AGILITY QUOTIENT (AQ)

David Alberts

How can we measure an entity's probability of success without specifying the nature of the mission or the circumstances under which it will be conducted?

Progress in designing and developing more agile entities will depend on our ability to observe appropriate behaviors and outcomes, associate these behaviors and outcomes with entity characteristics, and determine the amount of agility required.

The concept of agility is increasingly recognized as a "must-have" capability for individuals and organizations and for the systems that support them. Enterprises are called upon to perform successfully—if not thrive—in environments that are ever more complex and dynamic. Because of the complexity and dynamics involved, theoretical planning assumptions "to survive first contact with the enemy" are insufficient. The capability to effect, cope with, and/or exploit unexpected circumstances and changes successfully is necessary. This capability has been defined as *agility* (NATO 2013).

Commanders and managers at all levels are faced with the challenge of ensuring that their organizations will be agile, while system designers and developers need to ensure that systems that can adequately support users under these conditions. To know whether these commanders and managers have the requisite amount of agility to face an uncertain future, two questions have to be answered:

- How can potential agility be measured?
- What is the amount of agility required?

THE CONCEPT OF AGILITY

The definition of agility and its six enablers—responsiveness, versatility, flexibility, resilience, adaptiveness, and innovativeness—has been discussed and explored in North Atlantic Treaty Organization (NATO) and U.S. Department of Defense Command and Control Research Program (DoD CCRP) publications (International Command and Control Institute n.d.). These publications provide a conceptual framework that can be employed to find an appropriate balance between and among effectiveness,

efficiency, and risk and a rational basis for improving an entity's agility.[1]

Progress in designing and developing more agile entities will depend on our ability to observe appropriate behaviors and outcomes, associate these behaviors and outcomes with entity characteristics, and determine the amount of agility required. The article suggests a way forward and illustrates it in the context of command and control (C2) systems. It discusses the need to complement agility assessments based upon the observation of manifest agility with a scenario-free assessment approach that provides a measure of agility potential—an Agility Quotient (AQ).

AGILITY: KEY IDEAS

The situations that we face are inherently dynamic. Initial solutions—even if these solutions are effective—will become less effective over time. Plans will be, at best, short lived because no matter how much we invest in information and analysis to reduce uncertainly, a significant amount of residual uncertainty will remain. We will always have to address unexpected and unanticipated events and circumstances. Agility is the only way to meet the challenges of complexity and dynamics that does not require ignoring problem difficulty to find a solution (Alberts 2011).

While the definition of agility used here is widely accepted within the C2 research community, different communities define agility in different ways and/or employ a variety of terms (e.g., robustness, resilience, reliability) to refer to this capability. However, these various definitions of agility, despite their differences, converge on three key ideas (Dove and LaBarge – Part 1 and Part 2 2014):

- Agility is an appropriate response to the challenges posed by complexity and dynamics and the resultant reduced ability to predict and a rise in the frequency of unanticipated events. Increased complexity is also associated with exacerbating the adverse consequences of these events, particularly since these events may trigger cascades of effects that cannot be understood or controlled adequately. This inability to understand or control events leads to an increased probability of catastrophic failure.
- Agility is inseparable from success (i.e., an appropriate measure of agility must reflect outcomes). Thus, an entity manifests agility only if and when it can seize upon an opportunity to improve performance, increase efficiency and/or reduce risk, or is able to continue to operate successfully despite being subjected to a stress that would otherwise adversely impact its ability to operate successfully.
- Agility is not a passive concept but is one that includes anticipatory and proactive behaviors.

[1] *Entity* is used here to refer to the unit of analysis, whether it is an individual, a group of individuals, a formal organization, a coalition, a process, a policy, or a system.

