Boyd's OODA Loop
(It's Not What You Think)

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Abstract

Although the strategic ideas of John Boyd encompass much more than the well known OODA loop, the loop does provide a concise framework for improving competitive power throughout an organization. Much of this power will be lost, however, by regarding the loop as a simple, sequential, and circular pattern. Fortunately, Boyd only drew one sketch of the OODA loop, which bears little resemblance to this popular misconception. That one is the key to his entire body of work.

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Introduction: A Non-school of Strategy

Do not be persuaded by the seeming competence of a speaker or because you think "This guru is our teacher." The Kalama Sutra of the Buddha (Bodhi, p. 89), slightly paraphrased.

The late USAF Colonel John R. Boyd (1927 – 1997) was hard on ideologues: "Don't be a member of Clausewitz's school because a lot has happened since 1832," he would warn his audiences, "and don't be a member of Sun Tzu's school because an awful lot has happened since 400 BC."

We should not be members of Boyd's school, either: "If you're going to regard my stuff as dogma, if it's going to keep you from thinking," he would say at some point in his briefings, "you'd be better served to take it out and burn it." Why, then, spend time studying his works today? Boyd's (1992) answer was not to memorize the principles of any strategy, including his, but to follow his larger example, to achieve what he called *Fingerspitzengefühl*[*] — a level of skill and understanding so deep that actions flow without conscious decision — in creating, employing, and dealing with the novelty that permeates human life.

Boyd's Influence Today

In his eulogy, General Charles Krulak (Osinga, 2005, p. 1), a confidant of Boyd's and at the time commandant of the U.S. Marine Corps, summarized his influence on military strategy:

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[*] German, literally "fingertip feeling"

The Iraqi army collapsed morally and intellectually under the onslaught of American and Coalition forces. John Boyd was an architect of that victory as surely as if he'd commanded a fighter wing or a maneuver division in the desert. His thinking, his theories, his larger than life influence were there with us in Desert Storm. He must have been proud of what his efforts wrought.

Osinga (2005) noted that beyond the foundational outline of the maneuver warfare doctrine used by the Marine Corps in the 1991 and 2003 Gulf Wars, Boyd's influence reached deep into the theory of conflict. Such ideas as agility, shaping the mind of the enemy, harmony among all levels, and perhaps most important of all, promoting—not just exploiting or responding to—uncertainty and disorder, "were all either invented, re-discovered or inspired by Boyd." (p. 4). Osinga concluded that

Reading through Boyd's work nowadays one does not encounter novelty or experience difficulty following his arguments and accepting his ideas. His language and logic, his ideas, terms and concepts are part and parcel now of the military conceptual frame of reference. Western military organizations have to a large extent internalized Boyd's concepts, and perhaps even learned Boyd's way of thinking. (p. 316)

Nissestad (2007) summarized Boyd's contributions to modern strategy, and particularly to its leadership component, as:

Boyd was the first in the modern era to propose a comprehensive theory of strategy that is independent of size or technology and to identify an organizational climate for achieving it. (p. 11)

(Boyd) was the first to observe that the common underlying mechanism involved tactics that distort the enemy's perception of time. He

identified a general category of activities to achieve this distortion, the ability to change the situation faster than the opponent could comprehend, which he called "operating inside the Observation-Orientation-Decision-Action (OODA) loop." (pp. 11-12)

Boyd was not the first to appreciate initiative, even by privates and sailors, but he was the first to tie a specific climate based on initiative to the ability to generate rapid transients in combat and other conflicts. (p. 12)

Prior to his career as a strategist, Boyd exercised a profound influence on the design of air-to-air fighter aircraft and the tactics used to employ them. He was the first to quantify the relative merits of two such aircraft across their entire flight envelopes, a method, "energy-maneuverability," that is taught to fighter pilots to this day. Perhaps the best known aircraft designed "according to Boyd" is the F-16, which Boyd helped select as the winner of a competition in 1975 and is still in production (Coram, 2002; Hammond, 2001; Osinga, 2005).

Finally, at the end of his life, after the fall of the Soviet Union, he turned his attention away from war towards other forms of conflict, particularly business. Tom Peters referred to Boyd twice in his last major work, *Re-imagine!* (2003) and Boyd was an inspiration for Peters' breakaway strategy book, *Thriving on Chaos* (Osinga, 2005; Richards 2004). Although Boyd did not write on business, per se, he did collaborate on my book, *Certain to Win* (Coram, 2002; Richards, 2004), which drew upon the common principles that underlie both Boyd's concepts of moral and maneuver conflict and today's lean philosophies in manufacturing and product development.

Boyd himself might once have lost interest in armed conflict, but his influence on our national defense debate lives on. An American Secretary of Defense, Robert M. Gates (2010), summarized Boyd's contributions in an address to cadets at the U.S. Air Force Academy in Colorado Springs in April, 2010:

> *As a 30-year-old captain, he rewrote the manual for air-to-air combat and earned the nickname "40-second" Boyd for the time it took him to win a dogfight. Boyd and the reformers he inspired would later go on to design and advocate for the F-16 and the A-10. After retiring, he developed the principles of maneuver warfare that were credited by a former Marine Corps commandant and a secretary of defense for the lightning victory of the first Gulf War.*

The OODA "Loop"

If people know anything about Boyd, it generally has something to do with the OODA loop (Osinga 2005). The acronym "OODA" stands for "observe, orient, decide, act," and it is often depicted as in Figure 1, with the four elements arranged in a simple sequence, as if the acronym stood for "observe, then orient, then decide, then act" (Osinga 2005; Richards, 2004).
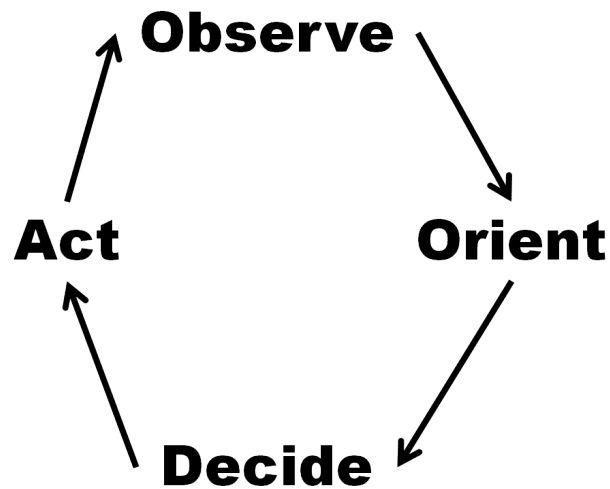
Observe

Act

Orient

Decide

Figure 1. The OODA loop is often depicted as a simple sequential process.

 Osinga (2005) described the usual interpretation of the OODA loop as a tool for strategy:

> *In the popularized interpretation, the OODA loop suggests that success in war depends on the ability to out-pace and out-think the opponent, or put differently, on the ability to go through the OODA cycle more rapidly than the opponent. Boyd's name will probably always remain associated with the OODA loop and this popular interpretation.* (p. 6)

Thus the study of conflict is reduced to dueling OODA loops, with the side that can go through its loop the more quickly building an insurmountable competitive advantage. A corollary to this approach is that the side that can make the quickest decisions is most likely to win (Osinga, 2005).

