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Configuration Management (CM) Plans: The Beginning to Your CM Solution

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Review and Approval

This report has been reviewed and is approved for publication.

FOR THE COMMANDER

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1 INTRODUCTION

1.1 Purpose

The purpose of this document is to give an understanding of the importance of the role of the configuration management (CM) plan, to give the results of a simple survey that shows how CM plans are used, and to provide an evaluation of three "standard" CM plans.

This section addresses the role of a CM plan in a CM solution by looking at the ten elements of a CM solution, of which one of the keys is the CM plan.

Section 2 of the document focuses on how CM plans are being used in industry today. The material presented in this section is based on a small survey carried out viainterviews conducted by the authors with software developers and configuration management personnel. The purpose of interviewing both developers and CM personnel was to gain a better understanding of how the CM plan was used by both. The goal, here, is to provide the reader with a better understanding of what is key to a CM plan, and of how the plan is actually being used in industry today. This section of the document summarizes the findings of the survey; the actual findings themselves are located in Appendix A.

The final section focuses on the creation of CM plans. This section includes outlining a model CM plan, tips for writing a CM plan, an evaluation and comparison of several existing, well-known, standards used in developing the plan, and a brief discussion on the use of automated tools for the generation of the plan. Supporting material for this section of the document is provided in Appendices B and C. Appendix B contains the model CM plan outline, and Appendix C contains the individual criterion evaluations of the standards.

1.2 Elements of the CM Solution

There are ten elements which are the keys to solving the CM needs in an organization. Seven of these elements relate to the problem preparation and solving work and the other three are the results of those seven element. All 10 elements are shown in Figure 1-1.

