Fallacies of Data Driven Decisions

John Cvetko

John.Cvetko@tekasc.com

Abstract

Businesses and governments spend an enormous amount of time and money in search of data that informs their decision-making processes. The barrier for an individual to accumulate large amounts of data has decreased dramatically and can easily overwhelm their ability to make sense of it. This new reality has increased the importance of quality decision making skills at the executive, program/ product, and technical team levels of the organization.

For this reason, it is first important to understand the distinction between data and information. Data is a collection of facts, while information puts those facts into context. It stands to reason that the data from which a decision is based upon can be of high quality, but the context in which the decision was made could be lacking.

Decision-making processes and culture are foundational components of an organizations ability for meeting the needs of a constantly changing business landscape. An organization may tout a data driven mindset and great agility but lack the understanding of the reasoning or method from which a decision is made. Not understanding this key component can result in decisions that promote chaos rather than agility.

In this paper the author will explore performance optimization through the lens of quality, relative to decision-making and organizational adaptability.

Biography

As a Principal of TEK Associates, Mr. Cvetko works with companies and government agencies to improve their organizations by helping them manage the IT challenges they face. He applies state of the art solutions to evolve business processes, creating more efficiency and productivity, all while improving quality. The last 10 years have been primarily focused on assessing and transforming large enterprise software systems for state governments. He has worked with the state governments of Colorado, Washington, Oregon, North Carolina, North Dakota, Mississippi, Utah, Kentucky, and Oklahoma. Earlier in his career he worked as a management/technical consultant for firms such as NIKE and Boeing, and in product development and program management for Tektronix, PGE/Enron and ASCOM.

1. Introduction

"*Fortune favors the data driven organization*" is the theme of 21st century. The volume of data available to the average employee has exploded, yet decision-making capabilities have not kept pace. The speed and fluidity of software development coupled with a well-educated and empowered workforce is a recipe for great performance or chaos.

At the turn of the last century management's goal was to have factory workers do small tasks in a highly controlled process. In the modern era, staff are expected to work autonomously to solve complex problems daily, some of which have significant impact to the organization.

The nature of the problems being solved, linkage between disciplines, time pressures, etc., make even seemingly simple decisions ripple through an organization. All decisions have unintended consequences that create a new reality that present a set of problems which need even more decisions. Organizations see this as being "agile" however, if the decision-making process is inferior or misaligned, it is more akin to crashing back and forth between guardrails.

Many organizations profess they are data driven, however, having vast amount of data doesn't guarantee a good or even an informed decision. A more appropriate tag line might be - "*Fortune favors a data driven organization with a culture that is born from robust and aligned decision making processes*". While this might be a more realistic representation, as a sound bite, it is arguably less catchy.

2. Agile (Scrum) and the OODA Loop

The Agile Software Development Lifecycle (SDLC) is employed to provide a platform that supports the modern software development reality. It provides a highly skilled workforce the flexibility to manage the software development process. This flexibility is necessary to operate in a fluid environment with tools that are highly malleable.

Dr. Jeff Sutherland is a signatory of the Agile Manifesto, founder of the Agile Alliance, Co-creator of Scrum and Scrum@Scale. Dr. Sutherland began his career as an Air Force fighter pilot in Vietnam, and as part of his training he was drilled in a rapid decision-making technique called the "OODA" loop or Boyd cycle, see fig. 1. OODA which stands for Observe, Orient, Decide and Act is a mental process model that was developed in the 1950's by an Air Force pilot, Colonel John Boyd.

Boyd began his Air Force career in the 1950's just as the jet engine was being introduced. The move to jets increased the speed of air travel 3-fold and was seen as a major advantage to the military. Boyd's time as a fighter pilot in the Korean war impressed upon him that the United States jet fighter design was fundamentally flawed. The enemy was utilizing faster, more maneuverable aircraft that were specifically designed for high-speed aerial combat. Not fully understanding the new technology and how it would be used in battle, the uninformed design decisions made by civilian engineers had lethal unintended consequence in battle.

Since a he could not change the technology, Boyd was forced to change his way of thinking. Even though fighter aircraft were used extensively in WWII, combat tactics were considered an art rather than a science. The enemy had leaned so heavily on the technology that they did not reorient their way of thinking to maximize the advantage. Boyd's mental adaptation resulted in leveling the playing field against the superior technology. His adaptation technique was the OODA loop.[Coram]

The OODA loop was one of many contributions of Colonel Boyd's which are still utilized by militaries, governments, and businesses around the world. To get a fuller view of the breadth and depth of his contributions please refer to the books and articles listed in the reference section of this paper.