As beguiling as this simple concept might be, it is not a powerful weapon of strategy, either in war or for business. There are several reasons for this possibly counterintuitive result:

- The most important is that a simple, sequential loop does not well model how organizations act in a conflict. A British officer, Jim Storr (Osinga, 2005), summarized this situation:

    > *The OODA process is not circular. It apparently takes 24 hours to execute a divisional operation. Planning takes a minimum of 12 hours. Thus a divisional OODA loop would have to be at least 36 hours long. Yet the Gulf War and other recent operations show divisions reacting far faster.* **Military forces do not in practice wait to observe until they have acted**. *Observation, orientation and action are continuous processes, and decisions are made occasionally in consequences of them. There is no OODA loop. The idea of getting inside the enemy decision cycle is deeply flawed.* (p. 8; emphasis added)

- It has sometimes proven advantageous to take extra time selecting a course of action—that is, reaching a decision to act—in order to create a more favorable environment for actions in the future. Such a slowing down in the tempo of operations is a common tactic by participants in the unconventional wars that developed countries are confronting today and which go under the names like "fourth generation warfare," "insurgency," and "protracted war" (Hammes, 2004).

- Similarly in business: One of the earliest papers on the Toyota Development System carried the subtitle, "How delaying decisions can make better cars

faster" (Ward, Liker, Cristiano, & Sobeck, 1995). The authors of that paper noted that a company can minimize the total design time of a car not by making decisions more quickly than its competitors but by ensuring that decisions once made never need to be revisited.

With objections as serious as these, it is well that Boyd never included the OODA "loop" as described by Storr and depicted in Figure 1 into any of his works, nor did he ever describe it as a sequential process, in any of his presentations on competitive strategy.[†]

The Real OODA "Loop"

For his Ph.D. dissertation on Boyd, Dutch fighter pilot Colonel Frans Osinga (2005) took the concept of rapid OODA looping head on. His thesis was, "Boyd's OODA loop concept as well as his entire work are more comprehensive, deeper and richer than the popular notion of 'rapid OODA looping' his work is generally equated with" (p. 10). Far from discrediting the OODA loop, Osinga made the case that the power of Boyd's ideas comes from using the right one, the "loop" that Boyd drew.

Why an OODA Loop?

In the 281 pages of his presentations on armed conflict — *Patterns of Conflict, Organic Design for Command and Control,* and *Strategic Game of ? and ?* — Boyd

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[†] Unfortunately, perhaps, Boyd did use the phrase "rolling through O-O-D-A loops" one time, on chart 177 of *Patterns of Conflict*. My personal opinion is that this isolated instance reveals how Boyd's ideas were changing in the decade between *Patterns of Conflict* and the non-cyclical sketch of the O-O-D-A "loop" that he drew for *The Essence of Winning and Losing*, described in detail below.

rarely wrote the term "OODA loop" alone but virtually always used the phrase "operating inside opponents' OODA loops," which he seemed careful never to define.[‡] The closest he came was 132 charts into his major briefing on war, *Patterns of Conflict* (Boyd, 1986), where he stated that to operate inside an adversary's OODA loop could be "put another way" as "Observe, orient, decide and act more inconspicuously, more quickly, and with more irregularity …" Another way to think about operating inside the OODA loop is that we change the situation more rapidly than the opponent can comprehend (Boyd, 1986, p. 5), that we "stay one or two steps ahead" of an opponent (Coram, 2002, p. 327). And keep doing it. Visualize a cat playing with a mouse.

These concepts go considerably deeper than cycling through "observe, then orient, then decide, then act" more rapidly than an opponent. He made the claim that the ability to operate inside O-O-D-A loops, rather than just cycle through them more quickly, enabled one to execute an agenda of heinous acts upon one's adversary, culminating in "Generate uncertainty, confusion, disorder, panic, chaos … to shatter cohesion, produce paralysis and bring about collapse" (Boyd, 1986, p. 132).

But what about the OODA loop itself, as contrasted with "operating inside the OODA loop"? In his final presentation, *The Essence of Winning and Losing*, Boyd (1996) made even more expansive claims for it:

[‡] In addition to the occurrence on Patterns 177, noted above, Boyd used the term "O-O-D-A loop" standing alone in *Organic Design for Command and Control*, on pages 16 and 26, but without definitions or figures.

Without OODA loops, we can neither sense, hence observe, thereby collect a variety of information for the above processes, nor decide as well as implement actions in accord with these processes. (p. 1)

When combined with the idea of operating inside an adversary's OODA loops, the OODA loop provided the key to success not just in war or in business but in life:

Without OODA loops embracing all of the above and without the ability to get inside other OODA loops (or other environments), we will find it impossible to comprehend, shape, adapt to and in turn be shaped by an unfolding evolving reality that is uncertain, everchanging, and unpredictable. (Boyd, 1996, p. 1)

As with the concept of "operating inside the OODA loop," Boyd did not provide an explicit definition of the loop itself.[*] You could reasonably infer that any concept that meets the requirements of the paragraphs just above would work. Figure 1, for example, "works," although as we have seen not very well. What Boyd did offer is the sketch (as he called it) shown in Figure 2 (1996, p. 3), and it is safe to say it was not what most people expected.

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[*] Boyd loved formal definitions and salted his works with them. At least 24 occur in just the "Categories of Conflict" section of *Patterns*, and others appear at the end of *Strategic Game* and *Organic Design*.
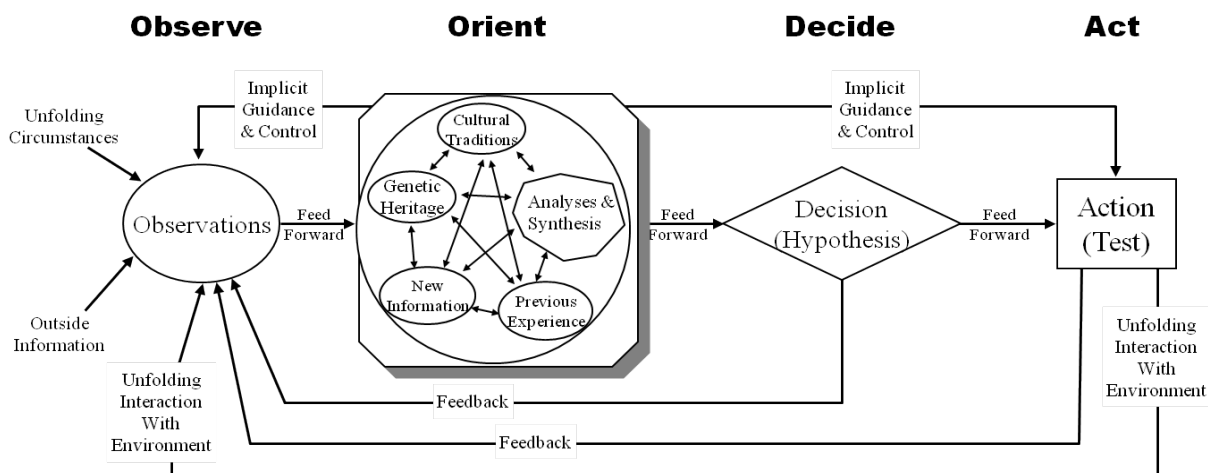
Observe   **Orient**   **Decide**   **Act**

Figure 2. The only OODA "loop" that Boyd actually drew.