OBSERVING AND MEASURING AGILITY

The manifestation of agility requires a successful outcome. Depending on the nature of the entity, success will be determined by some combination of performance or effectiveness, costs, and risks. While success or a lack thereof can usually be easily observed, the reasons are often less apparent. Clearly, one can conceive of numerous reasons why an entity might be successful in spite of itself, its capabilities, and even its lack of agility. Thus, success alone should not be equated with agility. While it is difficult—if not impossible—in real-world situations to establish a cause-effect relationship between a successful outcome and the "exercise of agility," it is possible to observe specific enablers of agility (or a lack thereof) in entity behaviors and employ measures of the degree to which these enablers are present.

The following enablers of agility have been identified and defined (NATO 2013):

- Responsiveness
- Versatility
- Flexibility
- Resilience
- Adaptiveness
- Innovativeness

The manifestation of agility and its impacts can be directly observed and measured but only when circumstances require agility and when the entity is able to respond appropriately. When an entity does not possess adequate agility, this lack of agility can also be observed.

A metric can be derived from these observations. For example, a measure of potential agility based upon experience and analysis is the probability that an entity has manifested agility when required. Calculating this probability is a three-step process:

- The first step involves the construction of an Endeavor Space, a space that includes the population of missions and circumstances. This construct provides the set of missions and circumstances whose characteristics need to be analyzed to determine whether the entity can successfully operate in different parts of the Endeavor Space (Alberts 2011). A more sophisticated analysis could estimate the conditional probability of success.
- The second step is to project whether the entity can successfully operate in each part of the space.
- The third step is to sum the outcomes across the Endeavor Space.

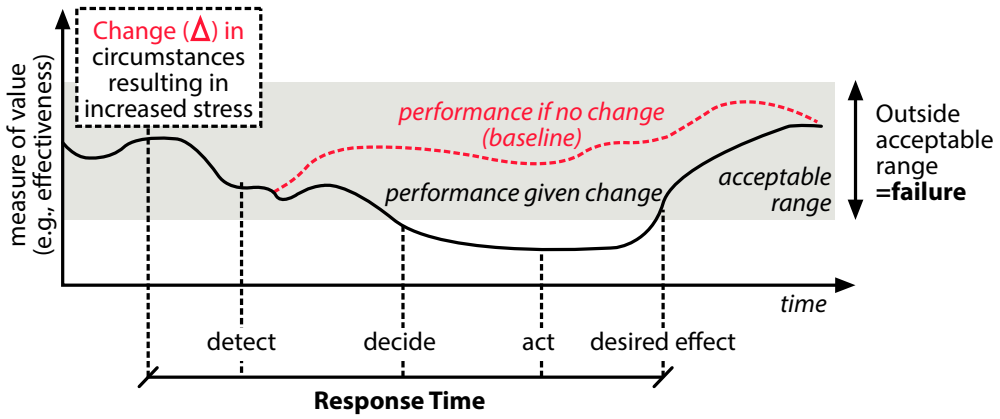
AGILITY ADVANTAGE

Success and failure have associated costs. One way to determine the value of agility is to take into consideration the amount of time that an entity could not perform acceptably and the magnitude of the performance shortfall, as is depicted in Figure 1.

Figure 1 provides a response timeline that, if improved, could (1) reduce the amount of time an entity failed to perform within acceptable bounds or (2) decrease the amount of the performance gap. While Figure 1 helps us determine the opportunity loss incurred by a lack of agility, we need more information to determine what is needed to improve agility.

AGILITY ATTRIBUTION AND MEASUREMENT

The SAS-085 case studies were able to identify the presence or absence of agility enablers and associate these observations with manifest agility (NATO 2013).[2] While identifying instances in which agility was not manifested can identify problems areas on which to work, instances of manifest agility should not be considered to be proof of adequate agility because the sample of stresses and conditions considered is extremely small and not necessarily representative of future conditions. Fortunately, we do not need to limit our assessment of agility to observations of an entity in operation. One approach augments real-world observations by putting an entity (or a simulated entity) in a controllable/instrumented environment, creating possible futures, and performing observations under a variety of scenarios without waiting for these scenarios to occur in the real world. The set of scenarios that is used, plus those scenarios that are thought to be "lesser included cases," could form the basis for an Endeavor Space. This space can be used to calculate an absolute measure of agility, a probability of success, or a relative measure that simply compares two entities or instantiations to the same standard.



