Measure Like a Fighter Pilot

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The late Col. John Boyd, U.S. Air Force, developed the Observe, Orient, Decide, and Act (OODA) Loop as a strategy for air combat and warfare. It is an elegant, fast decision-loop strategy that is also useful in engaging the measurement and analysis process with the corrective action loops of a development project. The OODA Loop will be introduced in this article along with practical suggestions and lessons learned related to implementation of the measurement and analysis process. These recommendations are based upon years of measurement and analysis experience, recently with a Capability Maturity Model® Integration Level 3 Best Practice measurement and analysis process.

A measurement analyst can face daunting challenges when implementing a measurement and analysis process. Project dynamics and the array of forces that oppose change can easily stall implementation, even when the process is based upon respected guidelines such as Capability Maturity Model® Integration (CMMI®). To be successful, a measurement analyst must have an effective game plan (a focused strategy of when to do what, where).

After years of experience with measurement and analysis, most recently developing a CMMI Level 3 Best Practice measurement program for a large development and integration program, I have accumulated a number of suggestions and lessons learned. I did not have a cogent game plan that I could share with others, however, until I discovered the Observe, Orient, Decide, and Act (OODA) Loop, which explained almost all the successes and failures I have experienced.

The steps of this decision-loop concept provide a forward-leaning framework for action that will bring measurement and analysis to its full potential. The OODA Loop will be used in this article as a framework to relate my first-hand suggestions and lessons learned.

The OODA Loop

Col. John R. Boyd, an accomplished U.S. Air Force fighter pilot and military thinker, originally developed the OODA Loop as a winning strategy for air combat. Later, it was a key part of Boyd's maneuver warfare strategy, which has been embraced at some level by most U.S. armed services. The phrase *getting inside the enemy's decision loop* can be heard in military briefings in recent years – a reference to the OODA Loop. Col. Boyd passed away in 1997 at the age of 70.

OODA Loop Definition

The OODA Loop is a strategy for effective decision making. Figure 1 is a simplified view of the concept. Boyd broke the decision-making process into four steps: Observe, Orient, Decide, and Act, as defined below:

1. **Observe.** Collect and organize information related to recent events, feedback from prior actions, and changes in the environment.
2. **Orient.** Orient to the unfolding environment and current observations. This is the most critical step and is prone to failure. The speed with which orientation is completed is dependent upon the current paradigm (i.e., expectation of what the observations and current environment should be). In simplistic terms, the Orient step will complete in one of three ways. Each is characterized by the speed with which orientation will complete:
   - **Fast.** Observations and environment match expectations (paradigm): Quick, gut-feel, decision/action can be initiated.
   - **Moderate.** Observations and environment differ in some ways from the paradigm: Analysis will be required to develop alternate plans of action and the paradigm may need to be adjusted.
   - **Slow.** Observations and environment differ substantially from the paradigm: The current paradigm may have to be discarded and a new one synthesized.
3. **Decide.** From available actions, select which one to take.
4. **Act.** Take action.

Boyd also asserted the following:

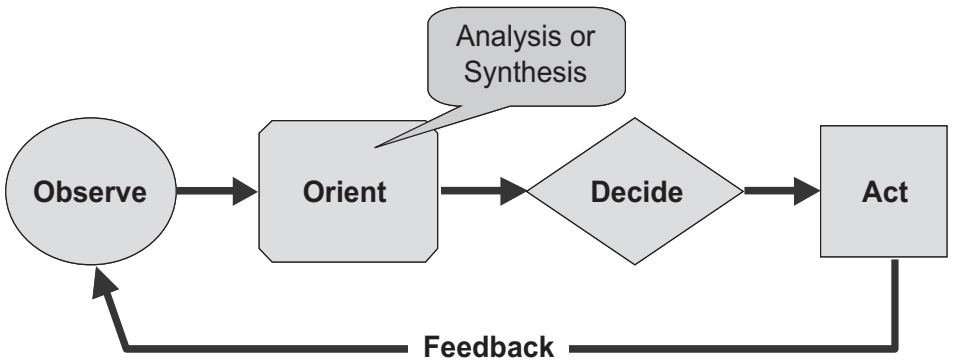
- All human behavior, individual or organizational, can be depicted as a continual cycling through the four steps.
- Success or failure depends upon the relationship of one's own loop to that of an opposing loop.
- Success or failure depends on one's ability to swiftly and accurately complete cycles of one's own loop faster than opposing forces can cycle through their loop.

