a predictable course of events and an environment that can be stabilised and controlled. Although in joint operations it becomes possible to predict certain repetitive patterns, forecasting any sort of discontinuity is practically impossible. Thus a quick reaction outside the formalised design is often better than the extrapolation of current trends and hoping for the best. The second is formalisation and concerns the formalised process that often detaches thinking from action, strategy from tactics and formulation from implementation. Formalisation requires hard data in the form of quantifiable measures that are often late, thin and aggregated. Course of action development is seen as a semi-exact science in which courses of actions are put into dry numbers. Although such an approach might once have

[162] Mintzberg et al. 1998: 48–63; Mintzberg 1994: 49–67; Mintzberg 1990: 175–180; Cleland 1990: 21–36.

had an advantage when conducting large-scale military operations, it equally can give room for "strategising and artistic expressions by talented generals".[163] In traditional terms strategy is defined by attributes such as "clarity of objective, explicitness of evaluation, a high degree of comprehensiveness of overview, and […] quantification of values for mathematical analysis".[164] These characteristics have been further reinforced by the influx of various scientific tools in the form of operations research techniques that attempt to blend the relative predictability of advanced military technology, modern mathematics and rapid data processing tools. Although such techniques make it possible to estimate the probability of hitting a target with a certain confidence, their power soon erodes when facing problems that cannot be easily translated into quantifiable formulas. Undoubtedly, aggregating military activities into measurable data is technically possible, but the subsequent re-aggregation of analytic results is often unsatisfactory even for the analysts themselves. Consequently, it is at odds with the more complex and constantly changing attributes of the joint effects landscape.[165] Objectives can be described in general as "[a] clearly defined and attainable goal or aim to be achieved".[166] The essence of objectives-based planning that drives course of action development is that higher-level objectives are decomposed into specific tasks and activities down to the lowest possible level. Objectives, tasks and actions are linked hierarchically from top to bottom and across the width and breadth of operations. Clausewitz emphasised that "[n]o one starts a war […] without being clear in his mind what he intends to achieve […] and how he intends to conduct it. The former is its political purpose; the latter its operational objective".[167] Objectives-based planning requires the identification of objectives, the analysis of various courses of actions and ends with a plan. Activities become linked around common elements, and theoretically everybody can see his or her contribution to the overall effort. Obsolete activities can be filtered out and eliminated, activities and resources elaborated based on substitution and

[163] Mintzberg et al. 1998: 64–77; Mintzberg 1994: 257–267; Robbins 1987: 32–33; Beinhocker 1999a: 96; Smalter–Ruggles 1966: 69–74; Mintzberg 1990: 191–193; (quotation Dawen 2004: 27).

[164] Quotation Lindblom 1959: 80.

[165] Millett–Murray 1988: 84; Farjoun 2002: 562–563; Mankins–Steele 2006: 76–80.

[166] Quotation Allied Command Operations 2021: 1–16.

[167] Quotation Clausewitz 1989: 700.

scarcity.[168] Forces are tasked to achieve objectives, which constitute the backbone against which joint operations and campaigns are planned, executed and assessed. It is a Clausewitzian construct in which "series of secondary objectives […] serve as means to the attainment of the ultimate goal".[169] Objectives flow from top to down. National security objectives form the basis for applying national power in order to secure national goals and interest. National military objectives guide the application of military power in various regions of the world. Campaign objectives on a regional operational level guide the successful prosecution of military campaigns. Military campaigns are again decomposed into operational objectives in order to position and deploy forces. Operational tasks and functions serve to achieve operational objectives.[170]

From planning to confusion

Strategy has the basic purpose of linking these levels in a coherent and clear framework since achieving a supported objective is partly a statement of a supporting objective with the result that objectives cascade downwards. This hierarchy defines the weight of effort among objectives over time at one level needed to attain a higher level objective in any given situation. Strategy links the hierarchy of objectives and provides the framework for achieving them. At each level objectives and strategies are accompanied by a set of processes and actions defined by various criteria and constraints. This sort of strategy development places a premium on mass information since the execution requires that those involved have access to all relevant aspects. Unfortunately, due to the frictional, chaotic and complex reality of war information is mostly inaccurate, untimely and incomplete with key pieces missing or hard facts lacking.[171] Objectives were well suited to the traditional levels of modern wars fought during the two world wars. National security objectives and national military objectives are on the strategic level, expressed in political-military terms and serve as a framework for the conduct of campaigns and major operations on the operational level.

[168] Kent 1983: 3–15; Smalter–Ruggles 1966: 64; McCrabb–Caroli 2002: 30–34; McCrabb 2002: 6–7.
[169] Quotation Clausewitz 1989: 228.
[170] Thaler–Shlapak 1995: 5–7; Kent–Simons 1991: 10–15.
[171] Thaler–Shlapak 1995: 8–12.

Tactical level battles and engagements are fought in order to achieve higher level objectives. Thus objectives at each level are linked to a source or actor within the hierarchy. They proceed from the general towards the particular in a deductive fashion until those actions that help attain higher level objectives are identified. This hierarchical design puts emphasis on vertical relationships despite the fact that some aspects may be well understood and quantifiable, but some more remain uncertain. The broad assumption is that lower-level objectives help attain objectives on a higher level as the output from one objective serves as input for others.[172] Although objectives-based planning presupposes that objectives are defined in a clean and coherent way, there is always a risk that the hierarchical order breaks down. The complexity of the challenges of the unfolding 21st century can also result that one might increasingly witness situations in which national military objectives are not articulated in a sufficiently clear and concise way. This hinders the proper articulation of campaign objectives, which again cannot contribute to coherent operational objectives. The result is that the entire process shifts towards hedging against the worst case, and ends up with completely inappropriate options. A good example for confusion of this kind was the bombing campaign during Operation Allied Force in which the final campaign plan, with its phased and incremental nature, left the planners mostly confused regarding the effect their actions should have on the enemy.[173] Unfortunately, fighting irregular forces of non-state actors or terrorist organisations means the involvement into asymmetric conflicts. It will be increasingly difficult to identify useful and coherent objectives that can guide military actions as often what appears to be desired might change under reconsideration. Although an adequate intelligence support infrastructure is a prerequisite for selecting an appropriate course of action to support strategy, the feedback loop required for planning, execution and assessment can easily break down. The result is that accurate information does not flow rapidly with consequences ranging from superfluous repetition of actions to dangerous negligence.[174] Despite the supposed neat and streamlined design of objectives it is most likely that in the unfolding 21st century the absence of clear guidance from higher echelons in the form of objectives will increasingly become the rule not the exception. More often, those who should define objectives will be in great need and may demand to get objectives

[172] Pirnie–Gardiner 1996: 3–20.
[173] Polumbo 2000: 6–24.
[174] Thaler–Shlapak 1995: 15–22; Lindblom 1959: 86.

suggested from below. This may pose a crucial challenge in cases in which national- and theatre-level objectives are not well defined or there is no clear causal relationship between military options and desired political results. Due to the complexity involved, the relationship between military means and political ends can either be subject to uncertainties or just poorly linked.[175] The situation political decision-makers and military commanders might face can become so highly variable and change so rapidly that the entire hierarchical design in the form of courses of action gets out of balance, and one should never expect definite and well-understood inputs to objectives. The assumed clear policy guidance in the form of objectives can often be ambiguous as various fields may overlap or become contradictory. Furthermore, policy makers often will have to juggle numerous values simultaneously without always making their rank order clear. Consequently, with a well structured, engineering-oriented, scientific approach it will become impossible to express and describe objectives with the required detail. Another problem is that objectives expressed on the highest level tend to be increasingly abstract. Although they often rely on direct and clear causality, their relevance soon erodes as they move down the hierarchy.[176] As a precaution, often menus of objectives are suggested to provide a certain baseline for times when the expected guidance from above is either insufficient or unclear. Instead of thinking in a single and rigid plan, it is believed that a spectrum of plans forming a pool of various courses of action can provide for useful strategies in case the situation changes, or fails to proceed as assumed originally. However, in terms of the joint effects landscape that displays joint operations as a complex optimisation problem solving process, it is very questionable whether it becomes ever possible to establish a sufficient pool of flexible and non-committal objectives that can cover a vast array of emerging possibilities.[177]

Empirical testing

A good example for practical problems coming from unforeseeable events and confusion can be found in the way NATO's Kosovo Force was deployed in 1999.

[175] Pascale 1999: 88; Lindblom 1959: 82–83.

[176] Thaler–Shlapak 1995: 37–41; Pirnie–Gardiner 1996: 21, 79–83; Pascale 1999: 91; Betts 2000: 13; Richards 1990: 222–224, 232.

[177] Wylie 1967: 84–85.

Despite heavy bombings and the assumption that advancing troops would find demoralised Yugoslav troops, the reality turned out to be different. Yugoslav troops withdrew from the province in a disciplined manner verifying the fact that even if *n* possible scenarios can be identified, the actual would always be an *n + 1* that could not be foreseen. Although the original mission was to enforce peace and deter the renewal of hostilities, as time passed the mandate emerged more into the civilian sphere and became essentially vague. Despite all efforts prior to the deployment intelligence gathering was poor and soldiers entering Kosovo faced a largely unknown situation. As General Sir Mike Jackson, then commander of Allied Rapid Reaction Corps concluded, in the end the campaign in Kosovo was lucky to be a success as potential enemies largely complied and took no particular actions to upset the plans. Thus he did not refer to any sort of excellence in terms of planning and execution. Clear and concise instructions regarding the UçK were mostly lacking, oral instructions were unclear and not confirmed in writing. Especially in the beginning, local commanders were forced to defuse the situation on a learning-by-doing basis in ad hoc arrangements in the field. Regarding other aspects of the mission KFOR soldiers were also left mostly in the dark as to how law enforcement had to be addressed. Thus they had to fill a vacuum and often had no idea on how to do it. Only five weeks after the first troops entered Kosovo, was General Jackson able to formulate at least his intent in broad terms to guide commanders down to company level and to achieve some sort of unity in KFOR's effort.[178] The joint effects landscape indicates that course of action development based on objectives is a maximising approach since the emphasis is to control everything that may happen on the landscape. Despite the discrepancy between the relative rigidity and linear character, and the increasing complexity of situations found in most out of area operations, the temptation to stick to this approach is still strong. This explains why linear and causality-based force employment concepts are still at the heart of course of action development. Often the emphasis is on the explicit linking of strategic-level objectives with tactical-level effects instead of seeking for opportunities to find new approaches to course of action development.[179] The biggest shortcoming of the objectives-based approach is its limited ability to adapt, which is discouraged as much by the articulation of objectives as by the separation between formulation and implementation. Despite the claim of being flexible, its very essence is to

[178] Brocades Zaalberg 2006: 289–340.

[179] Ho How Hoang 2004: 42–54; McCrabb 2001: 35; NATO Strategic Commanders 2003: 15.

realise specific objectives. Hence the focus is on realising rather than adapting objectives. Focusing on objectives is quantitative since it mostly deals with static states and not the transitions between possible states. It is a step-wise and incremental approach that proceeds hierarchically through the various levels of war, despite the fact that such links can become weak or even disappear as joint operations unfold. The joint effects landscape indicates a dynamic and constantly changing coevolutionary process, in which events are also influenced by what common wisdom would term external circumstances or just luck. It is often mentioned that a comprehensive understanding of objectives is needed, which requires that commanders must look at both above and below their respective levels.[180] This demand can easily put commanders under increased pressure and lower overall performance. Objectives-based planning attempts to see the end from the beginning and by going into ever finer detail it reflects linear causality. Unfortunately, joint operations seen as a complex adaptive system indicates that much of the continuum is non-linear and messy. Conceptualising joint operations in the framework of the joint effects landscape has serious consequences as objectives-based planning claims to identify single peaks and the path leading to those peaks despite the fact that the surface changes dynamically and in an unpredictable way. By going step-wise through the tactical, operational and strategic levels, objectives-based planning suggests that objectives simply add together and joint operations can be seen as a sum, and not the product of many factors. Instead of creating options and opening up new possibilities by discovering niches, objectives-based planning shuts down or at least limits the chance of exploiting emergent opportunities. Objectives-based planning thus means that one "pursue(s) relatively singular strategies and thus occup(ies) only one spot on the landscape", but does not employ any mechanism that provides for protection "when the landscape unexpectedly changes".[181]

[180] Mintzberg–Waters 1985: 261, 270; Pirnie–Gardiner 1996: 79–83; Senglaub 2001: 7–8; Chakravarthy 1997: 77; Lykke 2001: 184.

[181] Quotations Beinhocker 1999a: 100, 102.

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Chapter 6
Learning and Adaptation

Clausewitz's contribution to strategic thinking is unquestionable. However, his goal-seeking approach excludes a whole range of other aspects such as logistic, social and technological issues, which must be considered equally important in joint operations. This focus should not come as a surprise since he believed that every human activity is a rational undertaking and governed by reason. This also explains why he understood strategy as an objective-oriented, goal-seeking phenomenon.[182] His approach dominated most of the 20th century military thinking and is still dominant today. However, the unpredictability of joint operations indicates clear problems. Despite the neat and clean logic behind, planned strategies often resemble gambling. Although they rely on planning and careful evaluation of numerous factors, it is impossible to predict in advance which risk is more reasonable in selecting a particular course of action. Thus there will always be a certain error in the estimation regarding what we know and what we expect. The inherent contingency of joint operations limits the ability to control causes sufficiently well in order to produce desired effects. Friction, chaos and complexity include the probability of failure since they provide only for an insufficient basis for any estimate regarding odds. Strategic calculation is by definition vague, which also limits the possibility of causing intended effects. The personal character of decision-makers often distorts strategy. Thus power is as much applied for manifest political purposes as for subliminal personal ones, which can heavily influence the link between military means and political ends. Strategic decisions always go through non-logical filters such as bias and prejudice. Thought processes are influenced by cognitive constraints, which limit the decision-maker's ability to see or calculate linkages between causes and effects in a comprehensive way. Conscious calculations can often be non-rational as decision-makers tend to see what they expect to see. Strategies, especially coercive ones aimed at influencing will depend mainly on communication. However, due to cultural blinders the receiver often cannot hear the message sent by the signaller. Logical strategic calculations only have reference within their own cultural context. As detailed earlier, normal operational friction can significantly influence the way plans are executed and decouple assumed

[182] Howard 1979: 975; Millett–Murray 1988: 84; Ehrenreich 1997: 7.

causes from expected effects as coercive signals that depend on coupling often collapse. Through deflection the process of implementing stated political goals can often be influenced, even resisted, by established organisational routines. Habits and interests can distort the way means are applied with the result that stated objectives become closer to parochial priorities that reflect organisational stability rather than larger political aims. Strategy has the purpose of shaping the courses of action that suit policy. Unfortunately, the enemy does not co-operate, but opposes any neat and clean execution of plans and realisation of courses of action. Thus, the proper sequence of causes and effects is usually disturbed or reversed and does not unfold according to expectations. Opposing preferences also constrain options since they require compromise, which is useful politically, but can be harmful militarily. Political compromises can result in military half-measures that serve no strategic objectives. Such options can be acceptable to all, but ideal for none since not doing or over-doing is often better than doing something in-between.[183]

Strategic wisdom

In most cases attempts to realise objectives can become an illusion, although sometimes they might work and under fortuitous circumstances they might even work quite well. As depicted in Figure 8, despite all efforts to carefully plan and conduct joint operations, the continuum of war does not exclude blunt one-sided conventional attrition campaigns. In other words, brute-force campaigns involving impunity of the stronger can often be equally effective. Asymmetric warfare, complex contingencies, irregular combat fought in urban areas or on difficult terrain always constrain the ability to find and target the enemy and can turn joint operations into a very hard and frustrating process.

