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## Thoughts on the Future of Library Computing: Implications of the Use of Handheld Computers for Library Service

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## **Boyd Cycle Theory in the Context of Non-Cooperative Games: Implications for Libraries**

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### **Introduction**

The fundamental issue for survival in modern librarianship is adaptation. In the modern information environment the basic criteria that determines the success or failure of a library is the ability of the library staff to effectively adapt their policies and procedures to the needs of the user. On a daily basis we see users with technologies and skills that often exceed that of the library staff. The use of cell phones is a perfect example. This is widely used and accepted technology, but the response of libraries has been, in many cases, to limit the use of cell phones or ban their use completely. Cell phones are a symptom of a deeper problem – the inability of the library to adapt to change. In many cases, as most librarians will attest, libraries are woefully behind the curve.

Librarians have created a vast literature aimed at understanding these technological changes and their implications for libraries. In many cases the solutions for libraries are expressed in terms of the need for organizational restructuring or technological enhancements to increase and enhance the level of service to users. The purpose of this article is to suggest that there is a more fundamental issue: The lack of understanding of the Observation-Orientation-Decision-Action (OODA) loop. This lack of knowledge and use of this concept places libraries at perpetual disadvantage compared to other organizations which have made use of the concept. Increased awareness of this cycle would benefit libraries by making them able to adapt to change better and faster to the needs of their users and, more importantly, allow libraries to better articulate their reactions to change. When combined with a basic knowledge of game theory the result for libraries can be more optimal outcomes in a wide range of areas from operational questions to strategic planning.

### **The OODA Cycle – Theoretical Explanation**

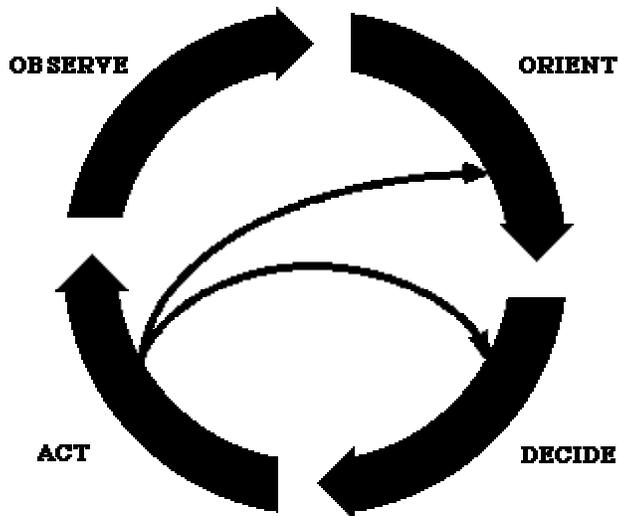
The concept of the OODA cycle was first developed in the 1970s for military applications. The originator of the theory, Colonel John Boyd, in an analysis of air-to-air combat outcomes postulated a scenario in which one side in a conflict presented the other

with a sudden, unexpected challenge or series of challenges to which the other side could not adjust in a timely manner. As a result, the side with the slower response was defeated, and it was often defeated at a small cost to the victor.

In Boyd's paradigm, victors consistently are able to recycle through the OODA loop or Boyd Cycle, faster and this gave them an advantage over their adversaries. The actions of the opponent, on the other hand, became slower and slower. Since they were going through the OODA loop slower, over time, they fell further behind until the faster side achieved victory. This model, although originally applied to military situations, is also applicable to business and other competitive situations.

Boyd postulated that any conflict could be viewed as a duel wherein each adversary observes (O) his opponent's actions, orients (O) himself to the unfolding situation, decides (D) on the most appropriate response or counter-move, then acts (A). The competitor who moves through this OODA-loop cycle the fastest gains an inestimable advantage by disrupting his enemy's ability to respond effectively. He showed in excruciating detail how these cycles create continuous and unpredictable change, and argued that our tactics, strategy, and supporting weapons' technologies should be based on the idea of shaping and adapting to this change — and doing so faster than one's adversary. (see Figure 1)

**FIGURE 1:  
THE OBSERVATION, ORIENTATION, DECISION, ACTION CYCLE  
(BOYD LOOP)**



The ability to understand the orientation function is the key to success because it allows a competitor to penetrate his opponent's decision cycle. Each of us bases our decisions and actions on observations of the outside world that are filtered through mental models that orient us to the opportunities and threats posed by these observations. As Konrad Lorenz and others have shown, these mental models, which the philosopher

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of science Thomas Kuhn called paradigms, shape and are shaped by the evolving relationship between the individual organism and its external environment.