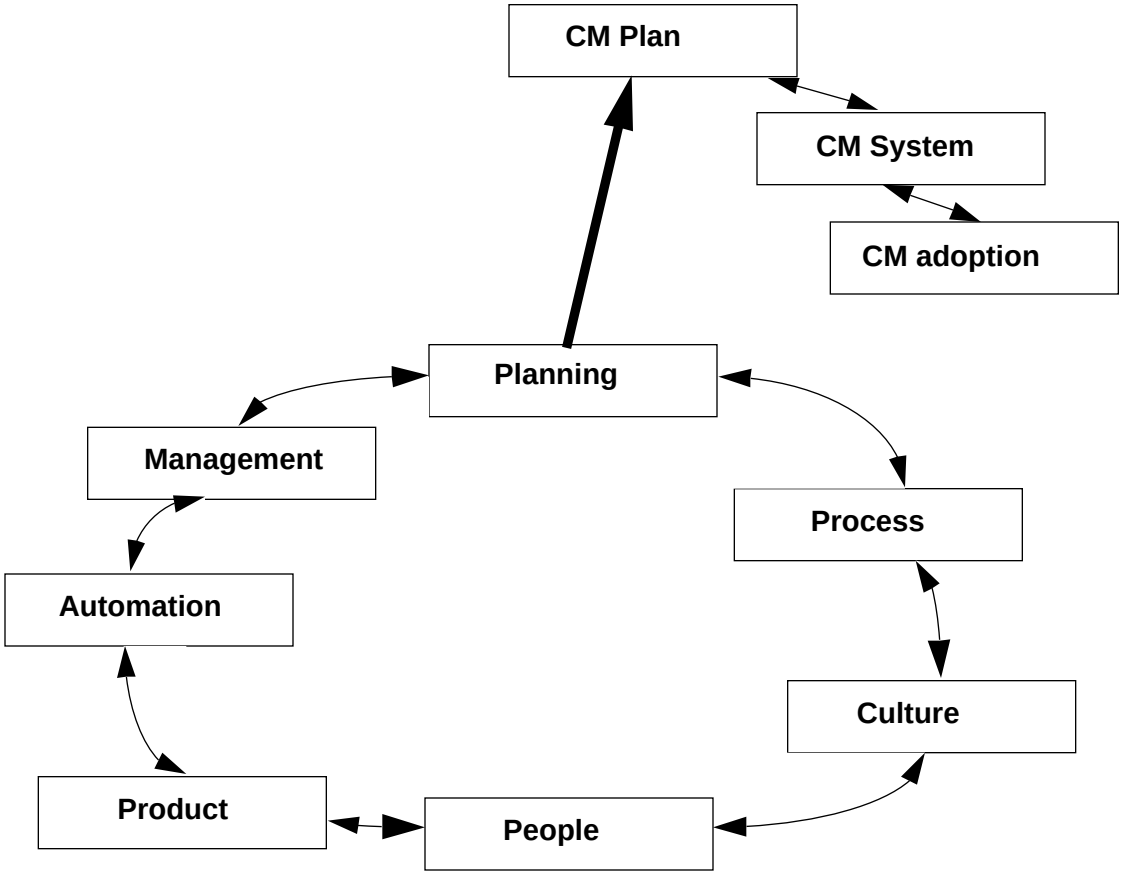

Figure 1-1. Elements of the CM Solution

The seven problem solving ones are:

1. Planning: this is deciding and resolving all issues the must be documented in the CM plan.
2. Process: this concerns describing the CM process and what level of control will be enforced when the CM process is implemented.
3. People: this is related to all the various roles, responsibilities and tasks that various people play during the implementation of the CM process.
4. Culture: this concerns understanding the kind of culture that exists within the organization and finding a CM solution that matches that culture.
5. Product: this involves determining what products and parts of products will be placed under CM control and what pieces actually make up the product.
6. Automation: this is deciding upon the requiirements for the functionality of an automated CM system.
7. Management: this is resolving managerial decisions involving buy or build a CM and when to start using the automated CM system.

The next three elements are the result of the above ones and represent the keys to a successful CM solution. They are:

1. The CM plan: this is the actual plan that will be implemented to address the CM needs.
2. The CM system: this is the tool(s) chosen to assist in automating parts of the CM process.
3. The CM adoption strategy: this is the strategy used to assist the organization in adopting the CM process and the CM system and instituionalizing such.

The CM plan is one of the three keys to the success of attaining a CM solution. It is generally the case that a CM solution is part of a corporate-wide process improvement plan and as such, the solution is co-ordinated with that effort. This means that the CM plan needs to be in agreement with any other plans related to the corporate improvement effort.

2 Analysis and Results of a Sample Survey

2.1 Survey Statistics

We conducted a very informal survey of practitioners to glean an understanding as to the perceived value to an organization is having a CM plan. This survey included ten people, who were carefully chosen to represent both CM and non-CM personnel, different sized projects, and commercial and DoD organizations. Details about the questions and responses are provided in Appendix A. Here we give a summary of the survey results.

Survey participants were asked ten general questions about CM plans. The questions asked focused on issues such as how the plan should be organized, how the plan is used throughout the life cycle, and whether there are any significant differences between CM plans for various environments (e.g., development versus maintenance). The questions focused on the utility of CM plans today, and how to make better use of them in the future.

2.2 Summary of Survey Answers

The 10 questions raised and the nswers given are paraphrased below. Following that we give some detailed comment about the answers.

4. Do standards aid in the development of a CM plan? Yes.
5. Should CM procedures (details of how to do tasks) be part of the plan? No.
6. Should the CM plan be continually updated? Yes.
7. Was the CM plan used? Yes.
8. Is there a need for a CM plan at different levels of the organization? Yes.
9. Does the CM plan differ for phases of the lifecycle? No.
10. Does the CM plan differ for hardware versus software? No.
11. Does the CM plan differ for a large versus small project? No.
12. Is there value in writing a CM plan? Yes.
13. Is a CM plan difficult to write? No.

When asked if standards aided in the development of a CM plan, all respondents stated that they did. The primary reason for this belief was that the standards could be used as a guideline for the plan, providing the plan author with a starting point and some idea as to what must be addressed in the plan.