The enemy raids, evades, subverts, submerges and withdraws, which both confuses carefully selected objectives and desired effects thus negating the realisation of a planned course of action. In a complex environment involving a multitude of players and motives, strategic wisdom can be more important than any formalisation, which makes strategic success very costly and in some cases impossible. The most difficult and painful aspect of confronting an enemy has traditionally been learning, adapting and embedding the lessons learned into

[183] Betts 2000: 8–40, 43–44.

the collective memory of the armed forces. Learning on the battlefield is a nasty business that does not provide for a clear and distinct picture. It was mentioned earlier that a complex adaptive system stands for polarities to manage rather than problems to solve. Thus course of action development must rest not only on traditional constructs such as plan, implement and pursue, but also on constructs that emphasise the impact of changing battlefield conditions. Unpredictability of joint operations indicates that the character of the enemy, the threat and the environment constantly change in a difficult-to-comprehend and complex way as the continuum displays both linear and non-linear attributes.[184] The author does not claim that there is no need for deliberate planning anymore, but emphasises that it is equally important to take emergence and self-organisation into account as even most sophisticated models cannot predict the reality with all its variables. An approach that emphasises exclusively the realisation of clear goals stated in the form of desired effects and demands to "assess […] strengths and weaknesses, plan systematically on schedule, and make the resulting strategies explicit are at best overly general guide-lines, at worst demonstrably misleading precepts to organizations that face a confusing reality".[185]

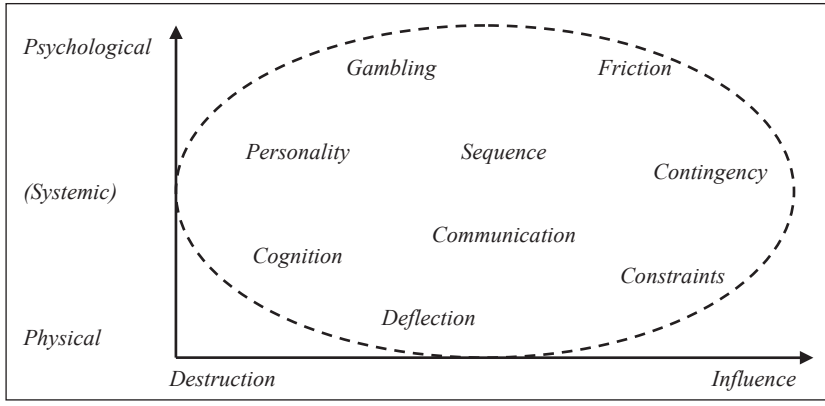

Figure 8. Elements of unpredictability in war
Source: Compiled by the author

[184] Millett–Murray 1988: 85–93; Grant 2003: 506.
[185] Quotation Mintzberg 1978: 948.

Objectives have the function to avoid confusion by reducing possible internal tensions as they make things focused, streamlined and quantifiable. However, one important consequence of the joint effects landscape is that due to the constantly changing surface it is difficult to see the end from the beginning. The result is that no one can predict the long-term changes in the environment with any accuracy."[186] The joint effects landscape indicates that it is impossible to see the shape the future will take as there is not one predetermined future, but many possible. Although in traditional terms strategy relies mostly on linear cause-and-effect relationships, if the dynamics of the joint effects landscape blur temporal and spatial dimensions, such an approach is simply inappropriate. An evolutionary approach to course of action development stands for creativity, constant change, evolving situations and limitations regarding comprehension, prediction and control. Conditions found in joint operations do not provide for safe havens or free lunch and any strategy that rests on prediction and planning is marginally helpful at best and downright dangerous at worst. Dynamic interactions cannot be engineered and controlled in a mechanistic way. Much depends on chance as possibilities always emerge and form a broad spectrum. Narrow predictions in the form of objectives indicate an entirely wrong mind-set for a phenomenon that is inherently unpredictable.[187] The joint effects landscape does not stand for certainties, only for possibilities in the form of options. Any strategy, which aims at harnessing emergence and self-organisation must refocus from prediction and rationality. The various events and activities that influence and determine the course of action development require a different approach.[188] The belligerents are forced to create or track emerging opportunities that can be exploited rather than to realise objectives of a predefined and analytically elaborated plan. An evolutionary approach to course of action development demands flexibility, robustness, learning and adaptation. Although they do not help reduce uncertainty, but help exploit the constantly shifting opportunities it contains.

[186] Quotation Williamson 1999: 118.
[187] Pascale 1999: 84–90; Courtney et al. 1997: 66–69; Beinhocker 1999a: 96.
[188] Macintosh–Maclean 1999: 298–290; Moncrieff 1999: 273–276.

Flexibility and robustness

With the joint effects landscape one can address the various revolutions that have taken place in the field of military affairs, technological developments and information processing capabilities all blurring traditional strategic boundaries.[189] In case of asymmetric and complex challenges, the three traditional levels of war often merge into a single integrated universe in which actions at the lowest level cause dramatic changes that ripple upward simultaneously. Although the joint effects landscape denies prediction, it appreciates the power of evolution. It calls for an approach, which is more robust and adaptive than a traditional strategy formulation with a narrow focus. From a traditional point of view, these strategies may not be optimal in every scenario, but they can survive under a wide array of changing circumstances and always keep options open over time. In order to minimise irreversible commitments they refocus from certainty, efficiency and co-ordination by offering flexibility and a higher probability of overall success instead. A bottom-up, emergent course of action development is powerful enough to account for the uncertainty of joint operations and the probability of different potential outcomes. Emergence indicates that selection pressures internally can better address external selection pressures that come from an ever-changing environment. Robust emergent strategies acknowledge that nothing is just out there as a separate entity since everything is created through a constant coevolution. Emergent course of action development stands for open strategic options and the possibility of various paths that can better contribute to a rapid change of directions as events unfold.[190] The author detailed earlier that in complex adaptive systems causes and effects are separated in time and space. Focusing on objectives and desired effects means putting on blinders as one normally looks either for the most immediate or the most obvious cause. There are many hidden trigger points that are responsible for the extremely fluid and haphazard conditions, which so often turn confusion into the very essence of war.[191] Robust and emergent strategies can better address problems in which threats are diffuse, uncertain and unpredictable, and make it increasingly impossible to "skilfully formulate, coordinate, and apply ends, ways, and means".[192] The joint effects

[189] Chakravarthy 1997: 69; Quinn 2002: 96.
[190] Quinn 2002: 96–105; Dent 1999: 13; Williamson 1999: 118; Luehrman 1998: 90–91, 95–96.
[191] Geus 1988: 74; Warden 1989: 1–6; Feld 1959: 16–18.
[192] Beinhocker 1999b: 49–55; Chilcoat 2001: 203–208 (quotation 207).

landscape indicates a profound difficulty in foreseeing the course of action to take since in dynamic and non-linear settings effects do not always directly follow causes. Creative and evolving belligerents are capable of initiating conditions that are far from equilibrium, and defy assumptions regarding clear causality. Dealing with emergent strategies can cause internal tensions that seem to be inefficient as the simultaneous pursuit of contradictory paths runs counter to a traditional understanding. However, they can leverage core skills and assets by creating various options, possibilities and choices. The joint effects landscape reminds us that it is better to accept conditions of unpredictability and constant change in which strategy formulation is not an exclusive mechanical downstream business, but something that can also emerge. Emergent strategies never assume that a particular input produces a particular output, but indicate probabilistic occurrences within the domain of focus.[193] Strategy formulation in traditional terms relies on the assumption that the enemy is known and rational. However, the continuum of joint operations is full of corrections where the pursuit of objectives on a once-and-for-all basis is mostly impossible and success often comes as a result of actions that respond to changing circumstances. Emergence stands for constant adjustments especially in the case of incomplete and changing information. It also indicates that in the dynamic and ever-changing environment of joint operations a bottom-up inductive approach can often be more helpful than the pursuit of a top-down master plan.[194] Effects always interact in a dynamic web of relationships and show all sorts of different and intricate behaviour. Their interactions and couplings often result in conflicting constraints that defy the logical rigor behind any sort of assumed causality. Although emergent strategies are of little help in predicting the future, they can be a valuable aid in promoting insights into how to become a good evolver. Traditional strategy formulation requires clear statements in the form of objectives. The frictional, chaotic and complex reality of joint operations stands for a variety of possible futures in which objectives and desired effects, however clearly and concisely stated, can perform badly. Emergent strategies often conflict and are intrinsically difficult to manage, but the greater the uncertainty, the greater their potential value. They do not presuppose the identification of the most or least likely outcome, but cover a broad array of possibilities as they evolve over time with some succeeding and some failing. Thinking about joint operations in terms of a complex adaptive

[193] Pascale 1999: 84–88, 90, 94.

[194] Wildavsky 1973: 134; Wall–Wall 1995: 4–19.

system indicates that victory is less the result of a sustained competitive advantage, but more of a continuous development of learning and adaptation aimed at exploiting temporary advantages. The emphasis is on keeping things that work in order to maintain sufficient variation based on innovation and novelty.[195]

Adjustments and compromises

Evolution is full of adjustments that come as a result of learning and adaptation. Both the interaction of the belligerents, and environmental changes influence strategic options by forcing a certain pattern onto the stream of actions. In other words, the frictional, complex and chaotic nature of joint operations brings any strategy formulation closer to a compromise position. Environmental factors neither pre-empt all choice nor offer unlimited choice. They just limit what the belligerents can do, and with learning and adaptation one acknowledges that messages from the environment cannot be blocked out. Evolution means searching for viable patterns or consistency in order to increase flexibility and responsiveness. Learning and adaptation are especially important if the environment is either too unstable or complex to fully comprehend, or too imposing to buck against. They force the belligerents to respond to an evolving reality properly without focusing on a stable and planned fiction. Effects cannot always be assessed a priori, but must be discovered empirically through actions that test where the enemy's strengths and weaknesses are. Emergence and self-organisation surrender control to those who have actual and detailed information to shape realistic courses of action. It is often more important to respond to an unfolding and ever-changing environment than to realise detailed, but inappropriate plans.[196] In a complex adaptive system such as joint operations, significant strategic redirections can often originate in little actions and decisions often initiated by "the foot soldier on the firing line, closest to the action".[197] In joint operations various levels interact and mutually adjust in order to reach consensus. Emergent strategies can arise everywhere and as time passes and interactions with the enemy evolve, some strategies may proliferate often without being recognised or consciously managed as such. Learning and adaptation indicate that strategy development is driven

[195] Beinhocker 1997: 27–36.
[196] Mintzberg–Waters 1985: 268–272; Luehrman 1998: 89.
[197] Quotation Mintzberg 1987: 70–71.

more by external forces and internal needs, than the conscious thoughts of the actors. Emergent strategies break with the traditional understanding of strategy formulation that often relies on the separation of planners and executants.[198] Learning and adaptation stand for the fact that it is sometimes better to let patterns emerge than impose an artificial consistency prematurely by stating highest level objectives and desired effects, and decomposing them into lower level actions and tasks. Those who are in constant touch with the enemy develop their own patterns that can lead to strategy either spontaneously or gradually over time. In a dynamic and changing environment it is not always possible to predict where strategies emerge or plan for them. They often just pop out as the various patterns proliferate and influence the behaviour at large. Thus strategy formulation is often less the result of a conscious and formal process, but more of a collective action that simply spread through. As they evolve through experiments, new directions can be established and exploited, which indicate that it is important to have a climate within which a wide variety of strategies can grow and contribute to a good balance between internal variation and external demand.[199] The joint effects landscape requires responsibility for engendering change and opening up new possibilities. Rapid and continuous responsiveness coupled to a minimum of organisational momentum emphasises a myopic and disorderly process. Similar to the frictional, chaotic and complex reality of joint operations, brilliance often does not come from foresight expressed in a carefully designed plan. A complex adaptive system requires the capacity and willingness to learn and adapt, which mostly come from qualities such as tolerance and commitment.[200] Learning and adaptation stand for trial-and-error and indicate that it is often more important to learn from failures than from success. Although failures are often costly and the temptation to bury and forget is traditionally large, some of the costs can be recouped and a thorough reflection help hidden shortcomings to surface. A sufficiently good decision made in time is often better than to make an excellent decision later. It is often better to fire more shots than to start improving one's aim.[201] Murky battlefield lessons must be put into accurate and perceptive after-action reports in which reporting is consistently honest and the bearer of bad news is not punished. Individuals should be afforded

[198] Mintzberg et al. 1998: 177–198; Feld 1959: 20.
[199] Mintzberg 1989: 213–216; Mintzberg et al. 1998: 196–197.
[200] Mintzberg–McHugh 1985: 191–196.
[201] McGill–Slocum 1994: 74, 79–81; Kanter 2002: 81.

the freedom to fail as only through failure is it possible to experience success. One has to strive for a constant improvement even if everything appears to be well at first sight. As an example Passchendaele was a disaster in World War I because of the "combined effect of the [commander's] tendency to deceive himself; his tendency, therefore, to encourage his subordinates to deceive him; and their loyal' tendency to tell a superior what was likely to coincide with his desires".[202] Structural inertia often prohibits detecting novel ways that might replace existing routines, systems and procedures. Emergent course of action development assumes that those closest to the frontlines know more than the remotely located headquarters, since traditionally "staff information eludes comprehension because it is esoteric; line information because it is trivial".[203] Learning and adaptation mean looking outside our own boundaries of knowledge. Mobilising this knowledge through various forms of interaction is important since it must be ensured that relevant knowledge finds its way to the unit that needs it most.[204] Emergent course of action development might on occasion equal with the conduct of random experiments. However, it requires the readiness to be exposed to evolving interactions and the willingness to learn, even from the enemy. An evolutionary approach to course of action development and strategy formulation emphasises less rationality and more common sense. It indicates strategic wisdom, which comes less as a result of a formalised intellectual knowledge backed by analytically written reports full with abstracted facts and figures, but stands for personal knowledge that comes from an intimate sensing of the situation. Emergent strategy formulation reflects that the frictional, chaotic and complex reality of war forces us to accept surprise and situations of no choice. Thus learning and adaptation mean linking the present with the future through experience, rather than linking the past with the future through analysis.[205]

Peripheral vision

According to a traditional understanding, course of action development is cerebral and formal: therefore, decomposable into distinct steps and checklists.