In a 1997 article published by the U.S. Naval Institute Franklin C. Spinney, a close associate of Boyd's, summarized the essence of the Boyd Cycle Theory:

In conflict, each participant, from the individual soldier trying to survive to the commander trying to shape strategy, must make decisions based on his orientation to reality — his appreciation of the external circumstances which he must act on. Boyd argued that one's orientation to the external world changes and evolves, because it is formed by a continuous interaction between his observations of unfolding external circumstances and his interior orientation processes that make sense of these circumstances. These interior process take two forms activity: analysis (understanding the observations in the context of pre-existing patterns of knowledge) and synthesis (creating new patterns of knowledge when existing patterns do not permit the understanding needed to cope with novel circumstances).

The synthetic side of the dialectic is crucially important to one's orientation, because it is the process by which the individual (or group) evolves a new world view, if and when one is needed to cope with novel circumstances. But as Kuhn and others have shown, the synthetic process can be extremely painful, because its nature is to build a new paradigm by destroying the existing one. Boyd strove to use multiple, quick-changing destructive thrusts to isolate his adversary from reality by destroying his existing paradigm, and at the same time, deny his adversary the opportunity to synthesize a new paradigm. The combination of menacing pressure and an inability to cope with external circumstances cause the adversary to experience various combinations of uncertainty, doubt, confusion, self-deception, indecision, fear, panic, discouragement, and despair — which, in turn, overload his capacity to adapt or endure.<sup>1</sup>

### **Implications of the Boyd Cycle for Libraries**

Libraries are recognized for many things such as good service to users, interest in issues of intellectual access and use of technology. What libraries are not noted for is speed. In many cases libraries are slow to respond to the changing needs of their users. One particular example is the use of interlibrary loan. Now, first, let the reader not think that I, as a librarian, am against interlibrary loan. It is a valuable service and the people who work there work very hard indeed.

The reality of interlibrary loan, however, is that it is often slow. This isn't to say that there are not rush services. However, it often takes a week to several weeks to get an item for a student. In many cases, telling a student they need to wait two weeks is tantamount to telling them the item is unavailable. There are various responses to this situation. The student can go to the local Barnes and Noble and purchase the book. Often, especially in larger cities, the book is readily available either at the store or can be

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delivered with a day or two. This response is a perfect example of the Boyd cycle. Given the library reaction to the request, e.g., “wait two weeks,” the student got inside the decision cycle of the library, reacted, and, in this case the library, in effect, was defeated in that the student obtained his materials outside the library.

A library response to this situation, in turn, that would get inside the decision cycle of the student would be to offer overnight delivery comparable to the bookstore or, even better, to offer the book online. The ultimate response would be, of course, to have detailed information regarding the student and anticipate his request prior to his even asking. For example, a system of electronic reserve that ties into the university registration system or the professor's syllabus and automatically sends the student the required reading when they need it e.g. the night before the material is discussed in class.

There are obvious implications in that this, and many other library activities, can be seen as dynamic non-cooperative games. For example, collection management decisions, especially activities such as like periodical reviews, can be seen the same way in that there are several players seeking to maximize their self-interest. The results of which can be expressed in a variety of ways – including a Nash equilibrium solution.<sup>2</sup> This concept will be further explored later in this article.

What these examples illustrate is that libraries already use the Boyd Cycle in their operations. There are mechanisms, of lesser or greater formality, in every library which make use of the concepts of the Boyd Cycle. Librarians simply don't recognize that they are using it and, in consequence, are not using the mechanism to their fullest advantage.

### **Anticipation as the Key to Success**

In the illustrations above the use of the Boyd Cycle dealt with a practical issue of materials delivery. In many cases the response of libraries tends to be reactive. For example, people bring in their cell phones. This is seen as a problem because it is loud or disruptive or otherwise is a problem in the smooth running of the library. Policies are put in place saying “No cell phones.” Students end up unhappy because they can't use their phones. Staff are unhappy because they feel they have to be “phone police” and are not doing what they really want to do. Using the Boyd Cycle the library could have anticipated the issue and created a better outcome.