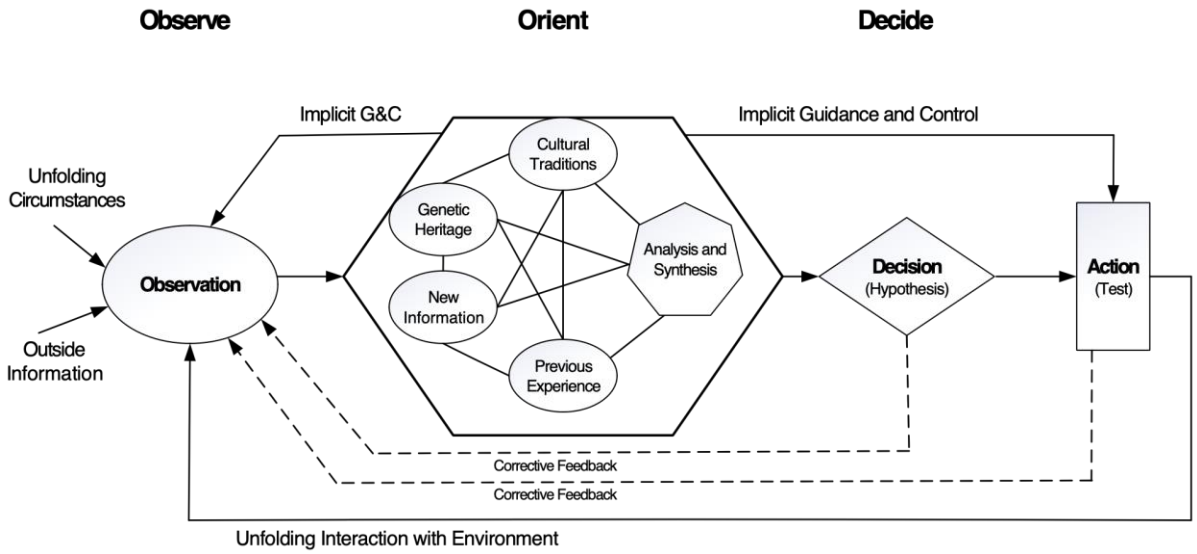

Figure 1. John Boyd's OODA Loop

2.1. OODA Loop Elements

Up until this time military personnel were generally told how to think through a ridged Command and Control structure. This approach assumes or takes the perspective that the only way to manage a large group of people toward a goal is through direct orders from the top. Henry Ford epitomized this with his "moving production line" where workers were required to stand in one place for 8-10 hours doing monotonous, repetitive tasks. The OODA loop is intended as a mental model that describes how knowledge workers consume and processed information. This understanding helps to better assess how to maximize the effectiveness of their actions toward a common goal. It is important to note that the Observe phase of the loop is on the left side or starting point of the diagram, this emphasizes that the OODA loop is an **information driven decision process**.

The OODA loop is better thought of as a series of loops that are continually switching back and forth as needed. The cycle can be thought of as three discrete loops and will be referred to as the Main Loop, Proactive IG&C and Reactive IG&C. Each loop has different processing speeds, mental energy requirements and corrective feedback emphasis. The OODA loop diagram in fig 2. is reformatted for discussion purposes.

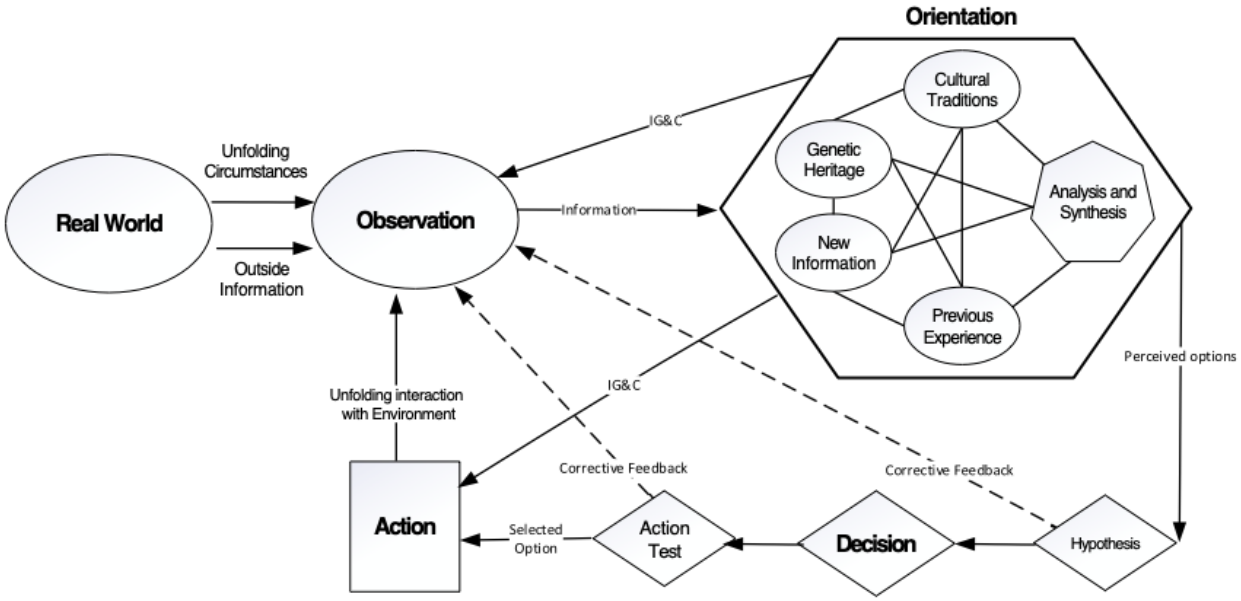

Figure 2. Reformatted OODA loop

2.2. Main Loop

When an individual receives information never seen before, they will process it through the Main Loop. They will attempt to identify patterns and orient themselves to understand its relevance, see fig. 3