Interpreting the OODA "Loop" Sketch

The "loop" depicted in Figure 2 is a wonderful framework for strategy, but it can appear daunting. To get a handle on it, begin with the centrality of orientation and imagine that when we are engaged with opponents—or in the case of business, with competitors and customers—our actions will flow from orientation directly and implicitly, that is, without explicit (e.g., written or detailed verbal) commands or instructions, most of the time, something which is difficult to model with the loop of Figure 1, which contains the explicit "decision" step. Orientation is an ancient idea, embodied in the concept of mindfulness, but it is as modern as fighter pilots, who talk about maintaining "situation awareness."

This emphasis on orientation implies that every conflict, whether business, war, the martial arts, sports, politics or whatever, contains an embedded learning contest of keeping orientations accurate so that we can make better predictions of the

effects of our actions than the predictions of our opponents or competitors (Boyd, 1976). But success under this model is not a simple, accumulative process, where one gradually adds to one's net competitive advantage account and the side with the higher balance wins. Instead, by maintaining better awareness, one can create opportunities to act. Boyd based much of his strategy on one particular pattern of actions, Sun Tzu's "*cheng/ch'i*" (Boyd, 1987; Gimian & Boyce, 2008)[*].

How to Become Certain to Win

The basic idea is simple: An organization uses its better understanding of—clearer awareness of—the unfolding situation to set up its opponent by employing actions that fit with the opponent's expectations, which Boyd, following Sun Tzu (trans. 1988), called the *cheng*. When the organization senses from its previous experiences, including training, that the time is ripe (note that this is a prediction from its orientation), it springs the *ch'i*, the unexpected, extremely rapidly (Gimian & Boyce, 2008).

Boyd (1976b) called the rapid transition from what an opponent expects to something that it does not an "asymmetric fast transient." He first observed its effects on an opponent's orientation while an instructor pilot at the Fighter Weapons School in the late 1950s (Coram 2002) and it became the basis for the concept of "operating inside the OODA loop" (Boyd, 1986, p. 5).

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[*] The official system, pinyin, for transliterating Chinese would write this as *zheng / qi*, which you are starting to see more often in books about oriental strategy.

Cheng/ch'i maneuvers are difficult to pull off against an opponent well versed in strategy, but when they succeed the results are worth the effort. The earliest descriptions attest to its power:

> *That the army is certain to sustain the enemy's attack without suffering defeat is due to the operations of the extraordinary and the normal forces. (Sun Tzu, 1963, p. 91)*

> *When the strike of a hawk breaks the body of its prey, it is because of timing. (Sun Tzu, 1963, p. 92)*

Boyd observed that the idea of fast transients or *cheng/ch'i* runs throughout what we might call the "Eastern" approach to strategy (Boyd, 1986, p. 14). In the mid-17th century, one of his favorite strategists, the samurai Miyamoto Musashi (trans. 1982), whose *Book of Five Rings* is still studied in both military and business schools, observed that such transients will produce a period, though perhaps only a moment, of confusion, hesitation, surprise, even debilitating shock and disorientation.

LeDoux (2015) concluded that this tendency to "freeze" is built into our brains,

> *Freezing is not a choice. It is a built-in impulse controlled by ancient circuits in the brain involving the amygdala and its neural partners, and is automatically set into motion by external threats.*

During that period, when the opponent does not have an accurate understanding of the situation or the ability to formulate a coherent concept for dealing with it, and when his orientation is not making useful predictions, we can act with little fear of effective counter-action. Put another way, the purpose of *cheng* /

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ch'i maneuvers is to create an orientation advantage over the opponent, which we can then exploit. As the Germans later described it:

> *Space and time must be correctly used, favorable situations quickly recognized and exploited with determination. Each advantage over the enemy reinforces one's own freedom of action. (van Creveld, 1982, p. 29, quoting the German Truppenführung of 1936)*

> *Each minute ahead of the enemy is an advantage. (Boyd, 1986, p. 79, quoting the German General Günter Blumentritt.)*

For this reason, some strategists including the ancient commentators on Sun Tzu, the Japanese of the samurai period, and Boyd in our day have raised the study of *cheng/ch'i* to the level of art.

Trying to employ *cheng / ch'i* maneuvers via the circular OODA loop does not work well when one is engaged with an opponent. The need to go through stages before coming around to action is too slow and too easy to disrupt (Klein, 1999). If, on the other hand, action can flow rapidly from orientation directly via an implicit guidance and control (IG&C) link, then any pattern of actions becomes possible. As Boyd (1987a) put it, "The key idea is to emphasize implicit over explicit in order to gain a favorable mismatch in friction and time (i.e, ours lower than any adversary's) for superiority in shaping and adapting to circumstances" (p. 22). This explains the two implicit guidance and control links in Figure 2, as contrasted with none in Figure 1.

Exploiting the Unexpected in Business

This is fine for war and other forms of our-side-vs-their-side conflict, where the effect on the other side is what counts. But when customers become involved, their actions—what they buy and at what price—trump everything else. If the *cheng/ch'i* concept is to be useful in business, it must influence the customer. To see how this can happen, consider how one effect of *ch'i*, surprise, works on customers. If you make an analogy with war, you can try to shock them—the effect extreme surprise produces in war—but that may not entice them to buy more from us or to buy anything at all from us ever again.

But if we work it cleverly via a deep understanding of our customers, we might delight them. Instead of surprise → shock → exploitation, as in war and the martial arts, *cheng/ch'i* could operate as something more like surprise → delight & fascination → become more committed customers. Apple plays this game, the "pursuit of wow!" as Tom Peters (1995) once described it, very well:

> *Apple has thrived above all in the last two decades by offering the particular beauty that lies in order, organization, and simplicity, and in the predictable delight that results when something technical, unexpectedly, just works. (de Monchaux, 2015)*

In other words, there are times when "just working" can often be unexpected, the *ch'i* (Richards, 2004).

It is important to realize that we are not talking in terms of analogies and metaphors. *Cheng/ch'i* in business is not "like" the concept in war (that would

probably give you something like "shock the competition"), it is exactly the same concept, but it manifests differently in the different arenas of war and business.

Using the OODA "Loop" Model

As noted in the previous section, Boyd intended the OODA "loop" to be a guide for action. To exploit the potential illustrated in Figure 2, however, organizations need certain attributes so that, for example, actions can actually flow from orientation without the need for explicit decisions.

Singing From the Same Sheet

The first of these attributes, following the ancient wisdom of Sun Tzu (trans. 1988), is to ensure that everyone on the team shares a similar view of the world. Successful organizations exploit the creativity and initiative found within their members, but they harmonize them to accomplish common objectives. This is not as easy as it seems. Rigidly enforced organizational dogma, for example, can produce a type of harmony, but it rarely encourages initiative. There is a way, however, to break the trade-off and achieve both harmony and initiative. Boyd (1986) asserted that "Without a common outlook superiors cannot give subordinates freedom-of-action and maintain coherency of ongoing action." In this view, "A common outlook … represents a unifying theme that can be used to simultaneously encourage subordinate initiative yet realize superior intent" (p. 74). Research is confirming this: Espevik, Johnson, Eid, and Thayer (2006), for example, found that when members of a group share mental

models of the situation, typically by keeping the group intact during training and operations, their performance can be sustained even under conditions of stress.