The key to success is anticipation. With the proper awareness of the emerging technology e.g. intelligence a library could anticipate that a new technology e.g. cell phones might be becoming important. The library could then process this information and get inside the decision cycle of the student, perhaps by creating quiet areas in the library or even installing soundproof phone booths (with appropriate signage) for users. The time to do this is before the technology hits a critical mass of users. Trying to regulate the technology after everyone has adopted it will be inefficient and, in any event, by that point the next decision cycle by users will have begun for the next wave of technology e.g. wireless laptops. The library is left behind. Fundamentally, what we're talking about here is an inability of libraries to react quickly to novelty.

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## **Adopting the Boyd Cycle approach: Practical Suggestions**

Libraries tend to be relatively slow in their decision making process. They also tend to be policy driven. The usual approach to a situation is to A) identify the problem B) decide if a policy is needed C) develop the policy and D) implement. This all takes time. It also reflects a top down management structure as far as decision-making processes are concerned. In some cases libraries have adopted a team based approach to management where the decision making process is decentralized from central administration and left in the hands of team members. However, this is sometimes not an improvement – especially if teams are large and develop cumbersome internal procedures for responding to problems.

In either case the real issue is the lack of speed. Any decision making process takes time. As an organization the library is at a distinct disadvantage against individual users because their decision-making process is more flexible and faster. Libraries have and should reduce barriers to timely decision making. However, there is a limit. The time for a decision will approximate 0, depending on the efficiency of the internal mechanisms of the library, but never be faster than that of the user – for reasons stated above. However, despite this the library can reduce the barriers to quicker decision making processes and, thus, get inside the decision loops of their users somewhat faster – by use of information.

It should be pointed out that this article tends to use technology as an example of the Boyd Cycle and its implications – largely because this is relevant and understandable. The fundamental principles being discussed here could, however, also be usefully applied to other areas of library operations with equal utility. For example, it also could apply to human resources where the internal mechanisms of the hiring process are in competition against the decision making process of the applicant. The job applicant can speedily choose between job offers A, B, or C in a time frame much faster than the library, as an organization, can make the hiring decision. The applicant is inside the decision loop of the organization and therefore comes out ahead. In a broader sense this can also be seen in terms of the competition between libraries for personnel. Or, even, in terms of the competition of libraries as a whole for personnel against related businesses such as the computer industry that are competing for the same people. The implication being that libraries with more streamlined and faster hiring processes will be at an advantage in the marketplace compared to their slower competitors.

Libraries, since they do have this inherent disadvantage of being an organization, can compensate somewhat through the use of strategic intelligence. Institutional changes, especially in the area of technology, tend to be slow. This reflects the complexity of technological infrastructure, the costs involved, and the various levels of administrative bureaucracy that exist. In the area of technology there is also a tradeoff between innovation and stability. Libraries tend not to be first adopters of new technology. They also tend to keep technology longer e.g. keeping computers until they literally fall apart.

In terms of technology, then, libraries to get ahead of the decision curves of their users, need to adopt a more proactive and less risk-neutral approach to technological innovation. This does not mean, necessarily, that libraries have to adapt wholesale change every time a new technology develops. However, libraries do need to be aware of the trends in new technology, especially in terms of their users, and be willing to invest in a regular basis in technology on a research and development basis – not only in investment in hardware and software, but in human resources for development. Too much of our time, as libraries, is spent on maintaining existing systems, often long past their expected dates of failure, rather than planning for the future services that we need.

Such an approach implies a greater integration of the library operation, especially in the area of technology, with other campus units such as academic and administrative computing. This doesn't mean a merger of these organizations – which often happens. It does mean a sharing of expertise and a willingness to disregard the traditional political and social boundaries between libraries and other technology innovators on the campus.

By doing so the library (and the campus as a whole) start operating within the Boyd Cycle at a higher and more effective level. The fundamental driving force behind the Boyd Cycle is information. The more you know about your adversary (or your patron) and what they plan to do the more effective you can be. By combining the expertise and information from different areas the library/computing complex attains a gestalt which allows them, as a whole, to move closer into OODA loop of their users – thus assuring a higher chance of a successful outcome for all concerned.