[202] Quotation Liddell Hart 1938: 346; Mankins–Steele 2006: 78.
[203] Quotation Feld 1959: 18.
[204] Hamel 1996: 75; Lampel 1998: 214–215; Millett–Murray 1988: 89.
[205] Mintzberg 1996: 96–97; Mintzberg 1987: 74.

Objectives emphasise a focused vision, which is mostly elitist and harnesses only a small proportion of the organisation's creative potential. Evolutionary course of action development emphasises emergence, and learning and adaptation. It requires a peripheral vision in order to detect and take advantage of unfolding opportunities as it is insufficient to "preconceive specific strategies, but also to recognize their emergence elsewhere […] and intervene when appropriate".[206] Conceptualising joint operations in the framework of the effects landscape requires to take both options equally into account. By applying the two approaches to course of action development in parallel, one can best exploit the unpredictable mechanism of joint operations. Harmonising internal diversity and external demand means that one can both strive towards perfection as indicated by efficiency, and find attractive opportunities for which effectiveness stands for. Whereas the former presupposes unity of perspective and diversity of purpose, as the planners are assumed to be at the top of the organisation and the executants down below, the latter emphasises diversity of perspective and unity of purpose by acknowledging that strategists can also be found deep in the organisation. Course of action development is distributed widely, reaching even to the peripheries where soldiers are forced to tackle with fewer resources and information, and exposed to factors that often defy ideas coming from the top. In a dynamic and constantly changing environment it is impossible to predict the very places in which useful ideas form; therefore, the net must be cast as wide as possible. From a bottom-up perspective the organisation tends to appear in the form of core competencies rather than a collection of various units and other elements. Integrating both top-down and bottom-up characteristics into strategy development means establishing something like planned emergence or emergent planning. These contradictory terms emphasise course of action development both as a bottom-up and as a top-down process. Whereas the former enables subordinates to exhibit autonomy and flexibility, the latter secures a certain degree of compliance throughout the organisation in order to avoid fragmentation of resources. In contrast to the traditional exclusive focus, this way it becomes possible that voices are heard and options explored since lack of diversity can lead to dogmas requiring little more than compliance.[207] This synthesis broadens both the understanding and provides information regarding constraints in terms

[206] Mintzberg–Lampel 1999: 22; Mintzberg 1987: 74–75 (quotation 75); Hamel 1996: 70.
[207] Hamel 1996: 76–80; Goold 1992: 170; Chakravarthy 1997: 80; Wildavsky 1973: 143–144; Wall–Wall 1995: 63–80; Kanter 2002: 76–81.

of causality. Seeing course of action development as a simultaneous top-down and bottom-up process can help rule out unnecessary factors and define how they complement or constrain one another in space and time. It does not mean that we exclude the possibility to achieve psychological effects. It rather indicates that the conduct of joint operations always requires that based on the context, one focuses as much on destroying the enemy as influencing him. Although this conceptualisation of joint operations is less ambitious, it better takes the frictional, chaotic and complex reality into account.[208]

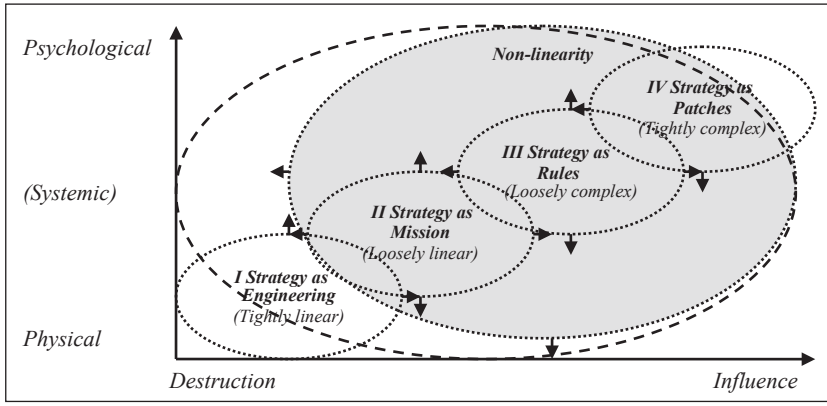

Figure 9. The four various approaches to strategy development
Source: Compiled by the author

In order to detail the consequences of the joint effects landscape in terms of strategy formulation the author introduces three new approaches such as strategy as mission, strategy as rules and strategy as patches. They move away from focusing on predefined and static end-states aimed at synchronising all activities of military forces towards ideas in which diverse elements of an endeavour collaborate simultaneously. The three approaches help cope with dynamic, uncertain and high-risk environments in which neither prediction nor planning is fully possible. Thus they are best suited to situations in which traditional approaches cannot cover all cases as we face situations that are complex and not controllable. As depicted in Figure 9, the more one ventures into non-linearity

[208] Plutynski 2005: 605–607.

the more it is required to expect emergence and self-organisation, and the more flexibility is required. Whereas the first of the three approaches can be seen as the most known and is familiar for many, the two others can be described as rather novel and thought-provoking. The first stands for an attempt to self-synchronise, the second for an attempt to de-synchronise, and the last for an attempt to a-synchronise activities. All three approaches suggest that in case of uncertainty one should not pull the reins to take more control. Increased complexity means fragmented information and often the best thing possible to do is to let things develop. Thus self-synchronisation, de-synchronisation and a-synchronisation stand for fragmented directions, relinquished control and a multitude of possible options. Only this way is it possible to access information and build up a foundation from which to exploit emergence. Although the approaches rely on different mechanisms, all emphasise the need to make choices based on limited information, to stop analysing and start acting even in case of uncertainty, and to learn and adapt that comes from a constant trial and error process. Strategy formulation understood this way makes it possible to become flexible and fluid "able to move one way while responding to local stimuli and changing direction in response to new information from the environment".[209] In other words the emphasis rests on people who are able to think as much in terms of how as in terms of what.

Formulation of strategies

The simplest way of finding the winning edge means that in strategy formulation one combines the higher rhythm generally found at lower levels, with the lower rhythm generally found at higher level in order to achieve a vertical and horizontal harmony within the organisation. This self-organisation indicates that general or larger efforts on the highest level become synchronised with particular activities conducted at lower levels. Empowerment in the form of responsibility and commitment throughout the organisation makes it possible to achieve a rhythm that does not push the organisation into chaos, nor turns it into a rigid monolith. Freedom of action and freedom of execution successfully combine subordinate initiative with superior intent. Whereas the superior's intent guides as it describes broadly the what, the subordinates' actions realise the intent as

[209] Grove 1997: 11–14; Markides 1999b: 40; Markides 2003.

best as possible since they stand for the how. Effectiveness expressed by what and efficiency expressed by how overlap and result in synergy. The process successfully combines long jumps and adaptive walks, which are the two parallel mechanisms of the joint effects landscape. Whereas the superior's intent describes the region in broad terms, the subordinates' actions aim at finding both path and peak within the region. In case the subordinates discover high peaks within the region, the inherently flexible relationship throughout all levels allows for a quick readjustment. Self-synchronisation also means that orders are not orders in a linear, classical and rigid way. The subordinates have the right to question the feasibility of the mission if they feel that the superior's ideas are not in accordance with the existing situation or no adequate resources are available. However, after an agreement is reached on what should be achieved the superior has every right to expect the mission to be carried out. This way it becomes possible to minimise loss of cohesion in the overall effort. Coupling bottom-up initiative with top-down intent enables military organisations to adapt to changing circumstances.[210] Strategy formulation as mission capitalises both on elements of deliberate planning, and learning and adaptation. It comes as the result of a dialectic process "generating both disorder and order that emerges as a changing and expanding universe of mental concepts matched to a changing and expanding universe of observed reality".[211] The process enables the organisation to dwell successfully at the edge of chaos facing no clear boundaries, a predictable opponent, or a future for which it can plan. As the situation becomes increasingly non-linear one must further lessen the approach to strategy formulation in terms of ends/means rationality. Only this way will it become possible to gain the required level of flexibility. Complex challenges and asymmetric warfare emphasise simplicity, organisation and proper timing. Nothing is more important than moving quickly, taking advantage of emerging opportunities and rapidly cutting losses.[212] Joint operations are extremely fluid in which a simple focus aimed at increasing flexibility is more useful than any overly detailed and difficult-to-revise plan. Although uncertainty is associated with lack of prediction, it also means abundance of opportunities that can be captured, exploited, or dropped should they fail to develop accordingly. Increased flexibility comes from a few critical strategic processes guided by a handful of rules that can

[210] Boyd 1986: 66–79.
[211] Mintzberg 1987: 69–70; Mintzberg–Waters 1985: 271–272; quotation Boyd 1976.
[212] Wylie 1967: 57–64.

define directions without confining them. They delineate only a few parameters within which the organisation tries to keep pace with the flow of opportunities. Simple rules make possible to screen and exploit opportunities and allocate resources to areas in which they are the richest.[213] Strategy formulation as rules indicates that the organisation follows the velocity of emerging, colliding, splitting and declining opportunities. The emphasis points towards mobility, modularity and scale as displayed by a Chinese folk rhyme drawn up by Mao and Zhu: "[When the] enemy advances, we withdraw, [When the] enemy rests, we harass, [When the] enemy tires, we attack, [When the] enemy withdraws, we pursue."[214] Strategy formulation based on simple rules addresses best the nature of joint operations, which cannot easily be explained by traditional notions since "any form of unstructured raiding qualifies".[215] Simple rules stand for a constantly evolving strategy formulation, which is normally considered unattractive in traditional terms. However, in a dynamic and continuously changing environment posed by joint operations a strategy formulation based on simple rules can better seize unanticipated and fleeting opportunities, should circumstances change. They not only provide for a just sufficient structure, but can also better capture and exploit the best regions of the joint effects landscape. Simple rules help define processes, boundaries, priorities, timing and exit should efforts fail to succeed. Process rules describe the way key features are executed in order to keep everything sufficiently organised to seize emerging of opportunities. Boundary rules help define which opportunities are within or outside the focus. A quick check of such rules helps sort through emerging opportunities as within the boundaries everything that looks promising can be pursued. Priority rules help rank the opportunities accepted in order to allocate precious resources. They help profit from nascent and highly attractive niches. Timing rules set the rhythm of key processes and help become synchronised with the best opportunities in order to move quickly towards new ones should they emerge. Exit rules make possible to scan emerging, converging or more promising niches and help pull out from opportunities should they fade.[216] Strategy formulation as simple rules does not indicate that objectives are useless, but in a constantly changing environment learning from experience often makes more sense than pursuing

[213] Brown–Eisenhardt 1998: 32–33; Eisenhardt 2002: 89–91; Grant 2002: 516–518.
[214] Hammes 2004: 46.
[215] Luttwak 2001: 152–157 (quotation 152).
[216] Eisenhardt–Sull 2001: 107–112.

predefined objectives that become either inappropriate or cannot be achieved. Simple rules often grow out of experience and mistakes. They might often exist already in some implicit form until they become explicit, and extend into stated objectives and desired effects. Although simple rules can provide for flexibility, one should never forget that in a dynamic and constantly changing environment posed by joint operations, it is impossible to predict how long an advantage will last.[217] Due to the frictional, chaotic and complex reality of joint operations it is very difficult to deliver timely, concise and appropriate objectives that can address the continuum of events. Unlike objectives, rules do not focus on static states, but by going better with the flow of events they can help find opportunities more effectively. It is a commonplace to state that military operations are often conducted under circumstances in which the amount of available information can become zero. However, even in such cases commanders must provide guidance to subordinates. For this reason three simple rules are often proposed such as "capture the high ground, stay in touch and keep moving".[218] The joint effects landscape depicts joint operations as a hard, conflict-laden task in which many factors interact as the result of internal and external constraints. In case the amount of constraints is extremely high one faces a very rugged landscape that does not allow for finding good peaks. In such landscapes new opportunities can always open up, sometimes converge, occasionally explode or just fade away. Consequently, the match between strategic directions and emerging opportunities constantly falls out of alignment. Finding the optimal solution in the form of desired effects is very difficult as there are many possible optima in the space of possibilities. However, conflicting evolutionary strategies are both distinct and modular as they can stand either alone or constantly re-map onto evolving opportunities.[219] Under such circumstances, course of action development resembles similarities with patches in a quilt in which the quilt equates with the joint effects landscape as a whole, and the patches represent various regions. Whereas in the traditional top-down approach strategy formulation is defined by the entire quilt, emergence happens optimisation first within the patches themselves. Although patches do not overlap, across their boundaries there are couplings in the form of epistatic interactions. Due to the underlying dynamism any selfish optimisation deforms the surface of other regions. A good solution in one patch might help solve problems

[217] Eisenhardt–Sull 2001: 112–115; Mintzberg 1989: 25–42.
[218] Quotation Snowden 1999: 19.
[219] Brown–Eisenhardt 1998: 226–231.

in some of the adjacent patches. By means of constant learning and adjustments, the patches can eventually gain the right size and settle down exactly on the winning edge poised in the transition between the two extremes, order and chaos. Whereas a single focused and carefully planned top-down strategy formulation freezes into rigid and poor compromise solutions, an exclusively bottom-up emergent strategy formulation churns chaotically.[220] Despite the errors made during the process of selfish optimisation, finding the optimum patch size equals finding the right strategic direction. Finding the right effects and exploiting them comes as a result of mutual and constant adjustments. Aggregate patchwork strategies seem to be valuable for two reasons. They make it possible to achieve good compromise solutions under conflicting constraints, and also help track moving peaks very well should the environment change quickly.[221]

Importance of means

Success in joint operations comes as a result of a phase transition in which one does not settle into a stable equilibrium nor falls entirely apart. This requires a mix of strategies that are rigid enough to organise change, but not too rigid to prevent change. Joint operations as a complex adaptive system indicate that often the central challenge in strategy formulation is to manage change. One must always be prepared to accept rapid and unpredictable changes that require the emergence of various semi-coherent strategic directions. Accepting surprise, making moves, observing the results and continuing with the ones that seem to work are inherent features of joint operations. There is simply too much going on, which does not allow every move to be orchestrated from the top, but often require uncontrolled and parallel actions. Strategy formulation must happen both at the top at headquarters and below at the front lines. According to traditional measures such an approach means short-term inefficiency based on duplication and misfit. However, addressing the challenges posed by a complex adaptive system requires strategies that are not based exclusively on causal assumptions. They must be built as much by top-level competence as by empowered individuals on lower levels who rely on expanded access to local information. The dynamic interaction with the enemy requires the elimination of unnecessary constraints.