Boyd (1987a) suggested a similar conclusion in terms of shared orientations:

> *Arrange the setting and circumstances so that leaders and subordinates alike are given the opportunity to continuously interact with the external world, and with each other, in order to more quickly make many-sided implicit cross-referencing projections, empathies, correlations, and rejections as well as create the similar images or impressions, hence a similar implicit orientation, needed to form an organic whole. (p. 18)*

It is hard to overstate the impact of shared orientation. One company that I've worked with, for example, has found that by concentrating on maintaining an accurate common implicit orientation, decisions that routinely took weeks can now be made in minutes (T. Barnhart, Pfizer, personal communication, August 2010).

Techniques that minimize the need for explicit decisions fall under the category of "mission command," commonly referred to by its German name, *Auftragstaktik,* which is the formal leadership philosophy of organizations as diverse as the U.S. Marine Corps and the Royal Norwegian Navy. In the extreme, explicit decisions may not be required at all. Marquet (2012, p. 126) reported that he was able to successfully complete operational missions in command of his nuclear submarine without issuing virtually any explicit decisions. The result was dramatic:

> *Eventually we turned everything upside down. Instead of one captain giving orders to 134 men, we would have 135 independent, energetic,*

> *emotionally committed and engaged men thinking about what we*
> *needed to do and ways to do it right. (p. 155)*

The common outlook in this case included a shared understanding of what it meant to "do it right" under all but the most exceptional and unexpected circumstances.

If you are going to use IG&C, thus bypassing the explicit Decision block of the OODA loop, where do you make decisions? Decisions are absolutely necessary within Boyd's framework because they select actions from among the myriad of possibilities. Because IG&C flows directly from Orientation to Action, the answer must be that decision—the selection of actions—lies inside Orientation. Boyd did not go into depth on how one makes decisions, but he assumes that we all have mental models, sets of concepts for representing reality, that we can use to assess the effects of potential actions (1976). You can see this represented as "analyses / synthesis" inside the Orientation block. True reflexes, that is, links from Observation to Action, exist but are not part of Boyd's framework.

Back in the Real World

Before leaving the subject of common outlook or shared implicit orientation and the implicit guidance and control that it enables, we need to admit that there are times when you cannot use the IG&C link. One of these is when nuclear weapons are involved. Another is when dealing with money, as anyone who has ever filed an expense report knows. In addition to money, there are now a whole host of "compliance" requirements where explicit documentation is required.

You will also need to be explicit about certain matters at the start of a project or operation, when you will assign missions and lay down time, financial, or other guidelines. Do this sparingly, with a light touch, and as orally as possible. Think of it as a test of your skill as a leader.[§]

Once things are underway, you would like to shift to implicit guidance and control to reduce friction and gain time advantages. But let's be brutally frank: Although implicit guidance and control is the ideal, sometimes it just doesn't work. Certain subordinates will not have the individual or group (common) experience or the personalities that would let you lead them implicitly so you are reduced to managing them explicitly. In other words, with some people you are willing to give up the benefits of initiative because you're tired of herding cats.

As Musashi (1982, p. 14) put it in his carpenter analogy:

> *To accomplish a task quickly and to perform it well is not to be haphazard about anything; to know where and when to use who and what; to know whether or not there is incentive; to give encouragement and to know limitations; these are what a master carpenter keeps in mind. The principles of strategy are the same.*

To use the magic of IG&C, you have to know the people on your team as individuals. At any given time, it will work with some of them, but if you get too implicit too soon, before someone is ready for it, the results will be comical at best.

[§] I cover the subjects of missions and control in another paper, "All by ourselves," also available from slightlyeastofnew.com.

Embracing Brutal Reality

The purpose of continuously interacting with the external world is to ensure that an organization's (similar implicit) orientation is at all times more accurate than any competitor's. Then, by interacting with each other, members naturally keep their orientations aligned. The result is, in Boyd's words, an organic system for command and control. Even so, human factors such as misunderstandings, jealousy, peer pressures, and deference to rank can corrupt the process.

In fact, the situation is much, much worse. We've been discussing the IG&C link in Figure 2 from orientation to action, but there's that other one, from orientation to observation. Orientation, whether we want it to or not, exerts a strong control over what we observe. Partly this is because we have to have some focus in our observations, and our orientation narrows down an otherwise infinite field of possibilities. This is inevitable, but one needs to stay mindful of Einstein's warning that "It is the theory which decides what we can observe."

However, in humans at least, this seemingly benign process can quickly become malignant. Once the theory starts to find data that confirm it, it locks out conflicting observations. To a great extent, a person hears, as Paul Simon wrote in "The Boxer," what he wants to hear and disregards the rest. This tendency to confirm what we already believe is not just sloppy thinking but is built into our brains (Molenberghs, Halász, Mattingley, Vanman, and Cunnington, 2012). If you search the Internet for "confirmation bias" and "change blindness," you will find many examples including the famous video of a person in a gorilla suit strolling around in the middle of a group

tossing a ball back and forth. About 50% of people who watch this video fail to notice the gorilla (Simons and Chabris, 2010) .

Strategists call the tendency to observe data that confirm our current orientations "incestuous amplification": Orientation influences observation via that other IG&C link to find data that confirm our orientation. So confirmed, orientation now even more strongly influences observation to find ... (Gimian & Boyce, 2008; Spinney, 2008). It is difficult to detect and for all practical purposes impossible to overcome only from within the organization because all the data confirm the accepted view of the world. People who take opposing views are marginalized. This often produces conflict and confusion, leading Boyd to insist that even attempting to assess the status of the organization only from inside the organization will increase the confusion and disorder within it. This was Boyd's first major conclusion on strategy, from his 1976 paper, "Destruction and Creation" (Spinney, 1998).

In threatening situations like military actions or natural emergencies, these effects are often fatal, and clever strategists can use them against their opponents, as when Sun Tzu (1988, p. 161) advised his followers to "accord deceptively with the intentions of the enemy." Play mind games with the opponent, locking in the *cheng* and making the *ch'i*, when it is sprung, that much more shattering and disruptive. Operate inside their OODA loops, in other words. For all of these reasons, Boyd considered the requirement to assess (he used the term "appreciate") the accuracy and depth of common understanding in an organization to be one of the primary functions of leadership (1987a, p. 32).

Tools for Shaping (and Coping)

> *Theory must have the discipline of experiment if it is to remain focused on the things that really matter, the things that manifestly happen in the real world. (Baggott, 2011, p. 408)*

Boyd (1996) considered "repertoire" to be those actions that an organization knows so well that it can initiate them via an IG&C link directly from its (shared implicit) orientation. This is how we want to act when engaged with a fast thinking and acting opponent.

We must achieve excellence in our repertoire: Our actions must accomplish what we intend them to accomplish. It is not enough, though, to be able to perform the same set of tasks more quickly and more smoothly day after day. Organizations that take only this approach make themselves vulnerable to competitors who observe them carefully, become able to predict these actions, and create new ways to counter and exploit them.

So the question arises of where our repertoire comes from and how we add to it. Oddly, given the emphasis so far on the IG&C link, the process for generating new actions is reminiscent of Figure 1, involving a classic loop of observation, analyses & synthesis, hypothesis, and test (Boyd, 1992). Although the circular OODA loop in Figure 1 is such a process, there are many others, including the Deming's Plan-Do-Check-Act cycle, Toyota's various scientific thinking processes (Ohno, 1988; Shingeo, 2006; Spear and Bowen, 1999), and the "logical thinking process" used by practitioners of Goldratt's theory of constraints (Dettmer, 2007).