Jet Fighter Example

The utility of the OODA Loop is best illustrated by an example from Boyd's combat experience in the Korean War – a dogfight between a U.S. F-86E Sabre Jet and a Russian MiG-15. Boyd was interested in a paradox related to these fighters. Sabre Jets were shooting down MiGs at a 10-1 ratio in the Korean War, in spite of the fact that MiGs could out-run and out-turn Sabre Jets. The Sabre Jet provided better visibility and was more responsive than the MiG, but this was not enough to explain its success ratio until the OODA Loop concept demonstrated the power of a fast decision loop.

Each Sabre Jet maneuver is creating a

Figure 1: *The OODA Loop*



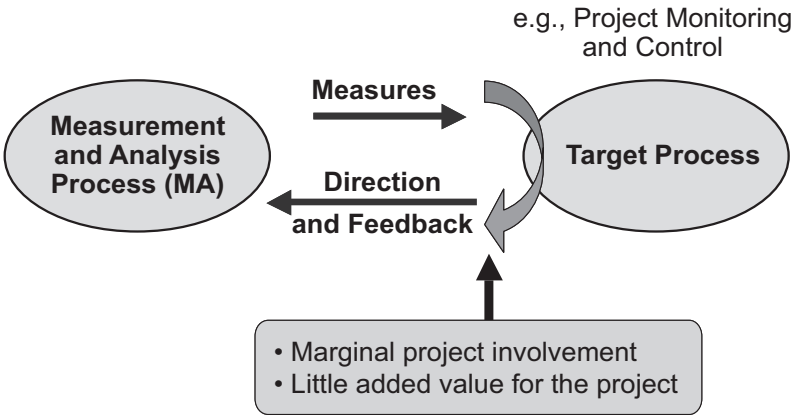


Figure 2: *Shallow Measurement Loops Fail*

change in the tactical situation. If the MiG pilot is completing maneuvers (and OODA Loop cycles) at the same pace, he will be able to observe and reorient to each maneuver as it occurs. New observations will generally match his expectations since he is reorienting to each new maneuver. His performance should therefore be on par with the Sabre Jet pilot.

A trained Sabre Jet pilot, however, will use his jet's responsiveness to complete maneuvers faster than the MiG. The MiG pilot, now unable to cycle through the loop as fast as the Sabre Jet, will fail to keep his orientation updated, and will begin to notice a mismatch between what he expects to observe and what he actually observes. Resolving the ambiguity of the mismatch will slow down the MiG pilot's orientation forcing him to cycle through the loop even slower, leading to larger mismatches. For the MiG pilot, time will appear to be compressed, giving him little time to think. For the Sabre Jet pilot, time will seem to almost stretch out and slow down. The Sabre pilot will be able to harass and eventually entrap the MiG pilot to win the engagement.

The Sabre Jet pilot can win by using fast transient maneuvers to degrade the MiG pilot's orientation. For air combat and warfare, speeding up one's own OODA Loop (operating within the enemy's OODA Loop) can be used to literally destroy an enemy's decision-making capability.

On the other hand, the same idea can be used constructively for engineering process. By operating within the OODA Loop of a target process, a process change leader can make supportive actions to enhance and positively influence the target process decision loop.

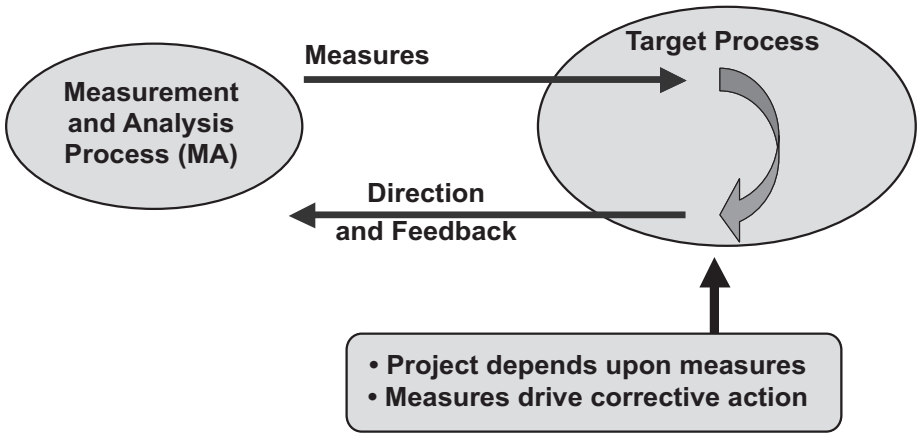
The OODA Loop as an Enabler for Measurement and Analysis