[220] Kauffman–Macready 1995: 26, 36–41.
[221] Kauffman 1995b: 127–129; Kauffman et al. 2000: 141–143, 162–164.

This way it is possible to exploit to our advantage the increased uncertainty and complexity that are normally associated with the conduct of joint operations.[222] Success and failure often rest on the shoulders of junior personnel down to the lowest level. By being closest to the events they have to make the right decision at the right time without any direct supervision. This requires an atmosphere that promotes agility, information sharing and peer-to-peer relationship in which everyone is empowered to do what makes sense. Thus one needs to redefine the individual, the relationship between the individual and others, and between the individual and the organisation. This makes it possible to successfully allocate responsibilities and resources. The particularity of time, place and the task defines who takes charge since empowerment means greater bandwidth of actions including even multi-tasking. Organisations can best take advantage of fleeting opportunities by making the most of available resources. Although such strategies are not optimal for accomplishing pre-defined objectives and desired effects all of the time, they can deliver more innovative solutions to problems at hand at any given time.[223] Seeing joint operations as a complex adaptive system does not mean that there is no longer a distinction between those who lead and those who are led. Leadership will still play an essential role, but "instead of fusing individual into a mass through the suppression of their individuality and the contraction of their thought, the lead […] only has effect, lightning effect, in proportion to the elevation of individuality and the expansion of thought. For collective action it suffices if the mass can be managed; collective growth is only possible through the freedom and enlargement of individual minds. It is not the man, still less the mass, that count; but the many".[224] Regarding cause-and-effect relationships in war "bad means deform the end, or deflect the course thither"; therefore, the only thing left possible is to acknowledge that in complex situations "if we take care of the means the end will take care of itself".[225] In a similar fashion also Helmuth von Moltke emphasised that "[i]n war it is often less important what one does than how one does it".[226]

[222] Brown–Eisenhardt 1995: 7–15; McGill–Slocum 1994: 85–86.

[223] Alberts–Hayes 2003: 5–6, 175–177, 179–200, 213–222, 223–231; Krulak 1999: 14–17; Fast 1997.

[224] Quotation Liddell Hart 1938: 356.

[225] Quotation Liddell Hart 1938: 357.

[226] Quotation Howard 1989: 33.

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Chapter 7
Command and Control

There are many technical arguments to use certain properties of biological evolution for a better understanding of the internal mechanism of joint operations seen as a complex adaptive system. A conceptualisation in the framework of the joint effects landscape requires a fundamental shift in the way one thinks about course of action development and strategy formulation. This conceptualisation acknowledges that despite best intentions, the achieved effects do not always represent a global optimum. Problems of unclear causality and lack of prediction cannot be solved by an allegedly better or more superior way. Unpredictability together with the frictional, chaotic and complex reality of war will remain valid factors in any kind of future joint operations. Variability of performance is not a sign of failure that can be eliminated. It is an inherent feature of coevolution and also that of war.[227] The joint effects landscape helps conceptualise joint operations as a conflict laden task in which one always has to deal with conflicting constraints, which makes it very difficult to strive towards predefined objectives and desired effects. Joint operations perceived as a complex adaptive system indicate that deductive thinking aimed at detecting clear causality only narrows options and does not address emergence and self-organisation. The traditional top-down approach to strategy formulation does not come as the result of a continuous coevolutionary process. Joint effects landscape as a framework not only profoundly influences the way strategy formulation should be approached, but implies further consequences in terms of command and control, and regarding the meaning of military efficiency and effectiveness.

Circular causality and cybernetics

In NATO terminology command is defined as the authority vested in an individual to direct, coordinate and control military forces. It stands for the way a commander impresses will and intentions on subordinates to achieve particular objectives. Command encompasses authority and responsibility for deploying and assigning forces to fulfil missions. Command includes direction action and

[227] Macready–Meyer 1999: 186–187.

coordination. Control is the authority exercised by a commander over part of the activities of subordinate organisations or other organisations, and encompasses the responsibility for implementing orders or directives. It allows the commander to verify what actions have taken place and their effectiveness relative to the objectives to achieve.[228] The principle of control has a strong mechanical connotation and assumes tight coupling among the constituents. Control means that the manipulation of one of the constituents in all its freedoms makes it possible to influence all other constituents indirectly. In a complex adaptive system attempts to find out precisely the way feedback routes are often difficult if not impossible, since any feedback loop can result in endless combinations. Effects have a dual nature, which indicates that the information contained can occasionally cross its own path. However, if something can be seen both as a cause and an effect, rationality is up for grabs and one faces a paradox. This is the very reason why a complex adaptive system can produce occasionally counterintuitive behaviour. Although such a system behaves dependably and reasonably over a long period of time, in a sudden they can equally show all sorts of surprising and unexpected effects. Very simple causes on the bottom can produce extremely complex effects at the top. The traditional military approach equates waging war with managing war despite the fact that there is little to say on most relationships in terms of causality. The frictional, chaotic and complex reality of war points towards emergence and indicates that joint operations have their own dynamics, and often do "what they want". When facing a complex adaptive system humans often assume more oversight than they really have and more than they ever will have, regardless of the technological achievements.[229] In joint operations one has to expect non-intuitive traits in which effects can become disproportional to causes since a small variation in inputs can produce a huge variation in outputs. As soon as there is feedback, little can be deduced about its character merely by studying it. The joint effects landscape can be seen as a generic model that attempts to visualise massive and simultaneous interactions of various constituents. It also addresses the intricacy of causal relationships since anything that registers input and generates output is interpreted as input by a neighbour. Effectiveness and efficiency indicate that one needs to develop the ability to adjust internal links so that they fit external demands over time. Biological evolution and war are nothing more than a set of complex

[228] NSO 2017: 5-3.

[229] Kelly 1994: 121–127, 324–330.

and dynamic interactions. This makes it possible to identify the hierarchy of codes most complex adaptive systems possess. The first such code is the general drive for survival, the second code is to achieve maximal flexibility, whereas the third is to identify useful strategies.[230] In case of war and joint operations, the author suggests a fourth code, which is finding useful command and control practices to make strategies work. Superior command, which properly takes the frictional, chaotic and complex reality of joint operations into account, serves as force multiplier. Technology can enhance command performance, but successful command does not come as a direct result of advanced technology.[231] Commanders have always exercised various sorts of command practices in an attempt to address the difficulty posed by space and time. Spatial and temporal limitations allow for two possibilities such as commanding all of the troops part of the time, or commanding part of the troops all of the time. Another difficulty of commanding comes from the problem of information dissemination. As the chain of command grows longer, its value suffers both from the number of stages and from standardisation attempts. The result is that information can become so profiled that it borders on meaninglessness. Heaving these two extremes and the problem of information, successful commanders have realised that it is always possible to defeat the enemy, but never uncertainty. They knew that the greater the uncertainty the better it is to avoid tight control over subordinates. Instead of trying to control war's frictional, chaotic and complex reality they accepted unpredictability as inevitable and tried to make the best out of the situation. The battle of Jena fought in 1806 can serve as a good example. Although Napoleon achieved one of his biggest victories he "had known nothing about the main action that took place on that day; had forgotten all about two of his corps; did not issue orders to a third, and possibly to a fourth; was taken by surprise by the action of a fifth; and, to cap it all, had one of his principal subordinates display the kind of disobedience that would have brought a lesser mortal before a firing squad".[232] Napoleon, one of the biggest commanders of all time, was not only able to tolerate a high degree of uncertainty and still exploit the situation, but also his subordinates were willing to accept responsibility and self-initiative. A complex adaptive system such as joint operations requires a large safety margin in order to ensure that mistakes do not accumulate and develop into disasters. Similar

[230] Kelly 1994: 389–403.
[231] Wallace 2005: 2–5; Whitehead 2005: 22–25.
[232] Creveld 1985: 4, 56, 75 (quotation 96).

to the trial-and-error mechanism of biological evolution, the conduct of joint operations equals making blunders and learning from them as best as possible. Emergence and self-organisation not only mean that planning should often not go further than the first encounter with the enemy, but indicate that the amount of information needed to act at any given level should be reduced to a minimum.[233]

Embracing uncertainty

Whatever the command practices employed, humans have always attempted to address the pervasive temporal and spatial uncertainty of war and the problem of insufficient information. It makes sense to distinguish between four possibilities that come as a result of the combination of spatial and temporal factors and indicate the possibilities of commanding all of the forces all of the time, all of the forces some of the time, some of the forces all of the time, and some of the forces some of the time. The four possibilities are command-by-direction, command-by-plan, command-by-influence and command-by-evolution. Command-by-direction means that commanders are positioned on a vantage point from where they can direct the battle, but spatial limitations often rendered them to observers rather than commanders. In order to offset this limitation they occasionally attached themselves to that particular element of their forces, which they assumed to be decisive. In case the situation was favourable they also moved from one unit to the other. Although they prioritised uncertainty depending on the unfolding dynamics of war, they commanded only some of their forces some of the time. Command-by-plan stands for comprehensiveness and an attempt to plan everything in advance and as detailed as possible. It is a highly centralised approach that emphasises rules and procedures. Predefined plans guide actions that both promote inflexibility and address only the strategic/operational levels of war. Commanders focus on certain enemy centres of gravity in order to achieve victory. This approach attempts to centralise and structure uncertainty in a top-down deductive hierarchy aimed at exploiting causality. This approach has also limitations since it makes possible to command all of the forces only some of the time, mostly before the engagement with the enemy. Command-by-influence means that only the outline and the minimum goals are stated in advance. This approach distributes uncertainty in order to influence

[233] Creveld 1985: 121, 145–146.

subordinates behaviour, but not to control events. Instead of a detailed and difficult to revise plan the commander's intent serves as a general guidance and assumes lower-level initiative exploiting local knowledge. The approach relaxes decision thresholds and promotes semi-autonomous actions down to the lowest level. However, despite its flexibility this sort of command tackles uncertainty only at the tactical level. It allows for adjustments downwards to changing battlefield conditions, but does not promote change upwards, which is so essential in the continuous coevolutionary process of a complex adaptive system. This approach has also limitations since it allows only to command some of the forces all of the time.[234] The three approaches do not cover the full spectrum of command possibilities and can be regarded as variants of a top-down, one-way methodology. The biggest difference lies in the way higher-level interference is relaxed in terms of lower-level actions. Although there is a gradual change towards flexibility regarding the superior's requirements and the subordinates' actions, none of them promotes mutual learning and constant adaptation. Even command-by-influence, which can be seen as the most flexible among them allows learning from the enemy rather than from the subordinate. Based on insights coming from the joint effects landscape the author suggests a fourth approach. This most organic approach makes it possible not only to live with, but also exploit uncertainty. Evolution requires constant learning and adaptation since in a dynamically changing environment bottom-up information can often be more useful then top-down intent. However, before detailing the fourth option, which is command-by-evolution it is of utmost importance to analyse evolution in terms of command and control. In order to conceptualise joint operations as a complex adaptive system one can draw on the analogy found in evolutionary biology. Any conduct of joint operations that takes the frictional, chaotic and complex reality of war into account requires the understanding of the mechanism of biological evolution. Similar to the evolution of biological species, the joint effects landscape indicates joint operations to seethe and bubble as a result of constantly changing disorderly processes. In biological terms war is an open system that continuously evolves. Assumptions regarding direct causality, linear deduction, and analytical categorisation do not address the full band-with of possible perturbations. Consequently, we can say that "in war […] even the mediocre is quite an achievement".[235] To paraphrase Clausewitz war is *evolution*

[234] Czerwinski 1998: 213–220.

[235] Schmitt 1997: 99–111; Quotation Creveld 1985: 13.

by other means as it deals with living and animate human beings. He also pointed out that we must "always leave a margin for uncertainty, in the greatest things as much as in the smallest".[236]

From monologue to dialogue

Tracing back the origins of command and control also known as *C2,* means going back to World War II. Command and control are not synonymous terms, although have a close relationship and are commonly used together.[237] Although there is no clear evidence that the terms were already used together, there is an increased number of various expressions closely resembling the current meaning. Over the years, the term evolved in a way that now it can be treated both as a phrase and a compound word.[238] Nowadays, there is an abundance of definitions indicating that command and control is well-entrenched both in military doctrine and vocabulary. Despite references to complexity theory and complex adaptive systems, the way Western armed forces understand strategy formulation and course of action development is still very much top down, deductive, analytic and linear. This does not take war's emergent and self-organising attributes into account. The same is true for command and control.

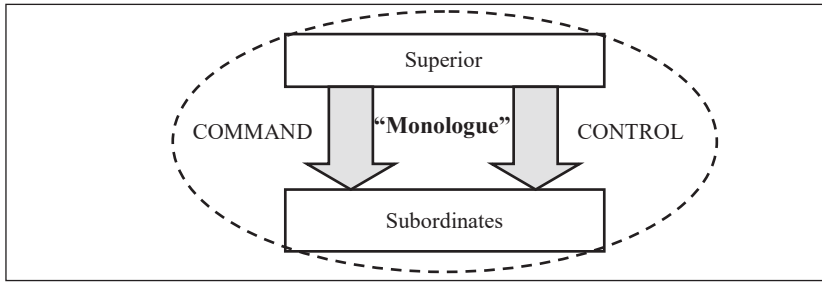

Figure 10. Command and control as "monologue"
Source: Compiled by the author

[236] Quotation Clausewitz 1989: 97.
[237] NSO 2017: 5-2.
[238] Sproles 2002: 19–26.

