Software Best Practice Development–An Experience

By George Jackelen
EWA Inc.

A Level 3 process capability requirement includes having documented software processes (best practices)[1]. This paper addresses an experience of initiating a process development effort.

Over the last several months, our prime contractor has been working on an initiative to develop documented best practices on how we do software Independent Verification and Validation (IV&V). The scope was narrowed to our current work, e.g., document development, review of customer supplied documents, test witnessing.

This paper provides some information about the work and decision making we do to get started and to develop a first set of project-level best practices. For instance, do we use a top-down approach (i.e., start with policies and work down to instructions) or did we use a bottom-up approach (i.e., start with instructions and work up to policies)?

The following describes some of the issues raised (not in chronological or priority order) and the eventual decisions, which could change. As with all decision-making efforts, the results do not apply to every environment. In some situations people may challenge a decision, but consensus and management direction are often more important than the actual decision.

This paper does not mean the process work we started has ended. It has just begun.

Getting Started

The IV&V Project Manager (PM) created a Process Development Group (PDG) consisting of eight people: a PM-appointed lead, a member from each organization, a person with experience in procedure development and implementation, and a person from the ISO 9000 development group. The PM attended almost every meeting to facilitate the process. Once the PDG created a Process Instruction (PI, described later), the PI would be distributed among the organizational leads and then to all the project members for comment and acceptance. The following are some interesting PDG characteristics:

- During the first three months, only two members participated in more than 90 percent of the e-mail discussions on how the Process Development Group should operate, the format and style of the PIs, and comments on the first PI. Attempts by the two members to insert controversial statements did not invoke discussions.
- During the weekly meetings, four people provided more than 90 percent of the discussion. When open-ended questions were asked to solicit opinions, the other four rarely responded. However, when the PDG Lead met with individuals one-on-one and asked them questions, they would respond, sometimes disagreeing with a meeting's decision.

Many organizations use the following hierarchy to describe their best practices: policies, procedures, work instructions, and checklists to insure the procedures and work instructions are implemented. Instead of developing one or more policies for our group, we agreed to use the Annual Business Plan (ABP),

(an agreement between IV&V and our customer). This also gave us flexibility since the ABP is revised annually to provide direction for IV&V during the upcoming 12 months.

Another get-started issue was determining the level of detail needed to provide direction to the project IV&V software engineers. For instance, should we develop procedures and work instructions? Part of the discussion resulted in the need to define the difference between procedures and work instructions. Some believe procedures are developed to provide process instructions stating what needs to be done to satisfy group interfaces; work instructions provide directions to individuals on how to implement their part of the procedures. Others believe there is no difference. Due to the engineers' talent, the decision was made to only develop PIs—a compromise between procedures and work instructions—and to provide just enough instructions for the engineers to know what to do, allowing them to provide the details. This provides flexibility and reduces the need for too many procedures and related documents.

Glossary and Terminology

Some people wanted each PI to contain the definitions it used. The consensus was to have a Process Dictionary for all terms and abbreviations. PIs would be allowed to modify a term in this list to satisfy their particular needs. PIs could also include terms not provided in a Process Dictionary. Definitions of terms normally found in a dictionary would not be part of a glossary. Draft PIs would include terms, definitions, and abbreviations not found in the Process Dictionary; before a PI was finalized, there would be a decision to add new terms to the Process Dictionary or leave them in the PI.

Terminology was a related issue. For instance, some people did not know the difference between a report (a document on results of an analysis or assessment) and a plan (a document describing methodologies, schedules, resources, etc., to be implemented). Another example was the belief that a walkthrough was the same as a review. Also, people did not realize they had different definitions of "peer group." These issues reinforced the need for a common documented set of terms and definitions.

Configuration Control

Discussion included the need to control the PIs, e.g., distribution of the latest version. The agreement was to have each PI maintained (responsible for creation, modification, and termination) by a maintainer/process owner. The process owner (the preferred name) would ensure each PI version was coordinated with the PM and all organizations involved with the PI. A new version would be published when there was a major change to a PI or the PI's process owner changed (e.g., a change in personnel). This would ensure that the new process owner was aware

of the PI and provided a chance for the new process owner to coordinate any changes he wanted to implement).