Source: Alberts 2011.

Figure 1. Observing Entity Performance

[2] SAS-085 Case Study methodology and results can be found in Chapter 7 and Appendix B of NATO (2013).

Scenario-based approaches can result in a biased measure of potential agility. Their accuracy depends upon the number and nature of the scenarios used to create the Endeavor Space and whether this space adequately encompasses future situations. Some analysts focus on the "most likely" situations and stresses, while other analysts focus on the most stressing circumstances. In either case, it seems inevitable—and the evidence suggests—that the set of scenarios employed will be constrained by preconceived notions, groupthink, and biases.

This situation does not imply that we should abandon a scenario-based approach; rather, it suggests that we should be careful to employ scenarios in a thoughtful way. Given these inherent limitations, the development of a measure of an entity's potential agility (i.e., AQ [Agility Quotient]), patterned after the Intelligence Quotient (IQ), makes sense. IQ tests seek to measure cognitive capabilities. These tests are attempts to measure fundamental attributes or capabilities of individuals that enable them to learn and apply knowledge. Since inception of these tests in the early 1900s, their developers have recognized that intelligence is a concept that is too encompassing to be measured in a scalar metric (Cherry 2016). Furthermore, a host of factors besides genetics could influence intelligence and, along with other factors, could bias test results. We need to keep this in mind as we try to develop and employ AQ tests.

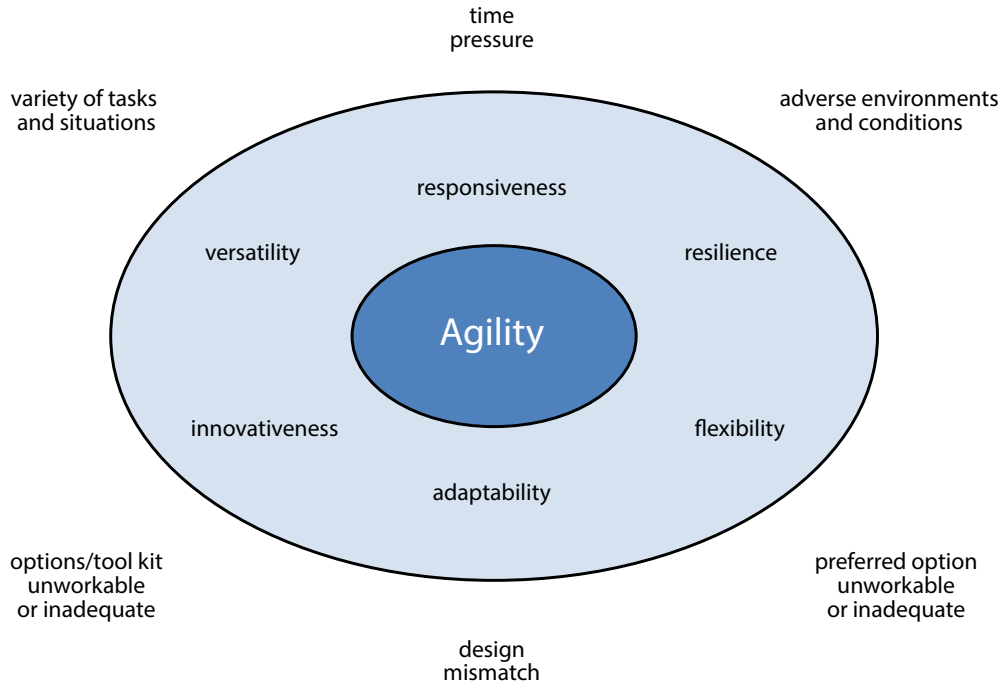
It seems reasonable to begin by building upon the enablers of agility that have, to some extent, been validated in case studies and experiments.