We next asked the respondents whether CM procedures should be part of the CM plan or be separate. This question was asked since this issue seems to be a moot point to CM planners. The overwhelming response was that the procedures should be kept separate from the plan, but that the plan should reference the procedures. While many reasons were cited for this po-

sition, the most common reasons were that separating the procedures allows the users to focus only on what applies to them, and makes maintenance of the procedures and plan much easier. Respondents also stated that procedures should focus on how to do something, whereas a plan should focus on what is to be done.

In discussing whether the CM plan should be updated throughout the project life cycle, most respondents stated that they felt it should. However, the respondents stated that updates should occur only when there are major structural or process changes. In general, the respondents stated that the plan did not require many updates because most of the changes occurred in the procedures, which were maintained separately.

Regarding the actual use of the CM plan, once developed, most respondents stated that the plan was primarily used during the initial software development stages to establish the process by which CM would be done. Once the process was established, the plan primarily sat on the shelf, and it was the procedures which were then used most heavily throughout the remainder of the project. Also regarding the use of the plan, the respondents stated that it was primarily used by the CM and QA organizations, while the procedures were used by all organizations.

The next question concerned the need for a CM plan at the company or division level. Most respondents felt that there was a need for a plan at this higher level, in addition to the project level. However, they felt the plan at this higher level should be very generic, or perhaps just a standard upon which projects could build. This generic plan, or standard, should also include processes and methodologies endorsed by the company.

The next three questions dealt with needed differences in CM plans for development versus maintenance projects, hardware versus software, and large versus small projects. In all cases, the respondents felt that there were no significant differences. They stated that the plan is based on the CM methodology, which is the same regardless of what it is applied to. The major differences, they felt, would be in the procedures. However, the respondents did state that in the case of a large project, versus a small project, the plan may have to be a bit larger, because the project will typically be more complex and require more coordination. Yet, even in this case, the plan for both can be built using the same standard or guideline.

The final two questions dealt with the value in writing a CM plan, and the difficulty in writing the plan. Regarding the value of the plan, this is where we received the most variation in the answers. While all respondents felt is was valuable to write the plan, the degree of perceived value was different. Some respondents felt the CM plan was very valuable throughout the entire life cycle; others felt its primary value was at the beginning of the project, and once produced, had served its purpose. Regarding the difficulty in writing the plan, most respondents believed that the CM plan itself was not hard to write. They felt that the difficult part was in determining how to perform CM, and in determining what processes should be implemented. A few respondents did find the plan difficult to write, however, because it is hard to get input and cooperation from the software engineers and developers, and the timeline to write the plan is usually very short.

2.3 The Use of Automated Tools in Developing a CM Plan.

We asked the survey respondents a final question as to whether having an automated tool to assist in developing a CM plan would help. The general response was Yes: all ten respondents answered that automated tools would definitely aid in the process of developing a CM plan; however, two of the respondents added caveats to their answers. The first caveat mentioned was that automated tools may not have value to all companies. The value to a company is dependent on that company's maturity level. If a company has been around a long time and has well established processes, an automated tool may not be of much, or any, value. This is because the company will already have well-defined standards/plans and tools in place within the company, thus will not need the tool. The second caveat mentioned was that in some situations the cost of the automated tool may exceed the benefit derived from using it. This may be especially true in organizations where the tool is not re-used from project to project. An automated tool purchased for use on one project only will probably be too cost prohibitive to justify its use.

When asked what type of tool they would want, all respondents stated that a CM plan template would be desirable. Many software companies are now beginning to produce templates, not only for CM plans, but for all of the standard documents created on a project. Most of these automated templates are geared to specific standards such as DoD or NASA standards. The current template programs essentially provide a plan outline containing all of the section headings. In addition, several of the programs provide one or two sentences describing what should go into each section, much like the model outline of the CM plan provided in Appendix B. All the templates we have seen are easily tailorable, allowing a user to add, delete, or move sections around as they would in any word processing program. In fact, most of these templates have been implemented in word processing programs.