Current development processes such as CMMI and Practical Software and Systems Measurement provide excellent guidance on how to plan and conduct measurement and analysis. A critical challenge in implementing these models, however, is interacting with other project processes; in other words, engaging with the managers and other stakeholders who actually initiate corrective action – the end goal for measurement and analysis.

We have all seen projects that *have metrics* but practice a shallow implementation, where metrics are collected and reported but do not have much of an impact on the stakeholders or drive corrective action at all. Figure 2 illustrates this situation. Stakeholders in this environment generally fail to appreciate the value of measurement.

On the contrary, the measurement loop should extend deep into the target process. Figure 3 illustrates the ideal situation. With a deep measurement loop, the target processes will depend upon measures, and the measures will regularly drive or shape change. In this situation, the measures truly engage target processes. Target process stakeholders will request more measurements over time, raising the importance of measurement in their project activities. At this level of engagement with its target process, measurement and analysis is exciting, vital work.

Figure 3: *Deep Measurement Loops Engage and Succeed*



Driving a measurement loop deep into the target process requires a focused strategy. My suggestion is to engage the target process by getting inside its decision loop. Visualize the decision loop that stakeholders use for their decisions (Observe, Orient, Decide, and Act) and include measurement collection and analysis in the Observe and Orient steps (see Figure 4). Consider this the playing field for the measurement analyst. All the measures provided should be weighed against how they will play in the loop. The measurement analyst should drive his/her own decision loop fast enough to stay *inside* the stakeholders' decision loop to deliver what they need when they need it. The measurement analyst should be making fast transient moves, like a Sabre Jet pilot, to enhance the stakeholder decision loop.

Getting inside the stakeholders' decision loop may be a significant paradigm shift for some measurement analysts. It will pull them away from the relative safety of the numbers and into the project where they will have to find out how to really drive and shape change. Measurement will become more challenging, but much more effective.

Practical Suggestion

A sign that you are truly inside your stakeholders' decision loop is the interaction with the stakeholders. They will ask questions, request and even argue over refinements, and take a real interest in your measures. During my measurement briefings to our customer, my project managers often add commentary of their own. They have played a significant role in refining the measures and are very familiar with my charts.

The OODA Loop Applied to Measurement and Analysis

The OODA Loop is used in measurement

and analysis as a framework for action. Illustrated in Figure 5, the OODA Loop cycle includes the measurement and analysis functions in the observe phase with the remainder of the loop's actions (Orient, Decide, and Act) primarily in the target process. The Orient step is a joint effort, wherein the measurement analyst orients the observations to the stakeholders' perspectives, and the stakeholders then familiarize themselves to the unfolding project environment.

Note that the figure represents a measurement and analysis loop for a single project activity. For a project, many of these will exist. The diagram includes three corollaries associated with the OODA Loop concept, which will be defined in the Corollaries section: tempo, harmony, and ground truth.

Each of the OODA Loop steps (Observe, Orient, Decide, and Act) is defined below, along with related practical suggestions and lessons learned.

Observe

The observe step for the measurement analyst entails the collection and analysis of measurement data.

Practical Suggestion

One of the most difficult and valuable services a measurement analyst can provide is forecasting (e.g., forecasting the expected number of defects that will be encountered during formal test). It is difficult because forecasting requires creative analysis and data collection from a variety of sources. Forecasting is especially valuable because it provides a basis for objectively assessing status, finding leading indicators, and confirming management assumptions.

Orient

Process stakeholders perform the Orient step by orienting to the ongoing situation in preparation for the last steps of the loop, Decide and Act. The measurement analyst plays a key role in the step by orienting the measures for the stakeholders (i.e., making the data meaningful in a perspective that is both familiar and effective in decision making).