These circular processes create the tools that strategy and tactics employ. The idea is that through repeated looping (observation, analyses & synthesis, hypothesis, and test) as individuals and as organizations, we engineer new options into our repertoire that we can use via an IG&C link and so realize the full power of Figure 2 (Boyd, 1996).

The Repertoire: Operating with the IG&C Feed

While it is true that most of the items in our repertoire are created ("invented") during training sessions, this is not enough. We don't know how well our new actions will work against a particular opponent until we try them. And if they don't work quite as planned, then what? Success against thinking adversaries or competitors, and *with* customers, requires not only using our current repertoire largely via an IG&C link but also and at the same time keeping our grey matter engaged to think up and try new actions on the fly and to find new ways to employ our existing set of actions, as illustrated in Figure 3. This represents the embedded learning process suggested above.
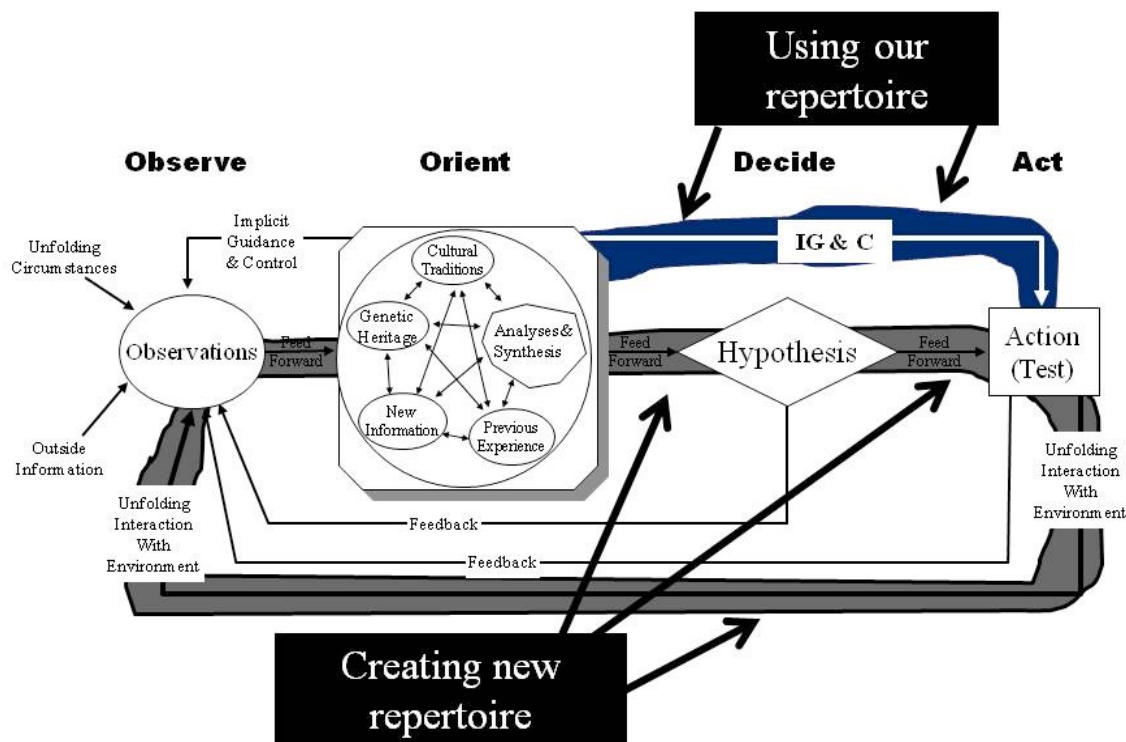
Figure 3. Keep your brain engaged, always.

Unlike the circular model, there is no trade-off between orientation, decision, and action, where to maintain speed through the loop, extra time spent on one function must be made up by shortchanging another. In Figure 2, thinking and action work together. As Hiroshi Mikitani (2012), founder and CEO of the Japanese e-commerce titan Rakutan, put it, "My experience has been that there is no real, valuable thinking until you move into action. It is the action that spurs thinking. Action is, literally, the food for thought."

Much of this learning will be implicit, as in the phrase "learn by doing," which applies to groups as much as to individuals. But to share learning more widely

throughout the organization, explicit means such as the after-action reports (AARs) and mission debriefs used by the military will prove useful. Although these are sometimes treated as perfunctory exercises, top performing organizations place a premium on learning while doing and treat AARs and debriefs with a seriousness that transcends rank. The ultimate purpose of these reports and debriefs, which in elite organizations are no place for the faint of heart, is to improve current repertoire and create new actions for it, all in the heat of battle. Although this may sound like an impossible task, the need to think on one's feet is well known to the military, who call it by such terms as "agility" and "adaptive leadership" (Albrecht, 2010; Vandergriff, 2006).

To "think on one's feet" at the organizational level requires a high degree of trust. Consider a situation where the group faces imminent destruction from an enemy attack or even from drowning or starvation, and suppose also that the members of the group do not agree on the seriousness of the threat or how to deal with it. To make things more interesting, throw in incestuous amplification and normal human emotions like jealousy, suspicion, and resentment. In OODA loop terms, this means that action cannot flow smoothly and quickly from a similar implicit orientation among group members because there is no such orientation. It also means that the group cannot invent new actions on the fly because it cannot agree on which actions to try. In extreme cases, such as an enemy operating inside its OODA loops—or nature acting as if it were—the group shatters into bickering sub-groups, takes no

effective action, and perishes (T. Krabberød, personal communication, March 5, 2012, citing Weick, 1993).

The "Loop" has Loops, for Different Functions

Because both of these functions—employing our current repertoire and creating new actions and tactics—must operate at the same time, the OODA "loop" sketch in Figure 2 is about as simple as it can be. It's worth pointing out that the process of observation, analyses/synthesis, hypothesis and test that creates novelty for strategy to employ also updates our orientations, including our concepts for employing that novelty (Boyd, 1992; Wass de Czege, 2011). This circular process therefore not only performs the function of engineering for a participant in a conflict but fulfills the purpose of science as well.

Astute readers may have noticed what appears to be one other use for the circular process and that is when you cannot use the IG&C link. In this case, it seems logical that you must invoke the explicit Decision block. You will give up the advantages of initiative and will slow things down to boot, but sometimes it seems like the best you can do.

As Boyd summarized the situation (1987a, p. 34):

> *Leadership must give direction in terms of what is to be done also in a clear, unambiguous way. In this sense, leadership must interact with {the} system to shape the character or nature of that system in order to realize what is to be done.*

That is, you have to *do* something—write it down and issue it, stand up before the assembled multitude and proclaim it, or roll on the floor and foam at the mouth— and these actions must also flow from Orientation, preferably implicitly. Putting this all together, you could characterize the process of controlling actions as "observe, orient (including make decisions, that is, select an action), act (including ensuring that your decisions are understood and accomplished)." That would give you "OO(D)A," but not a loop because you trigger actions using your intuitive competence —*Fingerspitzengefühl*—reinforced by analyses and synthesis, that the time is ripe, much as Jim Storr suggested: *Observation, orientation and action are continuous processes, and decisions are made occasionally in consequences of them*. If you must have an OODA *loop*, it should only be the OOHyT loop (observe-orient-hypothesis-test). This true loop creates repertoire and updates orientation. If we want to be purists about it, we should *never* use the expression "OODA loop." Probably too late for that now, though.