### **Implications of Boyd Cycle Theory for Management Analysis**

The real value of the Boyd Cycle is that it give organizations a method of analysis for determining where they are failing and succeeding in serving their users. It provides a concrete method of discussing, as was mentioned earlier, what, up to now, has been understood largely by intuition. If, for example, you know that the entire freshman class is bringing laptops and your response the summer before is to install a wireless network you have been operating in a Boyd Cycle. Essentially, what we're talking about here is vocabulary. It's not that libraries have done such a bad job. What we've been really bad about is articulating what we're doing and why – especially to ourselves and often to people outside our group. We react to external circumstance without any real analysis of what the reaction actually means. In sum, what we have going on is a kind of unthinking and unexamined evolution of process. We act without being actually aware of the motivations of why we act. The use of Boyd Cycle analysis provides a methodology for having a meaningful discussion about library activities and processes, placing them in the larger context of the organization as a whole.

### **Boyd Cycle Theory in the Context of Games: Implications for Planning**

To express this a different way: if one considers a library activity, as suggested earlier, as a form of non-cooperative game then one can see, as Hallett suggests, that the outcome can be considered an open loop decision where the decision is based on the

player's information set which is based on a variety of factors including realized values of past variables, expectations of future variables, and dynamic economic responses. Boyd Cycle theory is, at its core, about the collection and assimilation of information. In the context of games, therefore, the use of Boyd Cycle theory represents a methodology for evaluation of those variables mentioned above in a more efficient manner as well as a mechanism for creation of future responses.<sup>3</sup>

Modern library strategic planning is informed by numerical data. However, the decision making process is largely normative. That is to say, despite the presence (or absence) of data, the end result of strategic planning processes tends to be subjective. There are usually empirical metrics which these metrics can be gathered e.g. increase in number of patrons served, increase in number of materials owned, or some other measure of increase in efficiency. This results in a decision matrix – of lesser or greater complexity depending on the environment and level of analysis – on the basis of which future decisions are taken. The issue for libraries is that, although the decision matrix is based on metrics, it is not, nor should it be, totally derived from them, but also from subjective factors. In many cases, these subjective factors have not been subjected to a high degree of analysis – often because of the lack of a tool for that process e.g. the Boyd Cycle. The result can be planning decisions that are inconsistent – especially in terms of the overall institution.

Where the system also breaks down is in the level of cooperation between the library and other campus units, especially those at a higher level. The errors of subjectivity in the decision matrix are compounded on institutional basis since, normally, the strategic planning process is centrally controlled and administered across units in a uniform manner. In practical terms what usually happens is, in effect, the outcome of the process is considered by the participants a zero sum game where one participant's gains come at the expense of the other's equivalent losses. The use of Boyd Cycle Theory, in conjunction with the idea of non-cooperative games, can provide a useful mechanism for libraries to analyze their planning processes and result in more optimal outcomes.

1. Franklin C. Spinney, "Genghis John," *Proceedings of the U. S. Naval Institute*. July 1997, pp. 42-47. See also [www.belisarius.com/modern\\_business\\_strategy/thompson/first\\_with\\_most.htm](http://www.belisarius.com/modern_business_strategy/thompson/first_with_most.htm). This is the source of the graphic. It also contains an excellent discussion of the general theory of the Boyd Cycle as well as its application to a business environment to which I am indebted. For an overall discussion of the history and development of the theory the definitive source, at present, is Robert Coram, *Boyd: The Fighter Pilot Who Changed the Art of War*. Boston: Little Brown and Company, 2002. The literature is somewhat limited since during his lifetime Boyd consistently refused to articulate his theory in publication, preferring to offer an intensive multi-hour (or multi-day) briefing.

2. For a discussion of the dynamics of this situation as relates to game theory see A.J. Hughes Hallett, "Non-Cooperative Strategies for Dynamic Policy Games and the Problem of Time Inconsistency," *Oxford Economic Papers*, New Series, Vol. 36, No. 3.

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(Nov., 1984), pp. 381-399. Unfortunately, there is nothing in the literature that applies game theory specifically to library situations.

3. Hallett, p. 383.