Figure 5 includes an extra paradigm loop for the Orient step related to the stakeholder paradigm. This is an important concept. Based on experience and attitude, each stakeholder will have an expectation of how measurement should work, and what the measurements will be. This is the stakeholder paradigm. It will have an impact on how the stakeholder reacts to measures and can either help or hinder measurement. The measurement analyst will generally need to structure measures so that they are aligned with the stakeholder paradigm and, occasionally, work on modifying the stakeholder paradigm.

Practical Suggestion

Provide status data for the whole organization plus drill-downs (filtering or other methods of providing status for lower-level organizations). See Figure 6 for an example. This format is used to brief code-size status for the project (top left chart in Figure 6) and each of the lower-level subsystems. In this way, problems at the subsystem level (such as shown in the bottom right chart of Figure 6) are not missed. The charts are simple and provide limits/plans so that reviewers can objectively assess status.

Lesson Learned

I once failed to ensure that project managers reviewed measurement data at the normal periodic rate. The managers were busy and I did not see anything to worry about, so I did not insist on the normal

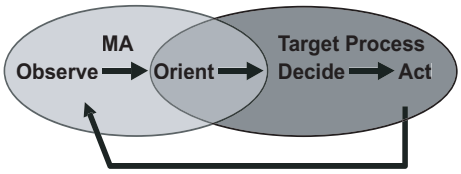


Figure 4: *Engage by Getting Inside the Target OODA Loop*

measures reviews. I realized later that we had missed an opportunity to take corrective action on a problem the managers would have spotted if they had seen the data. I had failed to recognize that it was their orientation, not mine, that was important.

Decide

Project stakeholders perform this step. The challenge for the measurement analyst is to provide measures that will support reliable and expeditious decision making by the stakeholders.

Practical Suggestion

To optimize decision making, I follow what I call the *Bruno the Trained Ape* rule for

Figure 5: *The OODA Loop for Measurement and Analysis*

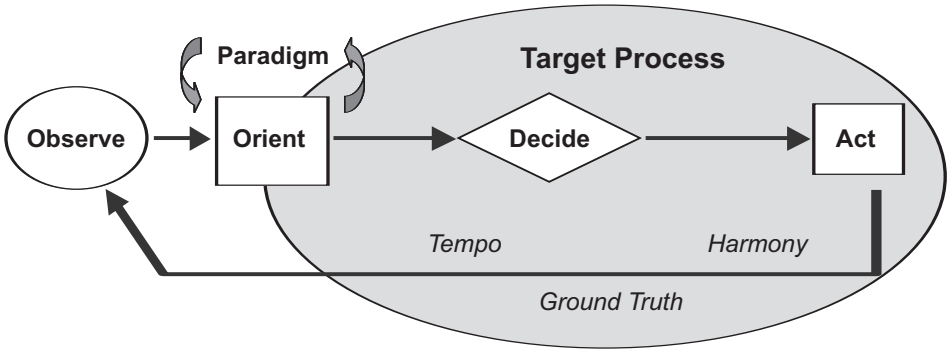
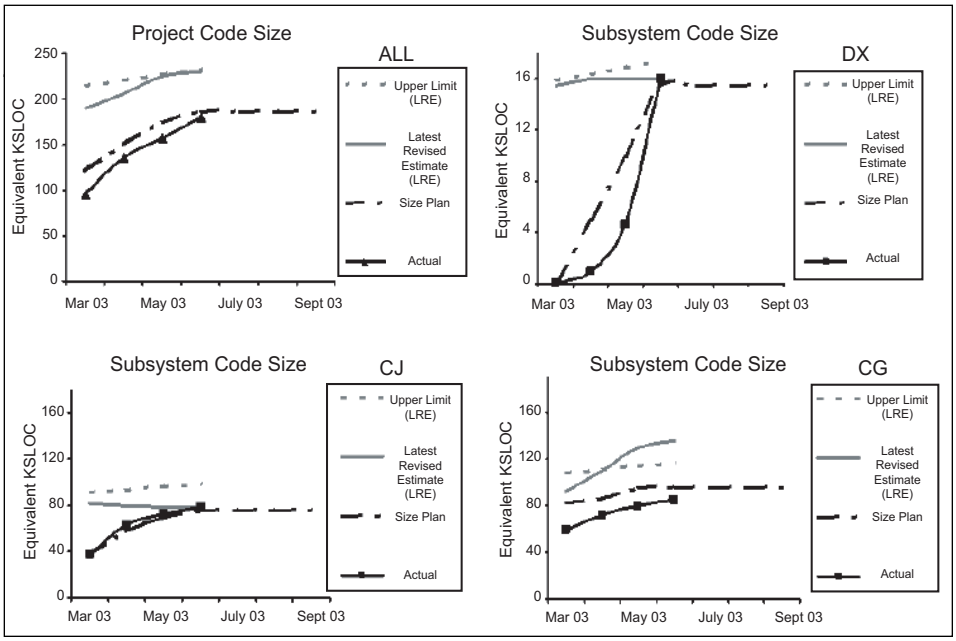