One way to harmonize the acting and learning elements of Figure 2, that is, to have both circuits of the "loop" working simultaneously, is to always have a reason, an explicit reason that you can explain to other people, for every action you take. Quite often, this reason will be backfilled in by your mind after you have selected the action, but that doesn't make it any less valid. Having a reason, a statement of what you're trying to accomplish, grafts an hypothesis onto your IG&C feed and so accelerates learning. If you are leading other people, the reason morphs over into your "commander's intent," which you share with your team as part of your control

mechanism. But even if it's just you acting alone, you'll find this little trick to be a great way to keep your orientation accurate and develop new repertoire.

However you view the role of decision, the loop of Figure 1 should not be regarded as a simplification or introductory version of the real "loop" in Figure 2. Better to start off on the right foot by regarding the OODA—really OOHyT—of Figure 1 as a subset embedded in Figure 2 that describes Boyd's concept for generating useful novelty and updating orientation (Spinney, 1998).

Summary: Top-level Organizational Objectives

No organization is going to be successful unless it can do all of these:

> **Using the IG&C link from Orientation to Action:**
>
> 1. Employ the existing repertoire, which includes repertoire (actions) for promulgating decisions
>
> **Using the circular OOHyT process:**
>
> 2. Create and test new actions (both while in training and on the fly),
>
> 3. Update orientations

simultaneously and harmoniously, with each function reinforcing the others. The OODA "loop" in Figure 2 captures all of this.

Is Faster Really Better?

> *The movements of a master of a path do not appear to be unduly fast.*
> *(Musashi, 1982, p. 94)*

As Osinga noted above, there is a popular conception that speed is in fact the essence of Boyd. There is no doubt that the ability to operate at a faster tempo, to, for example, introduce new products more rapidly than competitors (Stalk & Hout, 1990) or in the military, to exploit a breakthrough during a blitzkrieg attack, can be a powerful advantage. Boyd (1987b, p. 44) even maintained that:

> *The ability to operate at a faster tempo or rhythm than an adversary enables one to fold adversary back inside himself so that he can neither appreciate nor keep-up with what's going on. He will become disoriented or confused.*

Boyd's statement might lead you to think that we should always act at a faster tempo or rhythm than our competitors. But he may have oversimplified this a little. Note first that he entitled this chart, "Illuminating example," and in an earlier work, he had drawn a distinction between faster tempo and operating inside the OODA loop (1986, p. 5):

> *Idea of fast transients suggests that, in order to win, we should operate at a faster tempo or rhythm than our adversaries—**or, better yet, get inside adversary's observation-orientation-decision-action time cycle or loop**. (emphasis added)*

So which is it, faster tempo or inside their OODA loops? Can they ever conflict? They certainly can, and we can understand how by examining two common cases where operating at a faster tempo not only does not produce the effect Boyd suggests but actually provides an advantage to the slower side. First, consider deception. Sun Tzu (1963, p. 66) famously claimed that "all war is based on deception," and Boyd

(1986, p. 115) included deception in the "essence of maneuver conflict." So it is an important component of his philosophy.

A successful deception requires that the opponent, i.e., the one being deceived, make a decision, take the bait in other words. You just want that decision to be based on the false impression of events that you have so painstakingly created. Often, you want them to make their decisions quickly, while they still have their false impressions, and keep making them, becoming increasingly disoriented and frustrated as you create and spring *cheng/ch'i* after *cheng/ch'i*. Imagine a parent who is dealing with a small child kicking and flailing away.

Another case comes from the martial arts—karate, judo, kendo (sword fighting), and one might also include one-on-one air-to-air combat. If you've ever watched martial arts movies, you probably remember a scene where one of the bad folks (such movies tend to be morality plays) is thrashing around, shouting, flailing the air with fists, feet, or swords and then charges at our hero or heroine, who is standing motionless with perfect equanimity. You know what's going to happen: One strike almost too fast to be seen and the heavy hits the floor.

What happens in both of these cases is that the slower side, in terms of tempo, is inside the OODA loop of the faster. So long as you are operating inside their OODA loops, that is, so long as you retain the initiative or put another way, the orientation advantage, the speed of your opponents' decisions and so the tempo of their actions can work against them. In fact, so long as you are inside their OODA loops, practically anything they do can be used against them.

So always acting at a faster tempo, while often extremely useful, is not a good general principle for success in competitions. Boyd hinted at this when he, sort of, defined "operating inside the OODA loop," on chart 132 of *Patterns of Conflict*. In that chart, he passed on the opportunity to describe it simply as "more quickly" but also added "more inconspicuously," and "with more irregularity."

Putting all this together suggests a useful scheme regarding tempo:

- First get inside their OODA loops by whatever means you can—for example, deception & surprise (cheng/ch'i), ambiguity (e.g., attack via multiple thrusts or a flurry of activity as Boyd suggested), or a spy inside their HQ.

- Once evidence indicates to you that they are becoming confused and their responses are beginning to lag, then you have the opportunity to shift to high tempo exploitation.

What about the real circular loop, the learning process from Figure 3? Would going through it faster than an opponent generate a competitive advantage? It seems reasonable that going through the learning loop more rapidly than an opponent or competitor would produce more rapid learning, which would keep the orientation of the faster player better matched to reality and generate improvements to its repertoire more rapidly than those of the others.

This is not a bad general principle. Here's a classic example of how more rapid learning can produce a competitive advantage. Stalk & Hout (1990) documented a business "war" between Honda and Yamaha during the late 1970s as they competed for dominance in the Japanese motorcycle market. During the 18 months of the war,

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Honda introduced 113 new models to Yamaha's 37. So you might conclude that Honda's more rapid tempo led to victory. But suppose nobody bought the 113 new Honda models?

Stalk & Hout (1990, p. 59) identified a more powerful driver of Honda's success:

> *Honda succeeded in making motorcycle design a matter of fashion, where newness and freshness are important to customers. … Next to Honda's motorcycles, Yamaha's bikes looked old, out-of-date, and unattractive.*

In other words, Honda was learning not only what customers wanted but how to influence customers to prefer its models. Their orientation was changing to reflect their experience in the marketplace. Put another way, Honda was inside Yamaha's OODA loop, so their rapid tempo was more like the exploitation phase of a successful breakthrough in the blitzkrieg.

Was the rapid tempo necessary? Could Honda have produced the same result without introducing so many models? Both Honda and Yamaha had about 60 models in their product lines at the start of the war, so could Honda just have jumped to their final, highly attractive new models? It is hard to imagine how this could have happened because both Honda and its customers needed to learn what "fresh, new, and attractive" would mean. So Honda did go through a learning process, a real OODA loop, more rapidly than Yamaha. The decisive factor, though, was not speed through the loop but that each pass through the cycle improved orientation, giving Honda a

better understanding of where customer preferences were going and could be influenced to go.