3 Creating a CM Plan

The chapter consists of four sections. The first section discusses an outline of a typical CM plan. The second section provides tips on writing a CM plan and the third section provides a summary of three standards that were evaluated and a recommendation on which standard to use. The fourth section makes a recommendation concerning the use of automated tools in the development of a CM plan.

3.1 An outline of a typical CM Plan

A model CM plan would contain the level of information shown in Appendix B. This level of information is denoted in outline form only. To provide any further detail about each section would, in essence, be creating a new standard for the development of CM plans, or rewriting books that are already available. That is not the purpose of this document. This outline is provided to the reader as an example to be used in developing a CM plan. This outline will be used as the basis for the standards comparison, discussed briefly in Section 3.3, and in detail in Appendix C. The outline is representative of the level of a plan the authors would develop for a medium to large sized project.

The typical CM plan, as detailed in Appendix B, should contain an introduction, followed by sections about CM organization and responsibilities, the CM activities such as identification, control, status accounting, and auditing. Then CM milestones, training issues and subcontractor/vendor support should be addressed.

3.2 Tips in Writing a CM Plan

The first question that must be answered is “where do I start?” We recommend that you begin by reviewing available standards, sample CM plans, and books. Appendix C of this document contains an evaluation of three of the most used standards, and a summary of this evaluation is provided in Section 3.3. Our recommendation would be to use the IEEE standard, unless another standard is dictated to you by contract. Even then, we would suggest reviewing the IEEE standard for support information.

In addition to reviewing standards for the development of the CM plan, we highly recommend reviewing standards for the development of the CM process. These standards describe the various CM components, and in doing so give the reader clues as to what has to be addressed in the plan. There are many good standards available today that explain the CM components in great detail. Some of these standards even contain sample plans. Again, we would recommend the IEEE standards. Beyond standards, we suggest that you try to find sample plans for projects similar to yours. Unless you are in a small company, you can probably get copies of plans written for other projects in your company. Finally, we recommend reviewing books. There are several good books that detail the CM components and address the plan although not many focus on how to actually write the plan.

General CM standards and books that we would recommend are given in Appendix D.

Once you have done this review, you will be more equipped to develop your process and write your plan. This review can be performed in a couple of days of intense reading and data analysis. We suggest you keep good notes during the review so that you can easily go back to key sections, and relocate the best suggestions.

Once this review is competed, we recommend that you create a template for your plan. Do not attempt to write the plan at this point, but determine how you will lay it out, setting up all the section headers, and deciding what key information will be needed in each section. At this point use the plan as a guide to determine how you will actually perform CM on the project. This is the time when you need to determine items such as how you will actually perform change control, what configuration identification scheme you will use, who will need status accounting reports, and what will need to be in each report produced. This is truly the hardest part of the job - determining how to perform CM on the project. During this step, it is important to work with the other groups on the project who will have to use this process, because their buy-in to the process is critical. Once this is done, you must then write your draft procedures. To do this, take your defined process and determine what steps will have to be taken to invoke this process.

Once the process and procedures have been defined, they need to be compared to your CM plan template. Have you addressed everything in the template? If not, go back and work on the process and procedures until you have addressed all components of the plan.

Once the process is well-defined, you then document it in the plan, beginning with your template. The actual documentation of the process is not a lengthy task, if the process is well-defined. A good plan can be written in a week or less. On the other hand, good procedures will take much longer to write. Generally, it will take several iterations to produce a good procedure. The only way to produce a good procedure is to document the steps you believe must be executed and then actually attempt to execute these steps from the documentation alone. Once you have the procedures finely tuned, you will then discover a better way to perform the task and will start this documenting process over again. This cyclic action is to be expected with procedures, but not with the plan. Because your process and procedures will be well-defined, you should be able to write a good plan in one iteration, making only minor changes to it based on reviews by others on the project. The plan should be relatively stable, and you should have already gotten buy-in from the other groups that will have to follow the CM process.