Figure 6: *Example Code Size Charts*



charts. Charts must be so simple that an ape can understand them. This is an exaggeration of course, and has nothing to do with the intelligence of stakeholders. The issue is that busy stakeholders only have a few seconds to assess a chart. The answer needs to jump out at them. Charts should be stripped of anything that is not directly related to the decision at hand.

Lesson Learned

In terms of chart design and its importance in decision making, I have learned a great deal from the books by Edward Tufte [1, 2]. He provides profound suggestions and some interesting examples of lessons learned related to the importance of trimming charts down to only meaningful data.

Act

As with the Decide step, this step is taken by project stakeholders, so the challenge for the measurement analyst is to provide actionable measures that support expeditious corrective action. An analysis that leads to a decision to act is often useless unless a suitable corrective action is identified immediately or shortly thereafter.

Practical Suggestion

I publish integration defect spreadsheets every week to assist stakeholders in assessing the status of defect resolution. A well-known part of these spreadsheets is what the leads call, in jest, the flogging list. It is a listing of defects with a subsystem filter, which will display the details for all defects belonging to a selected subsystem. At weekly meetings, subsystem leads generally report status using the flogging list so that the project manager has the data needed to allocate resources and take immediate corrective action. The flogging list is a good example of an actionable measure.

Corollaries

The framework for action established by the OODA Loop lends itself to the development of corollaries – valuable principles related to the OODA Loop that I have used successfully. Three corollaries are defined below: tempo, harmony, and ground truth. Figure 5 depicts the OODA Loop and the context of these corollaries.

Tempo

Tempo is the goal that OODA Loop timing must match or exceed the timing of the target process. The OODA Loop technique will fail totally unless tempo is adequate. This includes both the measurement cycle time (how often the loop is executed) and the loop cycle time (how quickly each loop cycle is completed).

Practical Suggestion

The measurement and analysis OODA Loop must operate within the natural timing of the process being measured:

- Be aware that loop cycle times may be surprisingly short – even with long measurement cycles.
- Develop tools (e.g., macros, scripts, queries) to gain efficiency and reduce the time it takes to respond to ad-hoc management requests.
- Take advanced courses on spreadsheets, databases, etc. to gain proficiency in tool development.

Lesson Learned

I learned the value of tempo the hard way. By the time I completed a full analysis of our inspection process for our first increment, we were halfway through coding on the next increment – too late to help with that increment.

Harmony

Harmony is the goal of maintaining a good relationship between the measurement analyst and the project personnel that provide measurement data. Without harmony, data collection will be difficult, and corrective actions may not be constructive.

Practical Suggestions

To develop a good working relationship with data providers, consider the following:

- Try to use data that is easy for the data providers to obtain.
- Personally visit data providers whenever possible to develop a good working relationship.
- Discuss potential corrective action with data providers to emphasize the real goal of measurement.
- Never brief negative information without first informing the involved stakeholders and including their perspective in the briefing.

Ground Truth

Ground Truth is the goal of establishing project measurement archives and artifacts that are regarded by project personnel as highly reliable, comprehensive, and detailed. To attain this goal, the archives and artifacts must also be readily accessible and user friendly.