To sum up, perhaps the most basic problem with basing your strategy on OODA loop speed is that It's not clear what "going through the OODA loop" means. What happens when you get to orientation? Until Boyd's process of "projection, empathy, correlation, and rejection" comprising analyses and if appropriate reaching a new synthesis plays out, have you completed the orientation phase and thus the loop in any meaningful sense? Would rushing the process by skimping on analysis or not adequately testing trial syntheses make you more competitive?

On the other hand

It is worth reiterating that while going fast *per se*, either down a physical road or through some decision process—although useful at times—is not an dominant principle of strategy, not being able to act in a timely manner, to "think on one's feet," can be deadly. As we have seen, such a failing often results when lack of a similar implicit orientation reduces the cohesion needed for concerted action. This is what someone using Boyd's strategy is trying to inflict on their opponents by operating inside their OODA loops.

In other words, if you find yourself being slow to act, if most discussions end in shouting matches and without decisions, if you've fractured into parties and are bogged down in internecine warfare, then somebody else (or even nature) is quite likely inside your OODA loop. As described earlier, a large part of the solution is to get everybody back singing from the same sheet. Another part of the solution is to acquire

a repertoire of potentially effective actions that can flow from this nascent similar implicit orientation and to develop the ability to create new repertoire as events unfold.

The next section will give you some ideas for how this can be done.

Creating Your Own Repertoire

> *There are normally two reactions to what I have set forth in this article. One is, "We think this way already, but our thought processes are quicker, simpler and more natural." To this I say, "Really? Show me." (Wass de Czege, 2011, p. 56)*

To create a repertoire, a set of actions that we can apply intuitively and communicate implicitly, we need an organizational climate that encourages what we might call "OODA loop thinking." Like so much in Boyd's scheme, this doesn't happen by accident, and you won't have much success by ordering it into existence. What you can do is make changes to your organizational system and guide, primarily through the analytical/synthetic process, the evolution of new practices.

Here are a few suggestions to help you get started:

- Establish a school. The military have any number of educational institutions, from the German *Kriegsakademie* of the 19th and early 20th centuries to the various staff and war colleges of the U.S. and other militaries today. These serve to provide a common foundation (which the military calls "doctrine") on which to build the similar implicit orientation required by the OODA loop. Some companies have also established institutions to help establish a common

orientation, GE's Crotonville being perhaps the best known of these "corporate universities." A common problem with many of these, though, is that they only offer short courses, unlike the year-long programs common at military institutions.

- Give your human resources department a mission other than pushing papers and acting as bureaucratic police. The best mission might be as keeper of the culture, but without a day-to-day line management role (Welch J. & Welch S., 2005), that function of leadership that Boyd (1987a, p. 32) called "appreciation." Consider recruiting from line management as a special tour of duty for high potentials: They operate in the culture, then they get to step back and think about the culture. There are other possibilities. Family-controlled businesses, for example, have the unique advantage of being able to use non-employee family members as keepers of the culture, sort of an inside/outside play (Astrachan, Richards, Marchisio & Manners, 2010).

For the specifics of a competitive culture, Boyd (1986) suggested an "organizational climate"—the four German words described in *Certain to Win* (Richards, 2004)[**]—whose most important attribute is that it fosters creativity and initiative throughout the organization (Nissestad, 2007). Your team should

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** Near the end of his life, Boyd added *Behindigkeit*, which he defined as the ability to break out of longstanding and deeply held patterns of ideas and actions, that is, to change paradigms. *Behindigkeit*, then, complements the ability to be agile when applying our current doctrine. It implies the ability to recognize and ameliorate the effects of confirmation bias / incestuous amplification mentioned above. For a more detailed explanation, please refer to my paper "All by ourselves."

investigate, make your own decisions, and document them in an organizational doctrine.

- Write and nurture a living doctrine manual as the explicit component of an organization's culture, of its common orientation. Boyd, incidentally, would not agree: "Doctrine on day one, dogma on day two" was how he put it. This is a risk. On the other hand, if, as part of your common orientation, you recognize the risk, and if the keepers of the culture are doing their jobs (and if not, you're doomed anyway), you can have the advantages that doctrine provides while avoiding the dogma tar pit. Here's a suggestion: Make "doctrine on day one, dogma on day two" the first element of your manual.

Think of doctrine not as a checklist or menu that must be followed (or else!) but as *standardized work,* in the language of the Toyota Way (Liker, 2004; Ohno, 1988). Toyota (1992) considers standardized work to be a critical part of their system:

> *Standardized work and kaizen are two sides of the same coin. … Standardized work provides a consistent basis for maintaining productivity, quality, and safety at high levels. Kaizen furnishes the dynamism of continuing improvement and the very human motivation of encouraging individuals to take part in designing and managing their own jobs.* (p. 38)

In other words, rather than enforcing conformity and the status quo, standardized work encourages initiative and creativity within the framework of the Toyota Production System, which is itself a doctrine. In particular, if a team

member has an idea for improvement, it provides an explicit, data-derived standard to test it against.

Toyota, in fact, requires a formal process of observation, analysis and synthesis, hypothesis and test that would make any scientist proud, even for minor changes (*kaizen*) to standardized work (Spear & Bowen, 1999; Shingo, 2006).

Your doctrine manual is one device for retaining what you've learned through your analytical/synthetic processes and for spreading this knowledge throughout the organization. Given its importance to the organization, you might consider a contribution to the manual to be a prerequisite for promotion to senior levels.

- All of the above is interesting but falls into the category of navel gazing unless it results in effective actions. In business, for example, "effective" has something to do with customers buying whatever we're selling. So we can apply a simple test, first suggested to me by one of my colleagues at Kennesaw State University, who previously ran R&D for the James River Paper Co.: "Can you *demonstrate* that you understand what your customers want?" (G. E. Manners, personal communication, January 15, 2009). Your understanding of what your customers want—what they will spend money on, even, especially, if they aren't aware of it themselves—is part of your orientation, of course, which means that we can generalize this challenge to: Can we demonstrate that our orientation is more accurate and more deeply shared among ourselves

than any of our competitors'? While this can never be nailed down in a rigorous, scientific sense, we should ask ourselves, "If we can't demonstrate it, why do we think that it is? What's the evidence?" Are we, for example, any better at recognizing mismatches than they are? *Oh, really? Show me.*

You can apply this simple test to practically all of the recommendations that Boyd made, and senior management must create an environment where people enjoy and take pride in doing so.

Epilogue

OODA loops or "loops" — and any will do so long as they accomplish the processes shown in the OODA "loop" sketch — create and employ implicit repertoire. OODA loops are your factory for building snowmobiles. Think of them like a NASCAR racing team: They build the cars, race them, and improve them from week to week. Along the way, OODA loops also refine our orientations, our mental models for how the world works, the most important aspect of which is our ability to accurately predict the results of our potential actions.

The question of how we create and update these mental models is what led Boyd to begin his investigations into the philosophy of conflict (Boyd 1976):

> *Actions must be taken over and over again and in many different ways. Decisions must be rendered to monitor and determine the precise nature of the actions needed that will be compatible with the goal. To make these timely decisions implies that we must be able to form mental concepts of observed reality, as we perceive it, and be able to*

change these concepts as reality itself appears to change. The concepts can then be used as decision models for improving our capacity for independent action. Such a demand for decisions that literally impact our survival causes one to wonder: How do we generate or create the mental concepts to support this decision-making activity? (p. 2)

Some 20 years later, he finally arrived at a sketch of his answer.