PI Format

The following summarizes discussion about the PI format:
- Title of the process owner and date of implementation for this PI version would be at the top of page one.
- The header would contain the PI's title.
- Footer:
  - A PI identification number would include a version identifier. We agreed to use the document identification number to control the draft PI version. The PI identification number format would be "X.Y," where X is the approved version number and Y is the sequential draft number.
  - Page number to consist of "Page X of Y," where X = current page number and Y = total page count.
- PI date. The discussion was what this date represents. The decision was that this would be the date of first implementation of this PI, immaterial of how many revisions occur. For draft PIs this would represent the date of the draft.
- *Purpose* would be the first PI section, describing (normally in one to three sentences) the purpose of the PI.
- A *scope* section defines the limitations/boundaries of the PI.
- A *glossary* section would only define terms not provided in the central glossary, or a term to be modified for this PI.
- *References* would be next and provide references for higher-level PIs, lower-level PIs and PIs at the same level as this PI that a person may need to know about to understand it. As needed, references include textbooks, forms, etc.
- *Dependencies* follow and identify any activities, products, or services outside the control of this process, and not covered in the reference section, to which the success of this process is linked. For instance, if a PI required a template, the template's path name would be provided. If another PI needed to be implemented, that PI would be identified here.
- The *participants* section created discussion about what the paragraph title should be (e.g., roles, participants) and the need for this section if the responsible roles are identified in the procedure steps. The PM's preferred term, participants, was used. This section identifies personnel by title; organizations or groups participating in the given process; a brief description, if not already in the Process Dictionary; and a list of duties/roles for the PI. The purpose of this section is to provide an overview of roles and responsibilities.
- PI diagrams *(process mappings)* were a management requirement. A kind of diagram-style chart was agreed upon. The basic format would be input, process, and output (going top to bottom of a page). Each box, decision diamond, etc., would include a number(s) pointing to the related procedure step(s), identifying the participant for the action, and the action to be performed. If a diagram was to take several pages, it could be moved to an appendix. One person mentioned that diagrams are needed since, "A picture is worth a thousand words." A counter statement was, "But which thousand words?" A diagram must have the same meaning for everyone and clearly represent the intent of the text. PI diagrams are now required for all drafts.
- *Procedure steps* would be a numbered list of action steps, with one or more participants. The major discussion was to organize the steps along a time line or by each participant. We decided to use a time line, especially since the participant paragraph summarizes the participants' roles. A short discussion on the need to number procedure steps ended when the following illustration was given: Without numbering, how does a step refer to a previous or later step? During development of the first PI, a situation arose where a step was a lead-in sentence to a list (e.g., the statement "Identify topics") followed by some substeps. The agreement was that in this type of situation the substeps would be separately numbered procedure steps, but indented. It turned out that this became a popular PI style.
- Using checklists brought up various discussions, e.g., use table formats (which may have a psychological image of limiting checklist comments). Most people preferred not having a PI checklist. The issue was discussed as to how to show each process has been followed; for example, is a PI necessary to show that a PI has been properly implemented. The final decision was to use a checklist only when needed ("when needed" was not defined). As of this writing, this section was known as results and only one PI had an entry (a form to report peer review comments).
- As part of our process, required forms had to be attached to the back of the PI. An exception to this was the use of a reference if a form was part of another PI. If a form was a template, the template would not be part of an appendix, but identified in the reference section with its path name.
- Because some PIs overlap organizational lines, we discussed the need for management-level PIs. These would address processes not covered by lower-level organizations or that crossed organizations. In our situation, we saw no need for management-level PIs since the only formal prime-contractor company relationship we had was financial, contractual, and status reporting. If needed, the process owner could be the PM. This decision reduced the number of needed PIs.

Prioritizing the Processes

Since agreement had been reached on PI format and style, the next issue was the order in which PIs needed to be developed. Each organization developed a list of possible PIs and the organization's recommended priority. From this the PDG agreed on an IV&V priority list. A schedule was developed, along with a list of PI authors from the PDG. It was also agreed that the schedule would be a guideline rather than a mandatory requirement.

Process Instructions (PIs)

After the administrative details were worked out, the PDG started writing the PIs. The first PI was peer review. Part of the main discussion was:
- Will this be a peer review of documents we developed or a peer review of the comments on the documents that our customer wanted us to review?
- The answer to the above question would also address whether "the peers would be people with the same knowledge as the author, or a real management review."