Figure 2 depicts the enablers of agility in the context of the characteristics that make tasks difficult and/or conditions that stress an entity:

- Responsiveness is required to accommodate time pressures.
- Resilience is required to recover from damage or degradation.
- Flexibility is needed when one way of accomplishing something does not work.
- Versatility is needed when an entity is used for multiple purposes.
- Innovativeness is required when existing ways and means are not adequate for the task and circumstances.
- Adaptability is required when, to succeed, the entity needs to change itself. The ability of an entity to change itself includes but is not limited to being able to adopt different approaches to C2 (Alberts 2011).

A MODEL OF C2 AGILITY POTENTIAL: C2 AQ

The development of a model of C2 AQ is used to illustrate an approach to ascertaining an entity's potential agility. C2 Agility is about ensuring that an appropriate approach to C2 is being employed. There are many ways to accomplish the functions we associate with



Source: Alberts and Hayes 2006.

Figure 2. Enablers of Agility

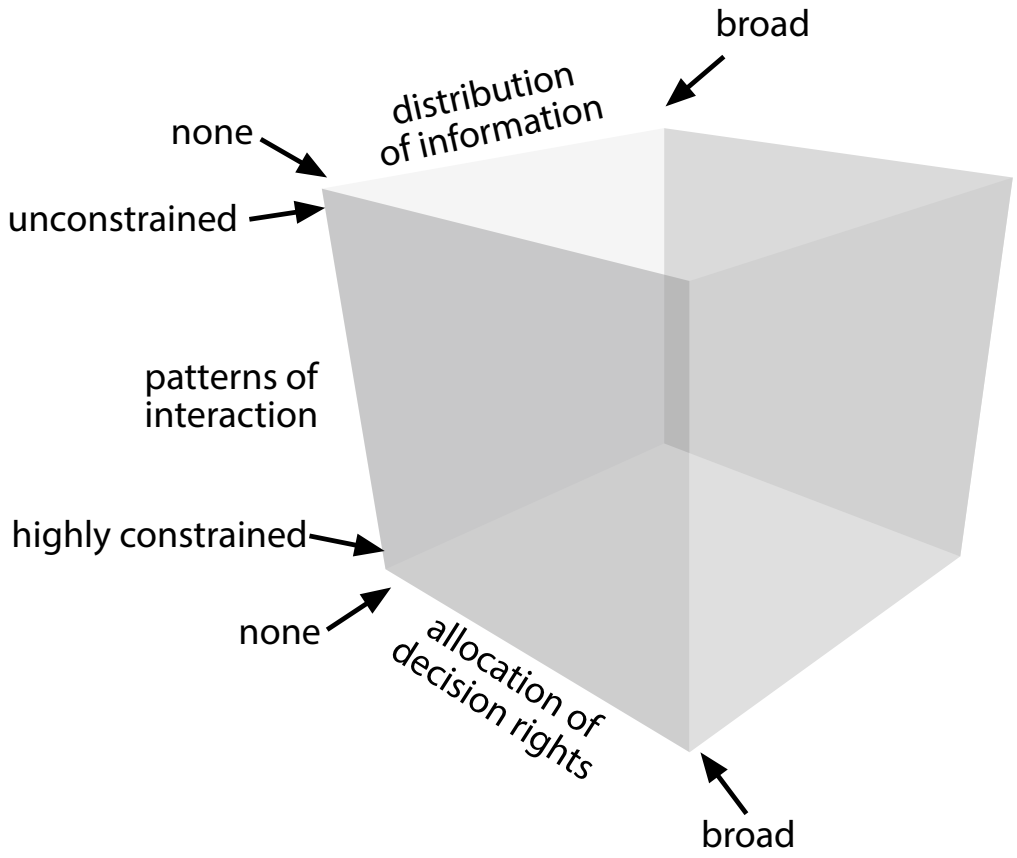
C2 with different approaches corresponding to different regions in the C2 Approach Space (see Figure 3)

Experience, case studies, and experiments have yielded many C2 Agility-related findings and have explored the following hypotheses to be considered in a model of C2 AQ:

- There is no "one-size-fits-all" approach to C2 that works well for all missions and circumstances.
- Network-enabled approaches to C2 are more agile than others.
- Balanced approaches to C2 are more agile.
- The "selected" approach to C2 may not be the one that is actually being implemented.
- Being able to adopt more than one approach improves agility (C2 maneuver).
- Agile individuals, processes, policies, and systems—each and in combination—improve the agility of a given C2 Approach and the ability to appropriately maneuver in the C2 Approach Space.