2.2.1.Observation

The Observation stage is the point at which the information gathered by an individual is their perceived reality. The Outside Information feeding the stage represents the information being presented to the individual in time. This sensory input includes external sensory information (visual, tactile, auditory, taste, smell) as well as internal sensory information (position in space and time, internal cognitive reflection).

Unfolding Circumstances surrounding the individual refer to the dynamic operational environment in which the decision maker (individual) is operating. This environment includes the actions of other people and unexpected or evolving events (third party engagement) or other environmental changes (e.g., change in weather) that shape the observation process.

The Observation stage also receives corrective feedback pre and post the decision phase in the OODA loop. Corrective feedback acts to shape the observations according to the information needs and goals of the individual. [Richards]

2.2.2.Orientation

Boyd further developed the Orientation component of the OODA loop in the early 1970's and he discusses it in great depth. He viewed it as a crucial element where the information received will be interpreted by the individual from their inherent perspective. The Orientation phase includes all the internal cognitive reflection and information synthesizing needed to integrate new information with the individual's current understanding of the state of the world. According to Boyd, we make sense of the world by continuously un-structuring (differentiation) and restructuring (integration) our perceptions.[Boyd 1976]

As patterns are analyzed and synthesized, they produce impressions that shape an individual's perceptions and may be permanently added as new information to their heritage, culture, or experiences for future orientations. Once the information is processed, they begin to understand what options are available to them relative to their orientation. [Blaha]

2.2.3.Decision

The orientation process has formulated multiple options available from which to act upon. These goal-oriented options are presumed to be "good", "bad", incomplete, and limited to the capabilities of the individual. For example, the individual may have limited memory capacity, unique processing capabilities, emotional intelligence, analytical style, etc.

2.2.4.Action

The Action (Unfolding Interaction with the Environment) taken by the individual will change the individual's observation reference (perspective) in a manner that will require a reorientation for the next set of options and decision. Action is not always physical, for example the action may be to store the decision to be executed later. Additionally, an implicit option always available to the individual is to take no action if it is determined that more information is needed.

2.2.5.Feedback Loops

Boyd emphasized that the faster an individual could execute the OODA loop relative to their competition, the more apt they were to get inside the competitor's loop. He contended that once inside the competitors OODA loop, they could be out maneuvered to the point of breaking their loop. Speed can be emphasized over accuracy in the main loop because of the rapid feedback adjustments being made to the observation.

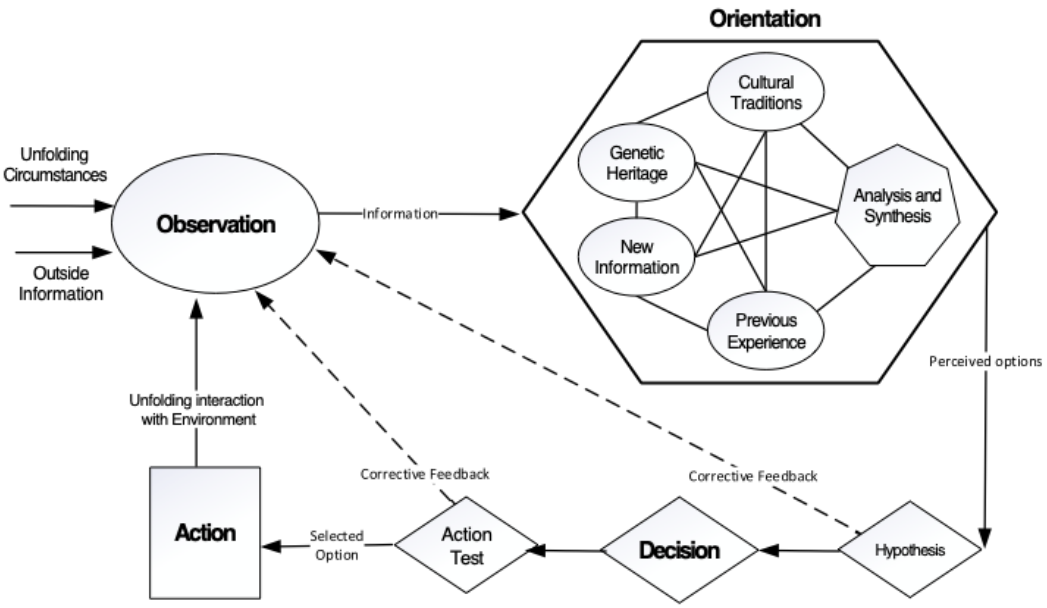

Figure 3. Main Loop

2.3. Internal Guidance and Control (IG&C) Loops

Internal guidance and control can be thought of as two sub-cycles that are more deliberative. As an individual develops experience from exposure, they move to the Implicit Guidance and Control loops which lessen the time and energy required to process information.