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References

Albrecht, J. H. (2010). *Understanding and developing adaptive leadership during pre-commissioning. A monograph.* Ft. Leavenworth, KS: US Army School of Advanced Military Studies.

Astrachan, J. H., Richards, C. W., Marchisio, G. G., & Manners, G. E. (2010). The OODA loop: A new strategic management approach for family business. In P. Mazzola & F. W. Kellermans (Eds.), *Handbook of research on strategy process* (pp. 541-566). Cheltenham (UK): Edward Elgar.

Baggott, J. (2011). *The quantum story, a history in 40 moments.* New York: Oxford University Press.

Bodhi, B. (2005). *In the Buddha's words, an anthology of discourses from the Pali Canon.* Boston: Wisdom Publications.

Boyd, J. R. (1976). Destruction and creation. (Unpublished paper). Retrieved from http://dnipogo.org/john-r-boyd/

Boyd, J. R. (1976). New conception for air-to-air combat. (Unpublished paper). Retrieved from http://dnipogo.org/john-r-boyd/

Boyd, J. R. (1986). *Patterns of conflict.* (Unpublished briefing). Retrieved from http://dnipogo.org/john-r-boyd/

Boyd, J. R. (1987). *Organic design for command and control.* (Unpublished briefing). Retrieved from http://dnipogo.org/john-r-boyd/

Boyd, J. R. (1987). *Strategic game of ? and ?* (Unpublished briefing.) Retrieved from http://dnipogo.org/john-r-boyd/

Boyd, J. R. (1992). *Conceptual spiral*. (Unpublished briefing). Retrieved from

http://dnipogo.org/john-r-boyd/

Boyd, J. R. (1996). *The essence of winning and losing.* (Unpublished briefing).

Retrieved from http://dnipogo.org/john-r-boyd/

Collins, J. (2001). *Good to great: Why some companies make the leap... and others

don't*. New York, NY: HarperCollins.

Coram, R. (2002). *Boyd: The fighter pilot who changed the art of war*. New York, NY:

Little Brown.

de Monchaux, N. (2015, December 12). Apple and Star Wars together explain why

much of the world around you looks the way it does. Downloaded from http://

qz.com/572076/apple-and-star-wars-together-explain-why-the-world-around-

you-looks-the-way-it-does/

Dettmer, W. (2007). *The logical thinking process: A systems approach to complex

problem solving*. Milwaukee, WI: American Society for Quality.

Espevik, R., Johnson, B., Eid, J., & Thayer, J. (2006). Shared mental models and

operational effectiveness: Effects on performance and team processes in

submarine attack teams. *Military Psychology*, 18(Suppl.), S23-S36.

Gates, R. M. (2010). United States Air Force Academy Lecture (Leadership/Character).

Downloaded from http://www.defense.gov/Speeches/Speech.aspx?

SpeechID=1443

Gimian, J. & Boyce B. (2008). *The rules of victory: how to transform chaos and

conflict*. Boston, MA: Shambhala.

Hammes, T.X. (2004). *The sling and the stone: On war in the 21st century*. St. Paul, MN: Zenith.

Hammond, G. T. (2001). *The mind of war: John Boyd and American security*. Washington, DC: Smithsonian.

Klein, G. (1999). *Sources of power: How people make decisions*. Boston, MA: MIT Press.

Ledoux, J. (2015, December 20). 'Run, Hide, Fight' Is Not How Our Brains Work. *New York Times*, SR9.

Liker, J. (2004). *The Toyota way*. New York, NY: McGraw-Hill.

Mikitani, H. (2012, December 19). Jump! Downloaded from http://www.linkedin.com/today/post/article/20121219160529-52782505-jump

Musashi, M. (1982). Unattributed commentary to the second chapter. *The book of five rings*. (Nihon Services Group, Trans.) New York, NY: Bantam. (Original work published 1645).

Nissestad, O. A. (2007). *Leadership development: An empirical study of effectiveness of the leadership development program at The Royal Norwegian Naval Academy and its impact on preparing officers to execute leadership in today's conflicts and the conflicts in the years ahead*. (Doctoral dissertation). Norges Handelshøyskole (Norwegian School of Economics and Business Administration), Bergen (Norway).

Ohno, T. (1988). *Toyota production system*. (Productivity Press, Trans.). Portland, OR: Productivity Press. (Original work published in 1978).

Osinga, F. P. B. (2005). *Science, strategy and war: The strategic theory of John Boyd.* (Doctoral dissertation). Delft (The Netherlands): Eburon Academic Publishers.

Osinga, F. P. B. (2006). *Science, strategy and war: The strategic theory of John Boyd.* London (UK): Routledge.

Peters, T. (1995). *The pursuit of wow! Every person's guide to topsy-turvy times.* New York, NY: Random House.

Peters, T. (2003). *Re-imagine! Business excellence in a disruptive age.* London (UK): Dorling Kindersley Publishing.

Richards, C. (2004). *Certain to win: The strategy of John Boyd, applied to business.* Philadephia, PA: Xlibris.

Shingo, S. (2006). *Non-stock production: The Shingo system of continuous improvement.* New York, NY: Productivity Press.

Simons, D. J. and Chabris, C. F. (2010, May 13). The trouble with intuition. *The Chronicle of Higher Education.* Downloaded from http://chronicle.com/article/The-Trouble-With-Intuition/65674/

Spear, S. and Bowen, H. K. (1999, Sept. - Oct.). Decoding the DNA of the Toyota production system. *Harvard Business Review*, 97-106.

Spinney, F. C. (1998). Evolutionary epistemology. Unpublished briefing. Downloaded from https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxibGFzdGVyYW5uZXh8Z3g6MTc5YTg1YmRiODA2YzdhNQ

Spinney, F. C. (2008, September 10). Incestuous amplification and the madness of King

    George. *CounterPunch*. Available at http://www.counterpunch.org/

    spinney09102008.html

Stalk, G. and Hout, T. (1990). *Competing against time*. New York: The Free Press.

Sun Tzu. (1963). *The art of war.* (S. Griffith Trans.) Oxford, UK: Oxford Univ. Press.

    (Date of original work unknown; generally thought to be c. 400 BCE).

Sun Tzu. (1988). *The art of war*. (T. Cleary Trans.) Boston, MA: Shambhala.

Toyota Motor Corporation. (1992). *The Toyota production system*. Tokyo, Japan:

    Author.

van Creveld, M. (1982). *Fighting Power*. Westport, CT: Greenwood Press.

Vandergriff, D. (2006). *Raising the bar*. Washington, DC: Center for Defense

    Information.

Ward, A., Liker, J. K., Cristiano, J. J., & Sobeck, D. K. II. (1995). The second Toyota

    paradox: How delaying decisions can make better cars faster. *Sloan*

    Management Review, 36 (3), 43-61. [Available for download from http://

    www.columbia.edu/itc/sociology/watts/g9058/client_edit/ward_et_al.pdf.]

Wass de Czege, H. (2011, September). Operational art: Continually making two kinds

    of choices in harmony while learning and adapting. *Army*, 46-56.

Weick, K. E. (1993). "The collapse of sensemaking in organizations: The Mann Gulch

    disaster". *Administrative Science Quarterly 38 (4): 628–652.*

Welch, J. & Welch S. (2005). *Winning*. New York, NY: HarperCollins.