According to the definition and as depicted in Figure 10, the terms command and control are understood as a one way process flowing exclusively from top to down. Joint operations as a complex adaptive system stand for polarities to manage, rather than problems to solve. Thus, similar to strategy formulation polarity must be included in the way one understands command and control. Although the current unidirectional understanding can best be described as a monologue, a close and separate examination of the two constituent words makes it possible to discern polarity in the form of a dialogue. Approaching command and control this way makes it possible to marry command-by-evolution with the proposed joint effects landscape. The inappropriateness of a top-down understanding of command and control becomes clear if one looks at the meaning of these two terms. Although command and control can both be seen as a phrase and a compound word, for a better analysis we suggest treating it as the latter. Whereas command refers to the full range of human innovation and flexibility needed to solve unexpected and complex problems, control stands for a set of regulated procedures, which restricts flexibility and excludes alternatives. In normal English usage command can also be understood as the ability to readily call forth or evoke. It refers to creativity, which is probably the most important requirement as it emphasises the importance of learning and adaptation, and points towards emergence and self-organisation, which are the most important attributes of a complex adaptive system. Although creativity is necessary for command, it is not sufficient in itself. It requires another characteristic such as will, which stands for motivation and opportunity. Control indicates either direction or restraints that emphasise proportion and appropriateness in terms of procedures, policies and guidelines aimed at certain end-states.[239] The two end-poles within which command and control activities take place can be defined by the creative expression of human free will on the one hand, and various structures and processes on the other. Command thus means novel solutions to emerging problems since it provides for starting conditions that indicate a diligent purposefulness. It is the act of expressing will creatively in order to accomplish a mission. Command stands for creating new structures and processes that allow for unanticipated changes to plans. Control makes it possible to express human will creatively in order to manage emerging problems and maximise the chance for good-enough solutions. It provides for the framework in the form of structures

[239] Pigeau–McCann 2002: 53–56.

and processes, and stands for monitoring and in the case it is needed, adjusting existing structures and processes.[240]

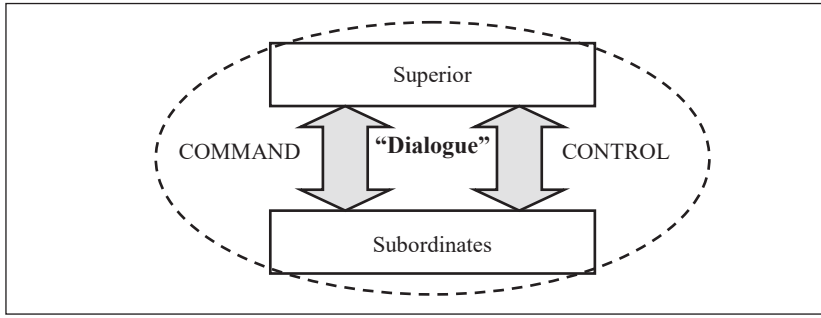

Figure 11. Command and control as "dialogue"
Source: Compiled by the author

The two end-poles suggest that similar to the three approaches to strategy development, command and control can also be perceived as a mutually adjusting top-down and bottom-up process. As depicted in Figure 11, command and control are not exclusive alternatives, but fundamentally interdependent and interrelated perspectives. Traditional military hierarchy emphasises a formal differentiation between superior and subordinate, which can often brake down as a result of unfolding situations and changing circumstances. The author does not indicate that there is no reason to differentiate between those who lead and those who are lead. Successful command and control requires a mutual adjustment in order to find the narrow edge of chaos and dwell there successfully. It appears that MCDP 1 Warfighting catches best the essence of command-by-evolution. It is one of the most successful doctrines ever published since it has survived untouched for more than three decades.[241] It recommends an organic, evolutionary approach by emphasising the importance of implicit communication. Mutual understanding, coupled with a minimum of key phrases, the courage to anticipate each other's thoughts is the most efficient way to successfully address the coevolutionary character of joint operations. A constant dialogue between superior and subordinates creates an atmosphere that enables constant learning

[240] Gove 1981: 455–456, 496–497.
[241] Thaddeus 2020: 37.

and adaptation, and promotes the readiness and willingness to learn throughout the ranks. Command-by-evolution means that bottom-up variety and rapidity leads normally to confusion and disorder if it does not accord with top-down harmony and initiative. However, it also indicates that top-down harmony and initiative without bottom-up variety and rapidity, can often lead to rigidity and non-adaptability. Whereas unbridled creativity can often lead to chaos, over-control can result in individual de-motivation. Command-by-evolution means that one becomes able to gain quickness and security. It does not stipulate that only commanders on the top exercise command and control functions. In terms of emergence and self-organisation command and control is as much a top-down as a bottom-up process.[242] Every human is inherently able to express will and capability in the service of the operation. Finding the right balance does not always mean finding the golden middle way. Dealing with a complex adaptive system such as joint operations indicates that the situation itself defines which side of the polarity must be emphasised in order to address successfully the challenges that come as a result of a continuous coevolution with the enemy. Command-by-evolution means the ability to find a "correct balance between encouraging creative command and controlling command creativity".[243] It is important to merge structures and processes with creativity and will to become able to address the roiling complexity of joint operations and adjust successfully.

Command-by-evolution

Any approach that emphasises centralisation can de-motivate subordinates to exercise initiative due to changing circumstances, and superiors to listen to subordinates carefully. Another danger comes from the reliance on advanced technology that easily allows superiors to bypass subordinates and relegate them to information administrators. Centralised uncertainty means that independence, trust, rapidity in terms of decision-making and taking risk deliberately into account are suppressed. These are the very factors without which joint operations cannot be conducted successfully. A top-down, mechanistic and linear approach resembling a monologue does not take into account situations in which

[242] U.S. Marine Corps 1997: 78–79; Boyd 1987: 9.
[243] Pigeau–McCann 2002: 56–62 (quotation 57).

commanders must deal with a thinking enemy who reacts and adapts to every move.[244] In order to elaborate on command-by-evolution in detail, the author approaches it from three different angles and proposes C2 as Confidence and Competence, Coping and Coevolution, and Creativity and Change. The biggest heritage of Clausewitz in terms of command and control is twofold. The first is a formal separation between those who lead and those who are lead, which is expressed in a strict pyramid-like hierarchical design. The second comes as a result of the first, since it is supposed that those on the top are more important than those serving below. Joint operations as a complex adaptive system requires that much of command must be delegated to lower levels in order to detect, track and exploit emerging opportunities in a self-organising fashion. Conceptualising joint operations as a search process in an imaginary joint landscape assumes the existence of various networks. Consequently, one must become a network himself and shift the emphasis towards a horizontal focus. Power must be distributed in a lateral way in which each boundary, cluster and node interacts up to the moment at which the engagement with the enemy starts. It is impossible to control complex adaptive systems; therefore, there must be refocus from command and control in traditional terms towards confidence and competence. Both superiors and subordinates must work in an autonomous and asynchronous way in which boundaries are neither fixed nor controlled, but adapt according to the requirements. Consensus does not come as the result of a top-down monologue, but as a stop-and-go process that rests on trust and confidence. Both superiors and subordinates know that despite the errors and blunders committed, everybody wants to achieve the right thing. Humans are willing to learn and change views, and adapt to constantly changing circumstances. Confidence and competence come out of a collective experience that helps exercise disaggregated and asynchronous command procedures in which information can find its way to those who need it even if they do not want to know it. The joint effects landscape stands for a constant change with often surprising opportunities that require rapid and immediate actions often carried out in novel ways. Formations, units and subunits must move from a formal and vertical to a more informal and horizontal organisational structure in which the emphasis is on people who tend to become better subordinates and better superiors. Only those can learn from their mistakes who have been allowed to make them.[245] Command-by-evolution

[244] Vego 2004: 101–103; MacGregor 1999: 28.

[245] Atkinson–Moffat 2005: 172–188; Storr 2003: 77–94.

takes mission command a step further and assumes that not only subordinates have the freedom to realise the superior's intent, but also the superior is ready to learn and adapt his intent to the battlefield realities that come as the result of a continuous coevolution with the enemy. This way it is possible to exploit emerging opportunities nobody could have imagined in advance, but can serve equally well or even better than those, which were planned and formulated in terms of desired effects. This two-way process of constant adjustment means that effects are achieved in a way that exploits both effectiveness and efficiency. Command-by-evolution exploits uncertainty in a novel way and calls for freedom and adaptability at all levels. It acknowledges that the frictional, chaotic and complex reality of joint operations requires only general statements to be stated in advance in order to start activities rather than a detailed plan. Only guidelines must be laid down in order to put the system into gear. As soon as the coevolutionary process with the enemy gains momentum, details that cannot be anticipated beforehand will emerge anyway. A good example for emergence and self-organisation was the 1967 Arab–Israeli war in which for the Israeli side "only the first [day] was planned in any detail; the rest was pure improvisation".[246] Israel achieved one of its most stunning victories over its neighbours at a cost of roughly 680 soldiers killed, 2,600 wounded and 15 more becoming prisoners. In contrast, according to various estimates the numerically superior combined Arab forces suffered 21,000 casualties, a further 45,000 soldiers were wounded and 6,000 became prisoners. Confronted by a much larger coalition and facing a three-to-one imbalance of forces, Israel managed to win within six days. A successful mix of surprise, intelligence, guile, gamble, determination and courage backed by a maximum independence of subordinate commanders, mutual trust and appreciation of each other in the form of an implicit brotherhood throughout the ranks resulted in communication and comprehension, which are so necessary for flexibility in joint operations.[247] Israeli units were able both to self-organise and exploit emergent windows of opportunities despite the many blunders they committed during the operations. They probably did not achieve what one would describe as desired effects, but were able to exploit those opportunities sufficiently to be successful in the end of the day. Command-by-evolution is an organic concept that does not over-emphasise the role technology plays in war. It just reminds that whatever the level of sophistication of the

[246] Creveld 1985: 195–203, 231, 252 (quotation 200).

[247] Harkabi 1967: 677–691; Gallois 1988: 17–19; Khan 1967: 267, 273; Bordoley 2013: 12–22.

employed technology, it equally opens up and shuts down possibilities. It is as important to exploit advantages it offers as to understand the limitations it has. Coevolution indicates the enemy to be composed of intelligent human beings who are always ready to exploit vulnerable niches in order to turn initial disadvantage to their favour. Conceptualising joint operations in the framework of a complex adaptive system requires seeing command and control in terms of polarity. Even the proposed joint effects landscape allows for command and control in a traditional top-down fashion resembling a monologue. The closer to the region of stability, the higher their value. However, it must be equally taken into account that as the dynamics of war unfold, the coevolutionary process with will shift towards the chaotic area of the continuum. Consequently, command and control in traditional terms become increasingly vacuous. Approaches attempting to prioritise, centralise or distribute uncertainty cannot cope with all the conflicting requirements and constraints. Belligerents must both address and take advantage of the emergent and self-organising patterns as they unfold. The most important message of the joint effects landscape is that success requires the harnessing of everyone's intelligence throughout the ranks. It is probably too far-fetched to state that if you order a soldier to do something, you have already failed as a leader, but one must acknowledge that people are in general ready and willing to work well, contribute their ideas and take responsibility. The frictional, chaotic and complex reality of joint operations demands everyone's contribution to solve emerging challenges and crises. Self-managed and autonomous teams can come up with smarter solutions to problems and achieve a higher level of adaptability. The higher the risk, the more needed the commitment and intelligence of everybody, and people often get together in order to achieve more and not less. This way they develop a shared understanding and behaviour to take required actions. Courses of actions developed this way are simpler and more localised. They require a constant search for solutions, which come as a result of intimate and local experience that can turn into system-wide coherence.[248] These activities indicate that organisations are able to tolerate a high level of messiness, and can provide for an atmosphere in which freedom and creativity are the driving forces for achieving sufficient local solutions. As the 1967 Arab–Israeli war showed, if people can develop trust for each other they also establish an atmosphere that is more creative and forgiving. Consequently, local responsiveness can turn into higher general adaptability and agility.

[248] Wheatley 2005: 64–74.

The story of Xenophon

The joint effects landscape depicts joint operations as a migratory process on an imaginary landscape. Based on the interaction of the belligerents, the surface changes and poses a serious challenge both in terms of planning and execution. A good example for emergence and self-organisation can be found in Xenophon's book, which describes the march of a Greek expeditionary force of roughly 11,000 men fighting its way back from Asia Minor to Greece 2,500 years ago. Similar to the joint effects landscape, ancient Greeks had to find home in a mostly unknown terrain guided only by local information that required a constant adaptation to changing circumstances and the exploitation of emerging opportunities. After the death of Cyrus who hired them, the Greeks found themselves trapped in a hostile environment. Surrounded by enemies, with most of their original generals and officers seized and killed, having no guides to show them the way, and facing unknown territory they managed to reach the Black Sea mostly intact. According to Xenophon, 8,600 men of the original 10,700 survived despite the difficulties they encountered, which means a total loss ratio of 20% over a year. Emergence and self-organisation were manifest in all of their actions. In book three Xenophon stated in the beginning of their long march that "let us not […] wait for others to come to us and summon us to the noblest deeds, but let us take the lead ourselves and arouse the rest to valour".[249] During their march the Greeks routinely assembled to vote on the proposal of their elected leaders, erected boards and councils to debate and discuss issues such as organisational modifications or suitable tactics. Having a flat-enough organisational design and a horizontal rather than a vertical structure, the superiors always marched and fought alongside their subordinates. As Xenophon emphasised "it is right to expect that you should be superior to the common soldiers, that you should plan for them and toil for them whenever there be need".[250] Whereas they achieved maximum physical flexibility by burning all their superfluous equipment before the march, their command flexibility resulted from the ability to compensate for the want of leadership and discipline. However, what made them really lethal is expressed in the explicit encouragement of subordinates to come up with alternatives and suggestions at any time. Xenophon always welcomed bottom-up initiative by assuring subordinates that "if any other plan is thought better than

[249] Xenophon 2001: 215–225 (quotation 225).
[250] Xenophon 2001: 226–231 (quotation 231).