Proactive IG&C Loop (Fig. 4)

The Proactive IG&C loop can be thought of as "goal-directed action". Reflect on a time that you were presented information or a situation that you are unfamiliar with, as you process and reprocess the information it becomes second nature overtime. Eventually, when presented again with the situation, your previous processing can be leveraged to tune and amplify the signal in the noise. The amplified signal is processed faster with less mental energy. For example, a Business Analyst who skilled at gathering requirements meets with a business stakeholder to discuss their workflows. The BA knows this meeting is to gather requirements, so he arrives in a specific frame of mind. As they discuss the workflow the BA's observation is tuned to amplify requirements he hears during the conversation. [Spinny]

Proactive IG&C Risk

This cycle has inherent risk associated with it, if the individuals frame of mind is over amplifying a signal, the corrective feedback loops cannot adjust. This condition limits the ability to consider other potentially relevant and important information in the decision process. Using the same example above, the BA arrives at the stakeholder meeting with a specific idea of how the workflow should be crafted, he is biased towards a specific approach. Everything he hears from the stakeholder will be toward reinforcing his bias.

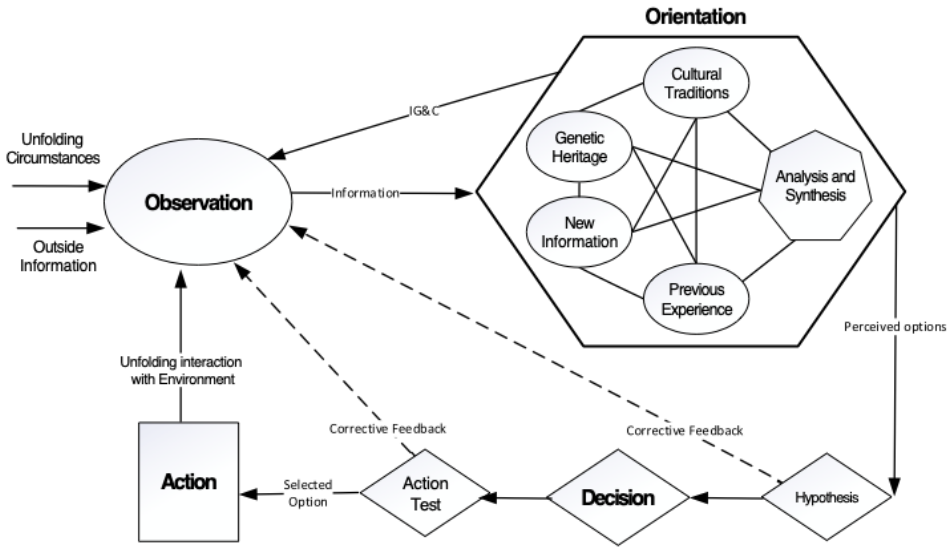

Figure 4. Proactive IG&C Loop

Reactive IG&C (Fig. 5)

The Reactive IG&C can be thought of as muscle memory or being in the state of knowing. This ability is from an individual's deep understanding of a subject, activity, or situation. The energy and time to cycle through this loop is minimal. For example, a software developer that is not required to have her code peer reviewed, does it as a matter of course because of the way she was trained. Another example would be that of a Black Belt in Karate that blocks a punch reflexively.

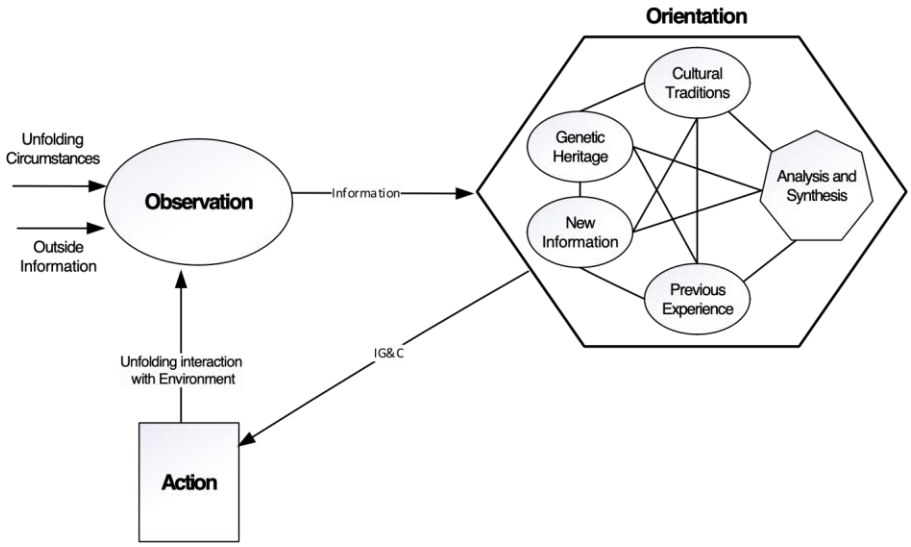

Figure 5. Reactive IG&C Loop

2.4. Organic Command and Control

To develop an organization mindset model, Boyd needed to understand how mindsets could be weaved together without compromising the speed and flexibility of the OODA loop. To put his scope into perspective the size of the five branches of the US military at the time was ~2 million individuals.