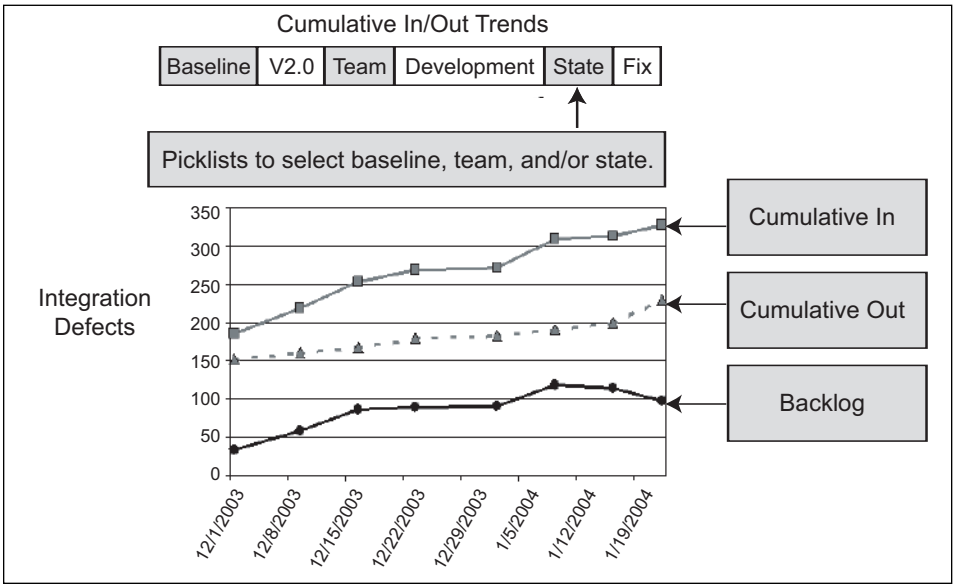
Practical Suggestion

Data should reach deep into the organization, providing a fingertip feel of the situation. See Figure 7 for an example of an approach to meet this need. Resolving integration defects on a large project requires the coordinated effort of several teams of professionals.

Defects flow through different states (e.g., review, fix, or verify) as they are processed (worked off) by different teams. If defects fail to flow as expected deep within the project, bottlenecks can occur that can slow the entire effort. With this drill-down type chart, the user can specify a bin (group of defects related to specific baselines, states, and/or teams) to be displayed and view the defect flow through the bin. The defect flow is indicated by three plots on the chart:

- **Cumulative In.** Cumulative number of defects that have entered the bin, which rises over time as new defects flow into the bin.
- **Cumulative Out.** Cumulative number of defects worked off, which rises over time as defects in the bin are

Figure 7: *Example Defect Chart*



worked off.
- **Backlog.** Current number of defects being worked within the bin, which will remain constant over time if defects are worked off as fast as they flow into the bin.

The plots answer status questions for the bin such as, "Is the team keeping up with the flow of defects?" or "Why is the backlog rising?"

Conclusion

Using the measurement and analysis OODA Loop to engage a project creates a focused, fast-paced measurement process, drives corrective action, and brings measurement and analysis to its full potential. The OODA Loop also imparts a high-energy, spirited tone to measurement by keeping the focus on the project dynamics of decision making. The result is a successful and rewarding process experience.◆

References

1. Tufte, Edward R. Visual Explanations: Images and Quantities, Evidence and Narrative. Graphics Press, 1997.
2. Tufte, Edward R. The Visual Display of Quantitative Information. Graphics Press, 1983.

About the Author

Joe H. Lindley is employed by Raytheon, Intelligence and Information Systems, in Garland, Texas. He has more than 30 years of experience in software engineering, project management, process improvement, customer relations, marketing, regulatory affairs, and software measurement. His successes include development of a best practice measurement program, successful project completions, complex Food and Drug Administration medical device approvals, and a patent for Global Positioning System technology. He has a master's degree in electrical engineering.

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Coming Events

October 16-20
Object-Oriented Programming, Systems, Languages, and Applications Conference
San Diego, CA
www.oopsla.org/2005/ShowPage.do?id=Home

October 17-20
MILCOM 2005
Military Communication Conference
Atlantic City, NJ
www.milcom.org/2005

October 17-21
Quality Assurance Institute's 26th Annual Software Testing Conference
Orlando, FL
www.qaiusa.com

October 24-27
8th Annual
Systems Engineering Conference
San Diego, CA
http://register.ndia.org/interview/register.ndia?

November 6-9
6th Annual Amplifying Your Effectiveness Conference
Phoenix, AZ
www.ayeconference.com

November 13-17
International Association for Computing Machinery SIGAda 2005 Conference
Atlanta, GA
www.sigada.org/conf/sigada2005

November 14-18
STARWEST 2005
Anaheim, CA
www.sqe.com/starwest

May 1-4, 2006
2006 Systems and Software Technology Conference
Salt Lake City, UT
www.stc-online.org