For this PI, the peer review process would be the review of IV&V-generated documents by people with the same knowledge as the author. Similarities of this PI to a future PI for the review of external documents would be addressed when the review of externally generated documents became the focus.

Process for Creating PIs

After the PI format, schedule, etc., had been agreed upon, the general PI development process was:

1. The PDG tasks someone (e.g., an author) to write a PI.
2. The PI is submitted to the PDG for review.
3. The PDG convenes, discusses changes, and generates comments.
4. The author makes designated modifications and resubmits the PI to the PDG.
5. The author distributes the draft PI to the organizational leads for their comments.
6. After the author addresses the organization leads' comments, the PDG addresses these changes.
7. Upon completing its work, the PDG distributes it to all project members for their comments.
8. The PDG and the author address each project member's comment. If needed, the PI returns to the project members for more comments.
9. Upon PDG approval, the PI goes though a coordination process (i.e., signing by the Process Owner) and goes to the PM for final approval.
10. The approved PI goes to the IV&V librarian for incorporation into the project library.
11. The IVV librarian notifies the project members of the new or revised PI.

Process Improvement

About two weeks after the first PI (peer reviews) was approved and implemented, the author of the second PI (a status report) ran into problems. The Peer Review PI did not account for the customer providing inputs to the draft documents under review. Allowing for the parallel processing of Peer Review and customer comments was seen as causing problems. Receiving customer comments and initiating the Peer Review PI would cause too much of a delay, i.e., we could not meet our deadline. The Peer Review PI also assumed it would initiate the distribution of documents to the customer. The second PI needed the author of the document to initiate distribution of the status report, again due to customer requirements not addressed by the Peer Review PI. Thus, the scope of the Peer Review PI had to be reduced, which resulted in rewriting the Peer Review PI.

This problem with the Peer Review PI also made the Process Development Group rethink the identification of PIs to be developed and how they would be developed. It was decided to develop a scheme to introduce new/modified business activities and how to associate these activities into PIs. As of this writing, this process had not been finalized, but an approach was developed and is awaiting approval.

Conclusion

The Mars Climate Orbiter (MCO) spacecraft, the first interplanetary weather satellite, failed on September 23, 1999 due, in part, to one group using metrics and another group using the English measurement system per the National Aeronautics and Space Administration (NASA). As stated by NASA,

". . . sufficient processes are usually in place on projects to catch these mistakes before they become critical to mission success. Unfortunately for MCO, the root cause was not caught by the processes in place in the MCO project" [2].

Besides the root cause, eight contributing causes were also identified, including [3]:

• The system engineering process did not adequately address transition from development to operations.

• Inadequate communications between operations and project management. This is illustrated by the following:

"Although the navigators [those who controlled MOC's approach to Mars] continued to express concern about the spacecraft trajectory, NASA's [Arthur] Stephenson explained why there had been no concern shown by management. "[Navigators] did not use the existing formal process for such concern," he stated. JPL [Jet Propulsion Laboratory] has a special form to invoke a so-called incident surprise and analysis procedure, and the navigators did not follow the rules about filling out that form to document their concerns" [4].

• The Verification and Validation process did not adequately address ground software.

Even though this paper provides an example of how a group began developing its best practices, the above illustrates the importance of ensuring that interfaces between groups are addressed and implemented. The work to document best practices has little value if the follow through is totally or partially ignored.

Remember: Best practices do not necessarily result in good products or services.◆

References

1. Humphrey, Watts S., *A Discipline for Software Engineering,* Addison-Wesley Publishing Co., Reading, Mass., 1995.
2. *NASA News Release:* 99-134, Mars Climate Orbiter Failure Board Releases Report, Numerous NASA Actions Underway in Response, Nov. 10, 1999.
3. NASA, *Mars Climate Orbiter Mishap Investigation Board Phase I Report,* Nov. 10, 1999.
4. Oberg, James, Why the Mars Probe Went Off Course, *IEEE Spectrum,* December 1999.

About the Author

George Jackelen works for EWA Inc., and has many years of experience in the Air Force and industry, having worked all aspects of systems and software life cycles. He has a bachelor's degree in mathematics from St. Cloud University and a master's degree in computer science from Texas A&M University.

1000 Technology Drive
Fairmont, W.Va. 26554
Voice: 304-367-8252
Fax: 304-367-0775
E-mail: gjackele@ewa.com