Boyd purposely did not create a "wiring" diagram to explain the idea of Organic Command and Control, he saw it as a shared mindset or culture that has implicit characteristics that make it fluid. Imagine trying to create a wiring diagram to explain the dynamic nature of the American culture. The diagram would require thousands of boxes and lines, that represent the multitude of perspectives, nuances, concepts, etc.

Boyd theorized that large organizations (corporations, governments, militaries) possessed a hierarchy of OODA loops at tactical, and strategic levels. In addition, he stated that most effective organizations have a highly decentralized chain of command that uses objective-driven orders, or directive control, rather than method-driven orders. This approach could harness the mental capacity and creative abilities of individual commanders at each level. Boyd argued that such a structure creates a flexible "organic whole" that is quicker to adapt to rapidly changing situations.

"A command-and-control system, whose secret lies in what's unstated or not communicated to one another (in an explicit sense)—in order to exploit lower-level initiative yet realize higher-level intent, thereby diminish friction, and compress time, hence gain both quickness and security".[Boyd 1987]

The use of the word" friction" was intended to describe a state of ambiguity, deception, uncertainty, but most of all mistrust. When friction is present the organization is spending energy looking inward instead of focusing on the desired goal. If an organization attempts to increase its agility and rapidity with friction present, it will amplify the friction causing confusion, disorder and ultimately chaos, lessening the chance to achieve the goal. He reasoned that if friction limits speed and agility then "harmony" could amplify it.

By viewing diverse individual orientations as a source of creativity, and exposing individuals to different skills and abilities, in a variety of situations where they can observe and orient to each other, a "harmony" is created. The harmony created by the bonds of implicit communications and trust become the culture of the organization. If the culture is tuned for harmony, then it will be able to maximize its speed, and agility.

2.5. Scrum

So why was the OODA loop and not another methodology (Deming, Shewharts, etc.) used by Sutherland to model Scrum? Because software is highly malleable, and requires a well-educated, adaptable workforce that can consume and act on large amounts of data and information quickly. Sutherland understood the dynamic nature of the challenge and the OODA loop design seemed like a logical fit. Like the OODA loop, Scrum is designed as an **information driven decision process** that emphasizes agility, rapid risk reduction, continuous feedback, and creativity.

3. OODA Examples

The following are real-world examples of decision-making successes and failures from the OODA loop perspective.

3.1. Medical Application

A large medical application was being modernized by an external vendor. Prior to placing the code into production, the customer was required to perform QA acceptance testing and certify the code. The contract with the vendor was created to facilitate an Agile SAFe delivery approach. Each release was comprised of multiple projects being combined into a single release every 4 to 6 weeks. This process cycle was called a "release train", and like a real train it could not be easily stopped.

The vendor would scope, and cost estimate a project and then set a target for a specific release. The vendor would receive payment +/- 10% of the estimate upon delivery of the code into production. This contract structure incentivized the vendor to deliver as many features as possible in the shortest amount of time. The vendor code quality was to be measured by the number of defects found in production. Tracing specific defects back to individual releases, especially releases that occurred months prior was not practical. This set the stage for the vendor to sacrifice quality over time and scope.

To reduce cost to the client the vendor proposed to consolidate the System Integration Testing (SIT) and the clients Independent User Acceptance Testing (UAT) testing into a single environment. The initial concept was that once SIT testing was complete the UAT testers would then begin their testing.

The QA management not understanding the purpose of separate environments agreed to this approach. This decision reduced cost, however, it began to blur the perspective of the test teams. This blurring of environments eroded the independent perspective of the UAT test team to the point they became a functional arm of the vendor, rather than a verification and validation entity.

Over time the features slotted in each release grew, and delivery of testable code to the test environment would be late, yet the final release date did not follow suit. This placed tremendous pressure on the UAT test team to certify the quality of the release prior to executing all their tests. Over time the discussions between the vendor and the QA manager became contentious.

In reviewing code delivery slips into the test environment relative to the defects found by the UAT test team there was an odd pattern that emerged. As the UAT test time shortened, priority 1 (P1) defects would appear just prior to QA certification. The distribution of defects found in each test period resembled a "V" shape. Upon initial release several P1 defects were identified and fixed, then just prior to release another spike of P1 defects appeared even though no new bugs were found.

Through discussions with the QA manager, it was found that when the code was initially released into the test environment it was not uncommon for several P1 defects to curtail the testing effort. Once these defects were fixed then lower priority defects were identified. As the release deadline grew closer, the UAT manager would reprioritize the defects to priority 1. Per the contract this forced the vendor to fix all defects prior to launch. This action resulted in creating a "V" shaped curve of high priority defects over the testing period.