mine, let anyone, even though he be a private soldier, feel free to present it; for the safety of all is the need of all".[251] This adaptability was enforced by an organisational design, which was regarded as a good-enough start. Xenophon emphasised that "for the future, as we make trial of this formation we can adopt whatever course may seem from time to time to be best. If anyone sees better plan, let him present it".[252] As a result, when the Persian commander Mithradates seemed to be superior because of having mounted troops and slingers, the Greeks were able to offset his advantage within a night by establishing similarly equipped troops. They were also willing to use either superior enemy equipment such as Persian arrows, or to innovate and build new ones. If the marching formation they originally choose was not good enough, which became clear as soon as they started to cross rivers, they went over to an even less structured formation that further delegated responsibility down to junior commanders. Another good example for flexibility can be found in a dialogue between Cheirisophus, the senior commander of the Greek army and Xenophon. During a battle with a Persian army, the occupation of a mountain top was seen as crucial and Xenophon offered his commander that "[i]f you choose, then, stay in command of the army, and I will go: or, if you prefer, you make for the mountain top, and I will stay here". Cheirisophus replied by saying that "I leave it to you to choose which part you wish".[253] Thus Xenophon led the Greek forces and when he was reminded by Soteridas, a common soldier, that he was riding on horseback while others had to conduct a forced march, he dismounted and continued to march on foot. On another occasion the generals collectively decided upon a proposition to cross a river. They concluded that although it was a clever alternative, its execution was rather impossible, which eventually led them first into the country of the Carduchians and then to Armenia.[254] Information was allowed to flow directly upward in an unconstrained way as displayed by an example in book four. By fighting their way through the mountains on one occasion, the Greeks encountered a joint force of Armenians, Mardians and Chaldeans that appeared to be superior in numbers. They were forced to cross a deep and fast flowing river, which was seen as a difficult and dangerous undertaking. The situation came close to a disaster as the Greeks saw a river difficult to cross, enemy troops

[251] Xenophon 2001: 232–251 (quotation 251).
[252] Xenophon 2001: 252–253 (quotation 253).
[253] Xenophon 2001: 254–279 (quotation 279).
[254] Xenophon 2001: 280–289; Hanson 2001: 1–5.

intended to obstruct their crossing and ready to fall upon their rear. However, by accident two young Greek soldiers discovered a save ford and since they knew that soldiers were allowed to go to Xenophon "whether he was breakfasting or dining, and that if he were asleep, they might awaken him and tell him whatever they might have to tell that concerned the war".[255] They passed the information directly to their superior and this way the cornered and desperate Greeks were able to slide out of the hand of their enemies. Later in Western Armenia, they came under a heavy fall of snow that covered the bivouacked men. The next morning soldiers were reluctant to get up. In order to show example Xenophon was the first to get up and split wood. One by one soldiers got up and also started to split wood, build fires and anoint themselves. On another occasion when they entered the country of the Taochians they nearly run out of provisions and were forced to attack one of the strongholds that was built on a steep hill. Every time when the Greeks attacked they were repulsed by stones rolled down from an overhanging rock. As a result Greek troops sought shelter in the cover of nearby trees. In order to solve the situation and to motivate subordinates, the captains of the companies developed a scheme and led by example. In their run across the stronghold Agasias, Callimachus, Arystonimus and Eurylochus "thus contending […] captured the stronghold, for once they had rushed in not a stone came down any more from above".[256] Despite the unknown terrain and hostile countries they marched through, the Greeks could eventually reach the Black Sea. As described in book five they took counsel for themselves in which the generals underwent an inquiry with reference to their past performance, and in case misconduct was discovered, they had to pay a fine.[257] They conducted a thorough after action report in order to enhance their effectiveness for the remaining part of their trip home. The example of the ancient Greeks shows that proper information coming through an emergent and self-organising mechanism can successfully limit, but never eliminate the frictional, chaotic and complex reality of war. Although the fog of war can occasionally be reduced to mist, information will never be complete or absolutely perfect. In joint operations one always deals with the likely rather than the true. More information might create more predictability, but the bigger its amount the greater the uncertainty, hence the unpredictability it contains. In any case one must deal with an inherent

[255] Xenophon (2001): 291–317 (quotation 317).
[256] Xenophon (2001): 318–361 (quotation 361).
[257] Xenophon (2001): 362–379, 447–465.

unpredictability that often hinders both the formulation and achievement of objectives. In the last decades there is a steep increase in the performance of information technologies Western armed forces can field. Due to the dependence on these joint operations are increasingly conducted in a multi-domain environment, for which various concepts are being developed.[258] The increased tempo of joint operations and the demand for making split-second decisions grows. It appears that the weakest link in this process is still the speed at which humans make decisions, which has not changed much since the age of Xenophon. Another problem is that despite the amount of available information, it is often "trivial in quality and overwhelming in quantity".[259] Contemporary commanders are confronted with two sorts of uncertainty in terms of information. The first type is due to the lack of accurate, useful and timely information, which has always been part of war. The second type is due to the overwhelming amount of information since advanced technologies can both collect and communicate nearly anything and everything.[260] In the unfolding 21st century both the deployment and employment of forces will frequently change. The joint effects landscape and the example of the ancient Greeks show that fleeting and unique opportunities require a constant adaptation based on local information harnessing individual initiative and responsibility. Information must often be generated and exploited on a local level in order to achieve effects that might not always be predictable, but are good-enough to become both effective and efficient at the same time.

[258] United States Army 2018.
[259] Ferris–Handel 1995: 40–49 (quotation 49).
[260] Ferris–Handel 1995: 52.

Chapter 8
Military Brilliance

In the preceding two chapters the author detailed the consequences of a conceptualisation of joint operations as a complex adaptive system in terms of course of action development, strategy formulation, and command and control. This chapter addresses the conceptualisation from a military effectiveness point of view. The ability to assess effects is seen as a significant detriment in joint operations to come as one must become able to "assess effects as opposed to counting things, today we count things". [261] Achieving effects is important in joint operations, but getting feedback is detrimental for which it is useful to elaborate more on the example of the ancient Greeks. The most important message of Xenophon's book, is that mastering the challenges posed by joint operations requires more than an exclusive focus on one particular area in the continuum. The conduct of joint operations does not mean that on occasion it is impossible to influence the enemy and achieve psychological effects. Xenophon was also successful in conducting psychological operations such as disfiguring the bodies of fallen enemies.[262] The Greeks took equally into account that war is a deadly business in which they must be prepared as much to destroy and defeat the enemy by the application of force, as to influence him through various coercive means. The joint effects landscape stands for a dynamically evolving phenomenon rather than a single instantaneous event. Joint operations are a series of dynamic interactions in which the belligerents attempt to gain advantage over time that might either accumulate or reverse into balance again. Events happen in the form of interactions of various sizes until one belligerent is defeated or decides to surrender. In this process it is the product rather than the sum of interactions that decides on the outcome, which can last until the bitter end or stop before total destruction.[263]

[261] Quotation NATO 2003.
[262] Xenophon 2001: 263.
[263] Smith 1998: 301–305.

Fighting power

The relative ability to learn and adapt expressed as military effectiveness appears to be an important attribute and refers to a gap in operational capabilities over time. It is a crucial factor and deserves a close examination. Regardless whether it is approached in quantitative or qualitative terms, one has to deal with a multitude of factors that are very difficult to calculate. Any attempt to describe it requires to limit the attention to certain features and the exclusion of the full range of possibilities. The result gained reflects as much practical benefits as a certain analytical convenience. The set of indicators appears to be strongly interrelated, but the insights gained are often narrow and highly inconsistent. Joint operations seen as a complex adaptive system means that any attempt to get a grip on military effectiveness faces the problem of no clear causality, which can only be lessened and never eliminated. Even if it is possible to establish a causal link between military effectiveness and the variables it explains, the only possible way to do so is by restricting the dependent variables and more clearly defining what sort of effectiveness is meant. The joint effects landscape indicates that events can have both systematic and accidental causes. In joint operations there are identifiable causes and effects, and phenomena humans cannot explain or understand based on analytical rationality. Any judgement regarding effectiveness colours as much the view of events as limits the attention as they include certain aspects and exclude others. Assumptions regarding military effectiveness are as much permissive as they are deterministic/heuristic. Measures of military effectiveness often reflect the sum of individual aggregates rather than collective characteristics. The complexity of those characteristics is responsible for problems that make any description and assessment of military effectiveness very difficult. Similarly to any abstract concept, it is not a concrete thing, but must be inferred from other clues. The more one moves towards psychological effects, the harder it becomes to disentangle indicators and variables from each other, and any attempt to address military effectiveness has to deal with collective attributes.[264] All these problems mean that assessing military effectiveness is context-dependent and always influenced by certain cultural and societal factors. This implies that the low effectiveness of some armed forces in the second half of the 20th century were mostly due to societal and cultural determinants. Indicators can include peculiarities such as over-control in the

[264] Liddell Hart 1960: 9; Elkins–Simeon 1979: 127–137; Schnaubelt 1994: 127–135.

form of the rigidly centralised command structure, the officer corps's contempt for ordinary soldiers and its distrust of a capable NCO corps. Impact of such societal and cultural deficiencies is often seen as responsible for the humiliating defeats Arabic forces suffered at the hand of Israel.[265] In the previous book the author stated that effects can be achieved on the strategic, operational and tactical levels of war. Psychological effects refer mostly to the strategic level, systemic effects address the operational, and physical effects the tactical level of war. Lower-level effects are easier to achieve than higher order follow-on effects. Physical effects, mostly in the form of destruction are relevant only to the extent they contribute to changes in enemy behaviour; therefore, they are mostly of secondary importance. Psychological effects are very difficult to achieve due to the inherent black box of the mechanism involved.[266] Military effectiveness can theoretically be measured on every level. Due to the fact that joint operations are at the heart of this book, the author suggests to examine military effectiveness on the operational level where it can be expressed by the concept of fighting power. This approach only narrowly grasps the meaning of military effectiveness as it does not address the relationship between political ends and military means, but conveniently provides for the fact that normally battle is the real test of military effectiveness. This approach does not exclude that military brilliance often cannot compensate for political incompetence. The biggest benefit of approaching fighting power on the operational level is to be able to explain the danger that comes from confusing flexibility in war with the illusion of being flexible. It is possible to build upon insights gained earlier detailing learning and adaptation.[267] This rather narrow approach does not exclude that low military effectiveness and disastrous battlefield performance often come as a result of various societal and cultural factors. They root in the absence of respect, trust and openness, and the lack of an implicit brotherhood among soldiers at all levels. Competence at winning battles on the operational level is an important contributor to victory in which aspects such as individual soldiering, battlefield behaviour, and organisational efficacy play an important role.[268] These factors together with societal and cultural determinants emphasise first and foremost the human aspect of war, which requires solid and strong bonds

[265] Harkabi 1967: 685–691; Lewis 1968: 331–334.
[266] Jobbágy 2019: 33–48.
[267] Record 1988: 25–29.
[268] Atkine 2000: 16–27; Biddle–Long 2004: 527.

in combat units rather than the availability of advanced technology. In terms of fighting power, the latter "only emerges as a powerful predictor of success when considered in a far more complex and interactive model of training, technology, and terrain".[269] Fighting power indicates that favourable technological disparity might erode over time.

Outfighting the enemy

On their march back home the Greeks kept winning as they consistently outperformed their respective enemies, as did the Germans in World War II in a similar fashion. During the entire war period soldiers of the Wehrmacht always outfought the opposing British and American troops. This was true "when they were attacking and when they were defending, when they had a local numerical superiority and when […] they were outnumbered, when they had air superiority and when they did not, when they won and when they lost".[270] Explaining such an outstanding fighting power by single attributes appears to be too narrow and dangerous. Even if one takes various societal and cultural determinants into account, a German made neither a better soldier than an American, nor is German national character more suitable to wars than the American. The involvement of various difficult-to-conceptualise factors has led many to state that military brilliance in the form of military effectiveness is nothing more than an ill-defined concept. War is a complex phenomenon in which the multitude of factors does not make it possible to fully comprehend everything that goes on. The joint effects landscape indicates that interactions with the enemy stand for a coevolutionary process. The direct result is causality brake-down with different levels of intensity and a confusing interdependency. The attempt to discuss military effectiveness even in rough terms requires to look across horizontal and vertical dimensions of activities.[271] The simplest way to define fighting power is seeing it as a process in which armed forces put resources into combat. The biggest similarity that connects ancient Greeks and modern Germans is that both regarded themselves as members of a highly integrated and well-lead team perceived by and large as just and equitable. This implicit

[269] Reiter–Stam 1998: 260–263, 271–275 (quotation 274).
[270] Dupuy 1977: 253–289 (quotation 253–254).
[271] Millett et al. 1988: 1–2; Parker 1999: 131; Creveld 1982: 13–16; Nielsen 2005: 61–84.

brotherhood meant that the best men fought shoulder-to-shoulder in the front. Military units were designed to produce fighting men of high quality. Fighting power came as a result of mutual trust, delegated responsibility and independent decision-making. Greeks and the Germans did not attempt to prescribe detailed solutions in advance as much was left to the intuition of commanders and subordinates on the ground. This led to empowerment throughout the ranks, and the emphasis on the means resulted in an unprecedented military effectiveness. They displayed fearsome cold-bloodedness that ranged from utmost stubbornness in close combat, to large-scale butchering of non-combatants. Similarly to the ancient Greeks, their modern German equivalents were true professionals both in positive and negative sense. Their battlefield performance during World War II was second to none regardless whether they were in the offensive or the defensive or committed atrocities.[272] However, even such a narrow conceptualisation of military effectiveness aimed at the operational level of war demands a warning. Fighting power depends largely on the humans involved and reflects the ability to prosecute operations and employ weaponry. Thus it is a reflection of the quality of an army's personnel and includes aspects that range from battlefield performance to the accomplishment of tasks on various levels and the way those tasks interrelate. Fighting power only expresses how successfully a military force operates on the battlefield once it has engaged with the enemy. Numerous examples in history have shown that outstanding effectiveness in battle can often be irrelevant for the outcome of war with the opposite being equally true.[273] Fighting power is the expression of superior human qualities rather than outstanding military technology. A good historical example for disappearing technological superiority, both in terms of quantity and quality can be found in the first phase of British imperialism. Around the end of the 18th century, some thousand British soldiers were able to defeat much larger Indian armies, despite the fact that in war-relevant technologies India was superior to Europe. Indian steel was not only better than British, but the steel making techniques in India were far more advanced. Indian forces also had better artillery and musket barrels on their side. However, technological inferiority did not hinder the British to expand their empire and extend their influence.[274] Advanced technology is an important element of joint operations and makes it possible to destroy virtually any target.

[272] Millett et al. 1988: 2; Creveld 1982: 163–166; Kanter 2002: 79.
[273] Millett et al. 1988: 26–27; Pollack 2002: 3–4.
[274] Rosen 1995: 22–23.