To the extent that these hypotheses have merit, an entity's C2 Agility is a function of the following:

- Number of different C2 approaches available
- Agility of each of these C2 approaches
- Ability to maneuver appropriately in the C2 Approach Space.



Source: Alberts 2011

Figure 3. The C2 Approach Space

The C2 Agility-related lessons learned suggest a number of questions (see Figure 4), the answers to which would provide some indication as to an entity's C2 AQ and point to some observables that could be used to construct a model of C2 AQ. These questions are but a small sample of those questions that are suggested by these and other lessons learned and reported on in the NATO Research Group SAS-085's Final Report on C2 Agility (NATO 2013).

C2 Agility depends to a significant extent on the agility of the systems that support C2. More agile systems are less likely to impose constraints on an entity's choice of C2 Approach. Thus, a holistic approach to C2 AQ should be taken—one that includes a consideration of the agility of the communications and information systems that support C2 processes and the agility of the processes themselves.

A number of systems engineering principles are thought, if followed, to produce more agile systems. These principles are related to reusability, reconfigurability, and scalability. These means of

enabling agility, as well as others that may be identified, can provide the basis for the development of agility "markers"—variables that measure the degree to which a means has been achieved. These markers can serve as indicators of potential agility and can be integrated into an agility value proposition. Systematic experimentation is needed to validate these markers and refine our understanding of the agility value chain. The aim of a model of potential agility is to integrate all of these means and markers into a value proposition—one that enables "designers" of organizations and systems (e.g., commanders, managers, and engineers) to understand better how they can enhance an entity's potential agility and to do so efficiently.

- **What is the most network-enabled approach that can be adopted?**
- **How many different approaches to C2 can be adopted?**
- **How is the approach to C2 initially determined?**
- **Is the appropriateness of the C2 Approach periodically assessed?**
- **Is the way C2 is currently being approached monitored?**
- **Are there processes in place to ensure that the C2 Approach is balanced?**
- **Is the state (performance) of supporting systems monitored?**
- **How agile are individuals, processes, and supporting systems?**

Figure 4. Agility-related Questions

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REFERENCES

Alberts, David S. 2011. "The Agility Advantage: A Survival Guide for Complex Enterprises and Endeavors." CCRP Publications Series. Washington, DC, Department of Defense, Command and Control Research Program. http://dodccrp.org/files/agility_advantage/Agility_Advantage_Book.pdf.

Alberts, David S., and Richard E. Hayes. 2006. "Understanding Command and Control." CCRP Publications Series. Washington, DC: Department of Defense, Command and Control Research Program. http://www.dodccrp.org/files/Alberts_UC2.pdf.

Cherry, Kendra. 2016. "History of Intelligence Testing." *verywell,* August 27. https://www.verywell.com/history-of-intelligence-testing-2795581.

Dove, Rick, and Ralph LaBarge. 2014. "Fundamentals of Agile Systems Engineering – Part 1." INCOSE International Symposium. 859–875. http://onlinelibrary.wiley.com/doi/10.1002/j.2334-5837.2014.tb03186.x/pdf.

——. 2014. "Fundamentals of Agile Systems Engineering – Part 2." INCOSE International Symposium. 876–892. http://onlinelibrary.wiley.com/doi/10.1002/j.2334-5837.2014.tb03187.x/pdf.

International Command and Control Institute. n.d. "Command and Control Research Portal." http://www.dodccrp-test.org/.

NATO 2013. "C2 Agility: Task Group SAS-085 Final Report." STO Technical Report STO-TR-SAS-085. Brussels, Belgium: Research and Technology Organization, September. http://dodccrp.org/sas-085/sas-085_report_final.pdf.