The QA manager, unable to convince his management of the vendor quality issues his team was absorbing, found an effective method to box the vendor in contractually. While unorthodox, he found a way to maintain the quality of the delivered product. This is a good example of the Main OODA loop in practice, see fig. 6. The QA manager analyzed and synthesized information that was unfolding over time.

In this example, the project was required to have an independent outside review, which identified the unusual pattern of defects. This led to discussions with the QA manager that uncovered the issue with the structure of the Agile contract. While the QA managers solution was creative it also highlighted his inability to effectively gather data and present his analysis to executive management in a compelling manner.

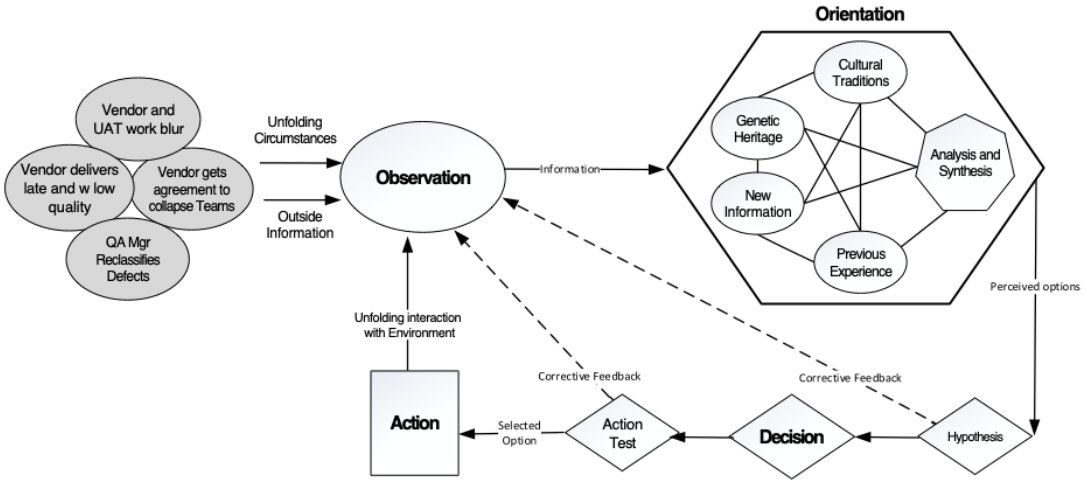

Figure 6. QA Manager Assessment and Decision Process

3.2. Commodity Contracts Application

An organization that managed commodity contracts required that a new system be implemented that would enable the management of more complex, long duration contracts. The business not being familiar with IT systems development, relied on the project and development teams to lead the effort.

3.2.1.Alternatives Analysis Solution Decision

To "sell" a big project internally, development and business representatives need to create a business case that will often use the best-case scenario to demonstrate the benefit to the business. As part of the business case the project team produced an alternatives analysis that presented financial and technical information in an incomplete and biased manner that led the audience to a seemingly obvious conclusion.

In this case the analysis identified and rated three alternatives, of which the third was selected. They are as follows.

1. Do nothing (Status Quo)

   This option could be a serious consideration if an organization has decided to exit a line of business and the system would be decommissioned at a specific date. If the business is exiting a line of business the time horizon would be a key factor for the analysis. The cost of maintaining the system for the period specified, stability, security and business efficiency are all factors in the analysis. In this case the option was not valid and should not have been included as part of the business case presentation.

2. Commercial Off the Shelf (COTS)

Procuring a COTS system or platform like that of a CRM or MRP is challenging when there is an existing team of developers, testers, and business analysts. The team felt threatened and were concerned they would have to downgrade their skillsets. To minimize these perceived threats the staff suggested that the business requirements are unique or too complex for a COTS/CRM solution. Uniqueness and complexity is in the eye of the beholder. Given the team was insular and at the edge of their skillsets, the tasks may seem complex when they are not. Additionally, it was presented that the risk of relying on a single vendor was too great.

There are three common reasons for the business and technical teams to exaggerate issues and rule out this option.

A. Changes to business operations - COTS systems that directly target the market will be less customizable and the business may not wish to change their workflows to accommodate the new system.

B. Unique and complex requirements – if there are existing commercial products that target this market then it is unreasonable to believe the requirements are unique or complex. Most likely this concern is related to #1.

C. Cost – COTS systems will have higher upfront costs that will be prominent in the financial analysis. The price tag may be shocking at first, but the price is clearly quantified. When establishing the cost of the internal team to accomplish the task it was underestimated, left vague and/or conditional. By doing a total cost of ownership analysis, the cost can be more accurately estimated.

   At the time the analysis was conducted, there was at least one COTS system in the market that was targeted specifically to this type of business. This vendor's product was not included in the analysis.

3. Internal development

The analysis of the COTS system option was used as the reference for the reasoning and cost for the internal development approach.