Stealth technology, information technology and precision weaponry appear to be less convincing in re-establishing security or winning hearts and minds. Recent operations of NATO and coalition forces in Iraq and Afghanistan are reminders that the ability to end wars does not come as a result of technological solutions. There is an emerging gap between advanced military technology and the gains to expect from its application. Recent operations required forces committed for long on the ground that are as much capable in searching and destroying irregulars of non-state actors, as winning hearts and minds of the local population. Enhanced destructive capabilities can improve fighting power, but have clear limitations in terms of stability, order and security. Joint operations as a complex adaptive system are composed of situations that can quickly switch from destruction to influence and vice versa. The joint effects landscape indicates an admixture of many unforeseeable physical, systemic and psychological effects, which makes the outcome especially in terms of perception and behaviour unpredictable.[275]

Problem of measuring

In simple English usage measuring indicates a process that points towards a comparison in which one ascertains a certain quantity in terms of a given standard. The evaluation of the effectiveness of Operations Desert Fox found that despite the obvious success of the bombing campaign, the destruction of various sites never fully equalled with the destruction of assumed centres of gravity. Thus, damages claimed always reflect a combination of a thorough assessment and empty propaganda. Assessing military effectiveness in a way that addresses the psychological domain requires the focus on perception and influence rather than on military exchange rates based on technological prowess. This area is extremely context dependent and indicates that any approach to assess military effectiveness will be full of controversies. The frictional, chaotic, and complex reality of joint operations indicates the existence of so many contextual factors that the relationship between the action taken, the object selected and the consequence in the form of desired effects will always be hidden to a certain degree.[276] Western thinking is inherently linear and efficiency obsessed. This is manifest in the general preoccupation with numbers, which are often regarded

[275] Valentin s. a.

[276] Gove 1981: 1400; Cordesman 1998: 29–31; Keaney 1993: 25–36.

as the only reality instead a simple means to look at reality. This preference is not surprising since numbers allow for management and something that is seen in Western culture as very important, which is control. Numbers and metrics are regarded as hard facts and number crunching as the primary means of control. Controlling a complex adaptive system such as joint operations is very difficult if not impossible. Fighting power and most of its attributes depend on humans and express performance capabilities, which can never be reproduced by simple measurement. Military effectiveness emerges as a result of qualities and behaviours that are choices, made by people on all levels. The joint effects landscape indicates that military effectiveness comes as much as the result of satisfying the superiors' needs as that of local knowledge and expertise. Any complex adaptive system lives on feedback. Probably the biggest difference between feedback and measurement is that the former is self-generated and depends on context. Feedback in a complex adaptive system changes constantly over time as boundaries are never static, but permeable. Feedback is not only essential in adaptation and learning, but an important contributor to fitness. It indicates that instead of letting measures define what is meaningful, the emerging meaning of actions should define the measures.[277] Feedback is the essence of a complex adaptive system and in case of joint operations it is present in the interaction or the coevolutionary process of the belligerents. It indicates that joint operations demand a conceptualisation in which the means applied are as much important as the ends sought. Feedback also means that no one can ever fully control events. As Clausewitz emphasised war is never "the action of a living force upon a lifeless mass. […] Thus [we are] not in control: [the enemy] dictates [us] as much as [we] dictate to him".[278] Military effectiveness grasped on the operational level as fighting power is not only manifest in combat, but also determines its outcome. The question of whether it is possible to quantify it in order to make military effectiveness measurable arises naturally. In his attempt to identify a useful theory of combat, Dupuy referred to Clausewitz and claimed that he had an analytical approach to war and thought of combat in mathematical and quantitative terms. Clausewitz used a vocabulary, which was interwoven with terms and expressions borrowed from various natural scientific disciplines. He referred to various measures throughout his work such as scale, degree or

[277] Gove 1981: 1400; Wheatley–Kellner-Rogers 1999; Murray 2001: 134–135; Janssen et al. 2003: 22–35.

[278] Quotation Clausewitz 1989: 86.

quantity to which, according to Dupuy, at least tentative values can be given and expressed as the "Law of Numbers". This law makes it possible to determine the outcome of battles, hence to measure fighting power and military effectiveness. For Dupuy fighting power (P) was the product of the number of troops (N), variable circumstances that affect a force in battle (V), and the quality of the force involved in battle (Q). Consequently, he claimed that fighting power can be seen as a result of the following equation

$$P = N * V * Q$$

The equation also makes it possible to express relative military effectiveness in case of two belligerents. It can be expressed as a difference in the belligerents' respective military effectiveness where (r) identifies the red force and (b) the blue force

$$P = \frac{N_r * V_r * Q_r}{N_b * V_b * Q_b}$$

His approach is especially interesting from a complex adaptive system point of view, as Dupuy explicitly emphasised the importance of a bottom-up, inductive process in approaching military effectiveness. He assumed that this way it becomes possible to provide insights into the various interactions of the variables and get to a reasonable quantification. However, even he had to admit that this quantification does not allow predicting the future with any accuracy. The best the equation can provide for is the avoidance of dangerous assumptions and false conclusions. The equation did not help Dupuy to address the multitude of factors such as leadership, morale, cohesion, motivation, initiative, and trust, which are easily identifiable, but also frustratingly intangible. In order to get a grip on higher order effects in the psychological domain, the best he did was to suggest that the effects of intangibles should be determined by historical analysis.[279] Thus even the attempt to assess military effectiveness in the internal and rather limited context of combat expressed as fighting power, suffers from inaccessibility of reliable data. Assessing effectiveness in a much broader context with its wider perspective pointing towards the political interest of the belligerents is even less reliable and has a transitory value. It should not come as a surprise that measures

[279] Dupuy 1987: 13, 21–30, 51–61, 105 (Dupuy preferred the term *combat power*); Murray 2004: 5–17; Burkett 2003: 10–17.

of military effectiveness such as battle damage assessment are normally related to physical activities since behavioural characteristics indicating higher order follow-on effects are the most difficult to measure.[280]

Wicked problems

Joint operations as a complex adaptive system are open ended, which makes the formulation of any outcome in terms of objectives and desired effects extremely difficult, if not impossible. The traditional planning approach emphasising reasoning, rationality and analysis must often yield to an approach based on engagement, action and overcoming. In the framework of the proposed joint effects landscape joint operations are conceptualised as a large and interconnected network. Due to epistatic interactions, the belligerents have to juggle with various sorts of conflicting constraints. As outputs from parts of the network become inputs to others, it becomes extremely difficult to define cause-and-effect relationships in a meaningful way. Efforts to plan for effects and objectives, and develop suitable courses of action can become troublesome activities. In terms of the joint effects landscape, one has to expect waves of repercussion since influencing any given nod can induce severe and unexpected effects elsewhere that very often negates the possibility to detect so called root causes.[281] Most challenges posed by joint operations cannot be solved through analysis as they happen on a continuum in which one always faces ill-defined and inseparable problems. The lack of clarifying traits in such wicked problems allows for resolution rather than solution – over and over again. The following listing provides for a better understanding of the nature of such problems. Wicked problems cannot be formulated definitively and exhaustively since formulating a wicked problem is a problem in itself. Setting up and constraining the solution space, constructing meaningful measures of performance are at the heart of the problem's wickedness. Wicked problems are infinite as there are no criteria that tell when solutions are found. Terminating works are rather due to external reasons such as running out of resources rather than to internal reasons coming from the logic of the problem. Wicked problems do not allow for objectively decisive criteria to define the correctness or falseness of solutions. Thus solutions

[280] DuBuis et al. 1998: 36–41, 140–146; Low 1995: 18–23.
[281] Rittel–Webber 1973: 157–158, 160–167.

can never be true or false only bad or good as they are influenced by the interplay of various cultural, social and political factors. Wicked problems have no solutions that can be tested immediately or ultimately. Whatever the solution to a problem, it always generates unintended and undesired consequences, which often outperform the desired effects we want to achieve. Wicked problems mean that history matters. Every solution implemented has a consequence that leaves traces we cannot reverse. Attempts to undo or reset past actions poses a significant challenge as they also represent further sets of wicked problems. Wicked problems do not have an enumerable set of potential solutions. Sometimes no solution can be found, or the selected solution is just as good as any other potential solution. What should be pursued, implemented and enlarged is a matter of subjective judgement. Wicked problems are essentially unique. They always yield a distinguishing property of importance since there are no classes that allow for principles of solutions fitting to all members of a class. Despite obvious similarities there is no certainty about the particulars of any given problem. Wicked problems are always a symptom of other problems. Addressing the problem at any given level can never be decided logically since there is no natural level of wicked problems. Even systemic approaches and incrementalism can make things worse, rather than better. Wicked problems can be explained in numerous ways since there is no rule that determines which explanation is correct. The choice of explanation is arbitrary and guided by attitudinal criteria since people generally choose those explanations that are most plausible to them. Wicked problems stand for ambiguity of causal webs in which solutions always point towards further sets of dilemmas. Actions always generate consequences and the effects regardless whether desired, undesired, intended, unintended, good or bad matter a great deal to those who are affected.[282] The American led Coalition Forces entered Iraq in March 2003 forcing an end to Saddam Hussein and his regime. After the war, conditions for the Iraqi people were different from the speculations prior to the invasion. The coalition forces encountered a situation characterised by decreasing civil insecurity and looting.[283] This facilitated an insurgency that grew in size and complexity over the course of 2004. At the beginning of 2004, attacks numbered approximately 25 per day and then averaged around 60 by the end of the year. Insurgents were able to increase activity around key events, for example, the number of attacks reached approximately 300 on

[282] Rittel–Webber 1973: 160–167.
[283] Global Security 2011a.

the day of election. Coalition Forces continued to be the primary targets, but also Iraqi officials, foreign nationals and the country's infrastructure were not spared. The continuing attacks have undermined efforts of reconstruction and stabilisation of the country and caused the death of more than 3,000 Coalition soldiers and wounded 22,000 more. Whereas in November 2003, the number of insurgents was estimated to be around 5,000, a year later their number doubled, and roughly 50 militant cells could be differentiated enjoying increasing popular support. The number exploded a year later as the Iraqi intelligence service director spoke of 40,000 full-time and 200,000 part-time fighters with no sign that things would get better.[284] Continuing violence, non-existing or shattered state institutions, a non-functioning economy, and a war-torn and exhausted society was the result. Coalition forces have failed to reconstruct Iraq in political, economic, social and security terms. Coalition forces increasingly withdrew into a physical and psychological bunker. Many signs indicated that the general "obsession with control was an overarching flaw in the U.S. occupation from start to finish".[285] Control has relevance only to a small portion of the continuum as the rest has much more to do with coping. Most objectives of Operation Iraqi Freedom were not purely military and were relatively clearly stated. They included the ending of Saddam Hussein's regime; the identification, isolation and elimination of weapons of mass destruction; the searching, capturing and driving out terrorists from the country; the collection of intelligence related to terrorist networks; the collection of intelligence related to the global network of illicit weapons of mass destruction; the ending of sanctions and delivering humanitarian support to the displaced and needy citizens; the securing of Iraq's oil fields and resources; and the creation of conditions that make the transition to a representative self-government possible.[286] In terms of the joint effect landscape, one can state that the original evolutionary stable situation between the United States and Iraq changed dramatically. In the early phase, joint operations were symmetric, force-on-force, delivered in a firepower-centric manner. Iraqi resistance was smashed within weeks, and achieving the highly ambitious objectives through the co-ordinated sets of various sorts of effects appeared possible. The maximising approach to strategy formulation, aimed at achieving centralised effects seemed to be promising and realisable. Unfortunately, soon

[284] Global Security 2011b; Global Security 2011c; Hoffmann 2004: 11–14.
[285] Diamond 2004: 34–40.
[286] Global Security s. a.

after the traditional phase officially ended and victory of the Coalition Forces was declared, the situation started to deteriorate and it slid out of control. It became increasingly clear that achieving the original objectives was more and more impossible. There were no attempts to lessen control and lower the initial ambition in order to adapt to changing conditions. Instead of establishing a mechanism that can increase the chance to discover new and exploitable opportunities, Coalition Forces shut down the possibility to discover and expand on good-enough scenarios. Their rigid focus aimed at climbing hills on the landscape identified for a given scenario resulted in an alarming inefficiency. An abundance of factors such as a serious legitimacy problem with the international community, the lack of area and linguistic experts, the Iraqi's distrust and deep suspicion regarding the occupation's real motives, their partial and puzzled understanding of democratic governance, and Western cultural bias seeing democracy as a one-fits-all, prohibited successful jumps across the landscape and the discovery of new and promising hills.[287] The situation in Iraq came close to a Red Queen in which Coalition Forces had to run ever faster to stay in the same place. Their average fitness level constantly declined and the chance for extinction, which equals defeat increased steadily. Coalition Forces were bogged down and the number of conflicting constraints they had to manage became so high that whatever they did and wherever they looked for, only vicious circles were available. For over years there was not even a not-very-bad scenario in sight.[288] Despite the abundance of publications dealing with the advantages of network-centric warfare, effects-based operations and similar concepts one has the impression that Western armed forces have much to learn how to acquire flexibility and agility to respond to altering challenges in an appropriate way. The obsession with efficiency, analytical rationality, technological focus does not make it possible to develop the level of adaptability that is needed to evolve as a complex adaptive system. Structures and models the Western armed forces employ are not fit enough to compete for survival with a challenger that has less an established bureaucracy, but more an ad hocracy. The lessons learned from evolutionary biology indicate that Western armed forces are extremely specialised and occupy only a narrow field on the joint effects landscape. They do not possess the ability to move constantly in order to find higher general regions. Based on their causality sensitivity, they are reluctant to apply various sorts of

[287] Diamond 2004: 42–50.

[288] Baker–Hamilton 2006: 9–27.

trial-and-error mechanisms, which are so important in learning and adaptation. The more the situation becomes chaotic, the more one has to rely on decentralised effects, which come as the result of bottom-up initiatives. Western armed forces do not have the necessary means to become truly networked in which they successfully subdivide into many local entities that can search and shuffle continuously. This way at least one entity can discover a good enough opportunity and pull the entire armed force towards it.

Bias and ignorance

The 20th century was full of examples that as soon as a war started it tended to generate its own politics based on its own momentum. This rendered both the original political purposes obsolete and erected new political imperatives. Any conceptualisation of joint operations can be scarcely more than an attempt to grasp a continual and kaleidoscopically shifting process. Joint operations perceived in traditional, rigid and mechanistic terms resembles similarities with engineering. It means that the emphasis is on predefined end-state, top-down command and control, and a slavish adherence to various objectives and measures. In the unfolding 21st century such an approach imposes demands upon Western armed forces they might not be able to meet. In contrast, joint operations conceptualised in the framework of the joint effects landscape as an interactive process means that goals, objectives and effects must be defined as much by political goals pursued by the military, as by acknowledging the limitations of militarily realisable political aims.[289] This conceptualisation takes into account that one at the expense of the other can easily jeopardise success. Rigidity and blind adherence to predefined goals, objectives and effects can result in mounting costs of money and men. An exclusive focus on the strategic level narrows exploitable tactical options with the consequence that one becomes imprisoned in false hopes chasing desired effects. War conceptualised in the framework of the joint effects landscape indicates that Western political-military thinking is based on dangerous assumptions. Due to the inherent bias towards the instrumental dimension, it cannot see and address international security problems other than in quantitative and technological terms. Attributes such as uncertainty, risk and ambiguity increasingly disappear from the vocabulary or

[289] Weigley 1988: 341–344.

are buried under empty concepts. This ignorance and the resulting mechanistic approach to joint operations explains why empty force employment concepts offering "quantitatively guaranteed predictive capabilities with respect to human affairs" can become an all-encompassing credo.[290] They represent a dangerous simplification of joint operations and the only logical outcome can be nothing else than panaceas that promise quick, easy and cheap victories. Joint operations stand for open-ended dynamic processes in which the best one can do is to act on local information, learn from mistakes and hope that a better mix of training, leadership, equipment and weaponry can result in success. Better military discipline contributes to better strategies, better command and control and higher military effectiveness. Both effectiveness and efficiency refer to the relationship between cause and effect, although they indicate different mechanisms as depicted in Figure 12. Probably the biggest benefit that comes from learning and adaptation is the ability to harmonise effectiveness with efficiency. Even a successful combination of both does not allow for perfect solutions, it can guarantee that one does not fall out of alignment in terms of external demand and internal variation. Being effective and efficient means doing the right things right, and successfully combining the science with the art of war. Unfortunately, the West still regards important aspects of war such as strategy formulation, course of action development, command and control and military effectiveness as part of a larger symmetrical engagement. Will, tenacity, skill and endurance can successfully oppose superior firepower. Not destruction in traditional terms, but time and commitment are important factors. Possible enemies in the form of state or non-state actors will not see victory or defeat in terms of decisiveness coming from a swift and crushing military success. They see it as a prolonged stalemate, which drags on for long with the purpose to erode political support and to turn technological weakness into an exploitable advantage.[291] The joint effects landscape indicates a continuous interaction of the belligerents in which both sides are simultaneously attacking and defending. Their efforts are continuous and disturbed only by few interruptions. The forces involved are dispersed in order to exploit open areas containing good-enough opportunities. The aim is not so much to seek a direct head-on annihilation and attrition of the enemy, but to confuse him through constant learning and adaptation manifest in quick and fluid movements rather than precise measurements. The emphasis is on improvisation

[290] Murray 1997: 57–64.

[291] Murray 1999: 32–40; Scales 2000: 7–14.

based on bottom-up local knowledge and working without any direct assistance from the top. Planning is seen as important, but not too important since success comes mostly as a result of loosely organised, fairly autonomous and dispersed units that carry out individual actions. The proposed joint effects landscape as metaphor offers an enhanced conceptualisation of joint operations.

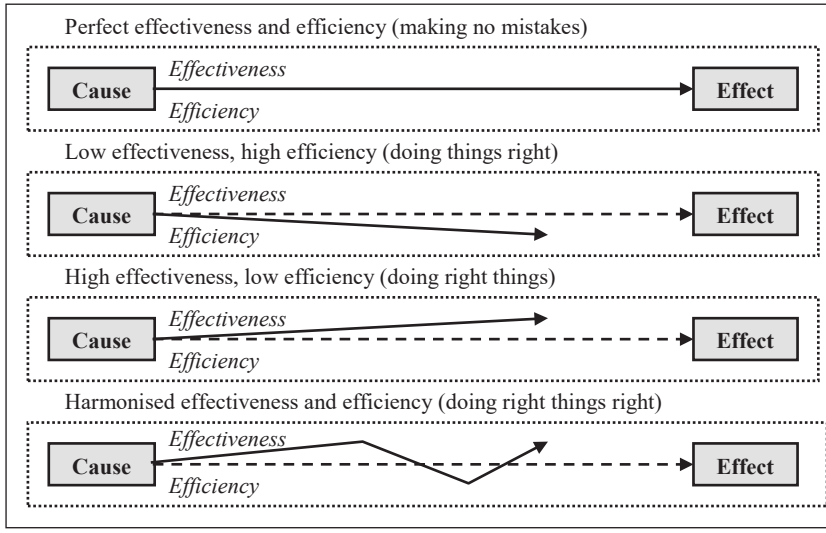

Figure 12. Causality, effectiveness and efficiency
Source: Compiled by the author

However, if one wants to see joint operations as an interactive process that requires continual effort and commitment over a long period of time, it is imperative to rethink in terms of strategy formulation, course of action development, command and control, and military effectiveness.

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Conclusion

In the book the author approached joint operations as a complex optimisation problem for which he used a metaphor coming from population genetics. The suggested joint effects landscape made clear that any conceptualisation war must be more a management activity with a clear cut beginning and a definite end. Any sober theory of joint operations must take into account that waging war has always been more than linking ends with means in a simple deductive fashion, and detecting obvious causality expressed in goals, objectives and effects. Order and equilibrium, the possibility for rational choice, and the ability to steer and control events stand in sharp contrast with the reality of the joint effects landscape. Variety and novelty must be expected and properties that remain mostly hidden or even unknowable to the human mind. It is possible to predict some things, but only those that are local both in space and time. Everything is interrelated and all one can attain is a temporary and partial interpretation in which humans often confuse causation with correlation and simulation with prediction. Several different futures are possible and there is not always time for mechanical, deductive systemic analyses aimed at detecting causality. Instead of focusing on certain desired effects, one should respond consistently to the unpredictable nature of joint operations and evolve rapidly in order to handle dynamic and changing situations. Joint operations contain an array of emerging opportunities that can help shape qualitative behaviour, but not necessarily realise certain predicted futures. Joint operations might display direct causality and equilibrium, but a constant environment makes up only a small fraction of war's bewildering nature. In the thesis, the author demonstrated that deductive thinking and analytical rationality do not make possible to distinguish sufficiently among various alternatives and cannot satisfyingly explain the preference for certain selected factors. Results are disparate and scattered statements lacking a true theoretical basis with simple and uncritical descriptions of positive findings. The proposed joint effects landscape approaches war from an organic point of view that emphasises the importance of learning and adaptation, which make it possible to find a harmony between effectiveness and efficiency. This approach does not allow for perfect solutions, but can guarantee to successfully align external demand and internal variation. Being effective and efficient at the same time means doing the right things right in which one successfully combes the science and the art of war. Much attention should be payed to the end sought to

the means applied. Thus, the book stands for a set of reasons and offers critical arguments for an organic conceptualisation of joint operations. Approaching joint operations as a complex adaptive system opens the door for finding analogies with biological evolution. An organic image requires a strategy formulation and course of action development, which is different from the traditional, top-down, mechanistic, analytically rational and prescriptive model. After a careful study of complexity theory and complex adaptive system theory, the author found that success in joint operations equates to a phase transition in which one does not settle into a stable equilibrium nor fall entirely apart. Success in joint operations requires a mix of strategies that are rigid enough to organise change, but not too rigid to prevent change. The joint effects landscape indicates that often the central challenge in strategy formulation and course of action development is to manage change. Instead of focusing on predefined goals, objective and effects one must always be prepared to accept rapid and unpredictable changes that require various semi-coherent strategic directions without a clear focus in terms of strategic relevance. Clausewitz suggested that accepting surprise, making moves, observing the results and continuing with the ones that seem to work are inherent features of war. Any conceptualisation can be scarcely more than an attempt to grasp a continuously shifting process. Joint operations conceptualised in the framework of the effects landscape stand for an interactive, open-ended process, which must be defined as much by political goals, objectives and effects pursued by the military as by acknowledging the limitations of militarily realisable political aims. Joint operations happen on a continuum and focusing only on certain factors is necessary for analytical reasons. The logical consequence are very narrow conceptualisations that do not provide for developed and compelling explanations. War is context-dependent and requires an appropriate conceptualisation, which must look as much on past errors as present successes in order to avoid sweeping generalisations without taking into account internal structures. An exclusive focus on the strategic level, the emphasis on advanced technology and systemic approach can give the impression that joint operations stand for a commodity that can be wrapped into catch phrases. The book can be seen as a deliberate effort to merge insights from different, but related fields of scientific thinking. Joint operations seen as a complex adaptive system negates the possibility to establish a sort of military checklist offering the take-this-get-that simplicity of effects-based operations. The proposed joint effects landscape allows for causal explanations only with clear limitations. It shows that joint operations stand for a coevolutionary process that spans over many

levels involving an abundance of factors. The belligerents must deal with circular causality, feedback and conflicting constraints. The obvious similarity between war and biological evolution has another important consequence, too. Any theory can aim at explaining real world phenomena, but in case of joint operations and its interactive character, a theory has only utility if it helps determine to what extent past experience can be useful for current problems at hand. Although it is always helpful to discern certain universals that can guide actions, turning those universals into fixed laws and values with the hope to detect causal relationships is mostly impossible. The conduct of joint operations is a context-dependent human phenomenon, which does not provide for blueprints to act. Seen it as a complex adaptive system provides for a comparative methodology in a dual sense. First it approaches joint operations as a phenomenon that moves back and forth from stability to chaos, and displays it as a process that simultaneously occurs across various levels. The most important message of such an approach is that success often demands the ability to learn from actual experience, rather than the ability to formulate action based on past experience. The conduct of joint operations is as much a science as an art, which must be taken into account in every conceptualisation. Given this conclusion, what practical guidance can such a book offer? Conceptualising joint operations as a complex adaptive system indicates an inherent difficulty when attempting to turn the insights gained into actual policies, programs and strategies. The approach does not offer clear and simple answers to the way armed forces should train soldiers, write doctrines and develop leaders in the future. The 21st century has just begun and as one contemporary scholar emphasised "it is time to let a hundred schools of thought bloom".[292] It is our hope that seeing joint operations as a complex adaptive system and expanding on the analogy that exists with processes and phenomena found in biological evolution, will be an important one.

[292] Quotation Metz 1994: 132.

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About the Author

After graduating from the Kossuth Lajos Military College in Szentendre as a mechanised infantry officer in 1990, Col. Zoltán Jobbágy, PhD was assigned to the 32nd Guard and Parade Regiment where he served as platoon commander until 1992. Following a successful application to the University of the Bundeswehr, he studied Education and graduated with majors in Personnel Management and Adult Education in Hamburg, Germany in 1996. He also graduated with a major in Diplomacy in International Relations and Diplomacy from the Budapest Institute of Graduate International Studies at the University of Economic Science in Budapest, Hungary in 2000. He received a PhD in social and behavioural science at the Leiden University in Leiden, the Netherlands in 2009. This degree was nostrificated as PhD in military science by the Zrínyi Miklós National Defence University in Budapest, Hungary in 2010. He successfully habilitated in military science at the National University of Public Service – Ludovika in 2017. He attended the General Staff Course (GSC-31) at the University of Public Service – Ludovika, Faculty of Military Science and Officer Training, General Staff Training Centre where he graduated in 2022.

After returning from Germany Col. Jobbágy was appointed to the Ministry of Defence where he worked in the NATO Department in 1997–1998. Following that he served as assistant to the Deputy State Secretary for Human Policy in 1998–2000. Then, he served as Senior Analysis and Planning Officer within the Human Policy Department in 2000–2003. He then got posted as a researcher at TNO Defence, Security and Safety and became associated with the Clingendael Institute in The Hague, the Netherlands in 2003–2007. After returning from the Netherlands he worked at the Planning and Co-ordination Department of the Ministry of Defence where he became deputy head of the Human Strategy Division in 2007–2010. He joined the Zrínyi Miklós National Defence University in 2010. He started to work as Associate Professor here and continues to do so at the successor institution, the University of Public Service – Ludovika since 2011. He served as Vice Dean for Science and International Affairs between 2017–2019. After the reorganisation of the Faculty of Military Science and Officer Training he served as Vice Dean for International Affairs, and since 2020 he also leads the Department of Military Strategy.

Col. Jobbágy's tours of duty abroad include a service as Officer in Charge of the 1st Hungarian Peacekeeping Company working with the United Nations

in Cyprus in 2000–2001. This was followed by an assignment in Sarajevo, Bosnia-Herzegovina, where he worked as NATO advisor for personnel management in 2008–2009. He also served as military assistant to the Chief of Staff Regional Command North, Mazar-e Sharif, Afghanistan in 2011–2012. Following that he was Chief Liaison Officer at the Joint Force Operations Command in Potsdam, Germany in 2013–2014.

Col. Jobbágy is a member of the NATO Science for Peace and Security Programme's Independent Scientific Evaluation Group, and also the University of Public Service – Ludovika's representative to the NATO Defence Education Enhancement Program. As the Academic Lead for Bosnia-Herzegovina he is a member of NATO's Education Development Working Group. He is also member of the Steering Committee of the V4 Professional Military Education Enhancement Initiative since 2018, and does the same in the Steering Committee of the Multinational Land Force – University of Ljubljana – University of Trieste – University of Public Service – Ludovika Consortium.

Col. Zoltán Jobbágy, PhD is happily married to Andrea Székely and has three sons, Kristóf (2002), András (2005) and Áron (2015). His hobbies include jogging, horse riding, kayaking / kayak sailing, and bushcrafting.

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A biological perspective on human behaviour has much to offer for a better understanding of the relationship between co-operation and conflict. Regardless whether one sees war and joint operations through the eyes of Clausewitz, approaches it as a complex optimisation process, or examines it along attributes that display similarities with biological evolution, there are timeless and innate characteristics. It is not difficult to conclude that both biological evolution and joint operations are intrinsically complex, and primordial violence is at the heart of both.

Thus comprehending joint operations in an evolutionary framework rejects classical theories and promotes complexity thinking that requires a shift from mechanics to biology. The emphasis should move from statics to dynamics, from time-free to time-prone reality, from determinism to probability and chance, and from uniformity to variation and diversity.

In this book the author approaches joint operations as a complex adaptive system in which the system properties emerge from the interactions of the many components at lower levels. Dispersed interactions indicate a mechanism that lacks global control, but feeds from a crosscutting hierarchical setup. Similarly to biological evolution, joint operations also feature perpetual novelty and are far from equilibrium dynamics that demand continual adaptation.

This requires soldiers to evolve rapidly to handle dynamic and changing situations instead of focusing on anticipated circumstances and conditions that come as the result of single and rigid prescriptive models. Biological evolution as a basis for better understanding the dynamics of military operations certainly does good service. First it helps value the many irregular processes found on the tactical level, second it can help find a balance between centralisation and decentralisation when executing tactical level tasks. Third, it can facilitate a better understanding for achieving a match between the external diversity of the environment and the internal variation of military organisations to cope with the many challenges present in that environment.

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