A. Changes to business operations – none were expected because the development team would customize it to the existing workflow.

B. Unique and complex requirements – the existing team knew the details of the requirements and their "complexity".

C. Cost – internal development costs were utilized to justify the price. These costs can be portrayed upfront as modest, however, there are hidden costs and risk that were not included either intentionally or unintentionally.

If the organizational structure is centered around internal product development, it is challenging to get an objective assessment because of self-interests. This bias is sometimes referred to as the "not invented here" syndrome and results in limiting innovation.[Katz] Since the business relies on development teams for technical guidance their bias will permeate through the entire organization as if it were fact.

In this case the information provided to the sponsor for their final decision was shaped (biased) toward internal development, see fig. 7. Subsequently the non-technical sponsor approved the analysis and recommendation from the development and project teams. Not being technical he approved it because of his bias to trust his team. The development teams Proactive IG&C loop amplified a specific approach that was continually being reinforced.

After the system was developed by the internal team, it was put into production with a fundamental architectural flaw. Over time this flaw severely limited business operations efficiency and growth.

The insular culture of the organization led to the perception that the requirements were very complex and could only be understood by the existing developers. Executive management's trust in the team was unfounded and the bias of

the team shaped the final decision to develop the system in house. Additionally, the governance committee was misled in the process, however, the purpose of governance is to guard against exactly this issue. At first glance it is easy to focus on the developers as the source of the issue, however, multiple post decision checks (formal feedback loops) had failed because of too much unwarranted trust at different levels of the organization.

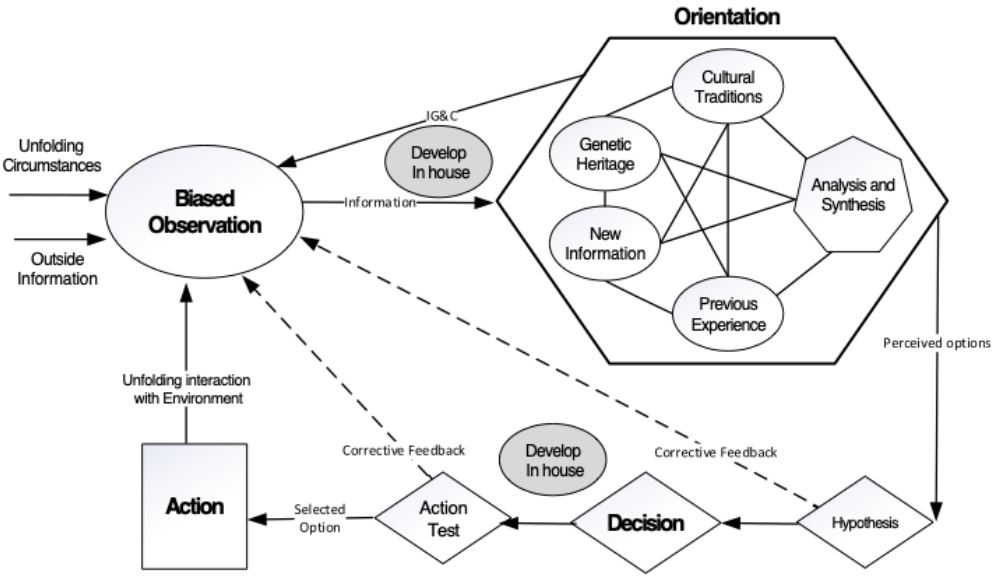

Figure 7. Internal Development Team Biased Recommendation

3.3. Product Manufacturer

A midsize company that developed and sold complex hardware and software was not releasing any significant features into the market for their existing products. The sales and engineering teams blamed each other and they both blamed product management. Through a series of interviews, it was clear the c-suite was unable or unwilling to prioritize and maintain a road map. The company was struggling to make revenue and the condition was being exacerbated by not delivering new features to the market. The team, under great stress, was folding in on itself.

If an individual salesperson were at risk of not making their quarterly revenue target, they would circumvent product management and contact the development managers and advocate for a specific feature to close a deal. This behavior was condoned by the VP of sales. Many of the features requested were significant and were not vetted relative to their desirability beyond the one customer. To support sales the development managers would deliver short term "sale closing" enhancements that did not close sales. Worse, if a feature required more than a couple of months to develop it ran a high probability of it being derailed at the end of the next quarter when new "sale closing" enhancements were requested. In an interview with a development manager, he expressed that they could "wait" sales out and just deploy their resources to longer term projects they "felt" were more important. It was clear that due to stress and pressure that the c-suite decision making processes were breaking down, refer to fig. 8. It was unclear as to how the situation began; however, it was certain that the culture of the organization was eroding, see fig 9 culture depiction.

Through a series of discussions/negotiations with the Sales, Development and Product Management VP's and Directors both individually and as a group, compromises were made, and a roadmap was established. In addition, a specific set of development capacity was left open to deal with simple tactical enhancements that could be turned around quickly. To support the approach the VP of sales committed to having all sales request go through product management, and the CEO understood there would be a short term hit to revenue as the organization was realigned. As short-term roadmap milestones were achieved and new features delivered, cooperation, trust and focus began to permeate the organization and accelerate the delivery of significant features in a more predictable fashion. The

company stilled struggled in a hyper competitive market, however by reducing the internal friction and reorienting the organization towards a set of goals it increased their capacity to explore new markets and revenue streams as a team.

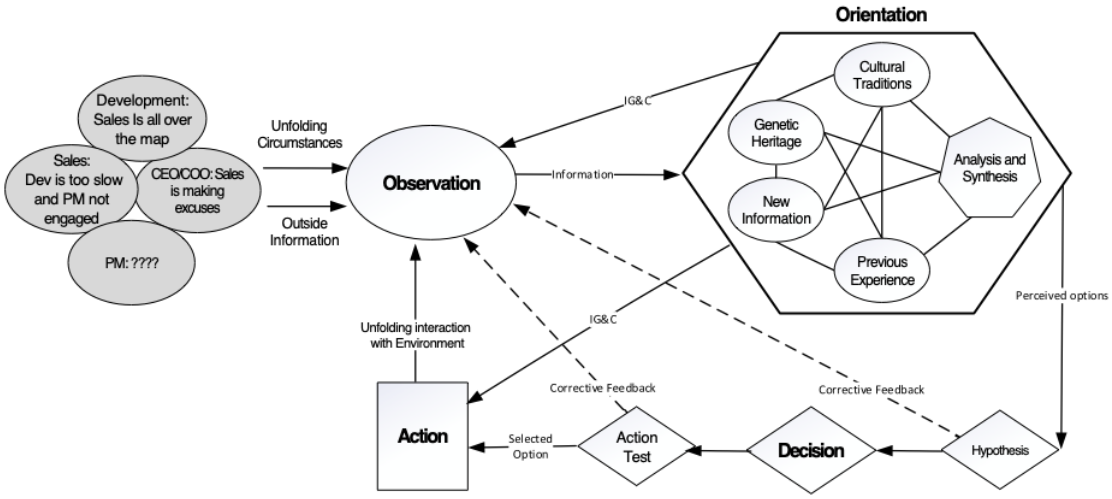

Figure 8. Multiple Individual Perspectives

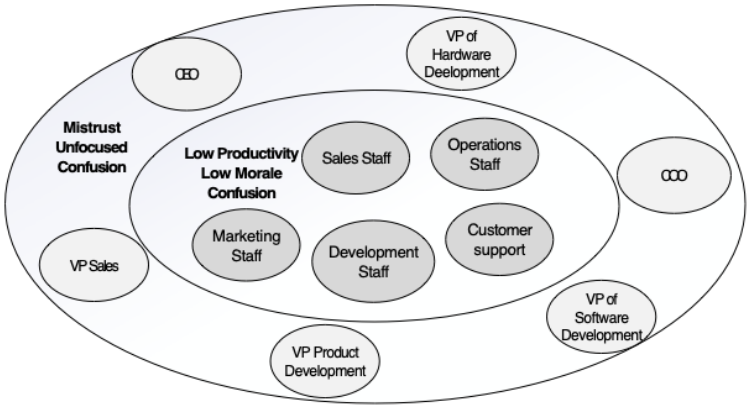

Figure 9. Organization Bonds

4. Conclusion

Most organizations focus on catching bad decisions through various control processes rather than spending the time and effort on making more informed decisions at the outset. This is akin to how an organization thinks about software quality. Some organizations rely only on the QA testing phase of the SDLC to control for defects, while others look to improve the quality of the final product by focusing on the source of the defects.

Being data driven and having the ability to “pivot quickly” or be “agile” is extremely desirable, however, without a mindset that supports these traits, the degree and fluidity of the agility will be minimal, ineffective, or even destructive to the organization.

References

Sutherland, Jeff, and Sutherland, J.J., 2014. *Scrum: The Art of Doing Twice the Work in Half the Time.* New York: Currency.

Coram, Robert. 2002. Boyd: The Fighter Pilot Who Changed the Art of War. Back Bay Books.

Richards, Chet, 2020. Boyd's OODA Loop. Necesse Vol 5, Issue 1. Sjokrigsskolen. Norway.

Boyd, John R., "Destruction and Creation" (unpublished paper, Sept. 3, 1976), Defense and the National Interest, Dec. 6, 2007.

Blaha, Leslie M. 2018. Interactive OODA Processes for Operational Joint Human-Machine Intelligence. NATO Science and Technology Organization MP-IST-160-PP-3 Bordeaux, France.

Spinny, Chuck. 2019 Evolutionary Epistemology Talk. Expeditionary Warfare School (EWS) Quantico, VA

Boyd, John R., "Organic Design for Command and Control" (unpublished briefing, May 1987), slides 26, 16, Defense and the National Interest, Dec. 6, 2007.

Katz, Ralph, and Allen, Thomas 1982. Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R&D Project Groups. Sloan School of Management M.I.T. Cambridge, USA.