The goal in writing the plan should be to document the process well enough that: (1) you won't have to change the plan often, if at all; (2) other groups on the project will understand it and will be willing to support and follow it, and (3) management will support and fund CM.

The plan itself is not hard to write, the difficult part is defining the process and writing the procedures. Defining the process can take weeks or even longer, and the procedures may change frequently over a period of months, but the plan is usually written in a matter of days.

However, it is the requirement to develop the plan early in the life cycle that forces you to develop the much needed process and procedures as well.

3.3 Summary of the Standards Evaluated.

The authors evaluated three standards. Each of these standards have been established for use within a large segment of the industry, not for one specific company. The standards compared were:

- IEEE Standard for Software Configuration Management Plans (IEEE Std 828-1990)
- NASA Software Configuration Management Plan Data Item Description (NASA-Sfw-DID-04)
- DoD Software Development Plan Data Item Description (DID) associated with DoD-STD-2167A (DI-MCCS-80030A)[1]

These three standards were compared using six criteria. They were: ease of use, completeness, tailorability, consistency, correctness and lifecycle connection. These are explained in detail in Appendix C. The rating of the three standards is shown in the matrix in Figure 3-1. The rating system used was 0-3. A standard received a score of 0 if it did not meet the minimum attributes for a criterion, a score of 1 if it met the minimum attributes, a score of 2 if it met the attributes associated with a good standard, and a score of 3 if it met the attributes associated with an excellent standard.

1. The DID associated with DoD-STD-2167A is actually for a software development plan (SDP) as stated above. However, as part of the SDP there is a section on the configuration management plan (CMP). This DID states that the CMP can be included in the SDP, or published as its own document and referenced in the SDP.

CRITERIA	IEEE	NASA	DoD
Ease of Use	3	1	1
Completeness	2	1	0
Tailorability	3	1	1
Consistency	3	3	3
Correctness	3	1	1
Life Cycle Connection	1	1	1

RATING KEY

0 = Does not satisfy minimum requirements
1 = Satisfies requirements for average standard
2 = Satisfies requirements for good standard
3 = Satisfies requirements for excellent standard

Figure 3-1: Comparison Ranking Matrix

As can be seen from Figure 3-1 the IEEE standard had the best rating. The following subsections summarize each of the standards, providing a brief discussion of the strengths and weaknesses of each. These summaries are then followed by a subsection that provides the reader with our recommendations for use of the standards.

3.3.1 IEEE Standard for Software Configuration Management Plans

The IEEE standard is an industry-wide standard, which means it could not be written for a particular segment of industry, thus it is very tailorable. This standard intentionally addresses all levels of expertise, the entire life cycle, other organizations, and the relationships to hardware and other activities on a project. Furthermore, it is not restricted to any form, type or class of software. Other strengths of this standard are the special attention it pays to interface control and subcontractor/vendor control, and the extensive lists of items it provides for consideration in each key component area. Regarding interface control, this standard provides a list of possible interfaces and a minimum amount of information that must be defined for each interface. Regarding subcontractor/vendor control, this standard provides a list of information that must be addressed for subcontracted and acquired software. This level of depth in these two areas was impressive.

Other strengths of this standard are its thorough handling of each of the CM plan components, its general completeness, and the section by section cross-reference it provides to its associated general CM concepts standard (IEEE Std 1042-1987). This cross-reference makes it very easy for a user to go to the general standard to get more information on any of the key components, without losing a lot of time in doing so.

Although this standard is generally excellent, there were a few weaknesses associated with it. The first is that it did not provide an index. With an index, a user could have easily located any reference in the standard in very little time. This weakness did not work against the standard in the ratings, however, because it is considered a desirable feature and not a necessary attribute. The second weakness is that the standard did not provide any sample CM plans or portions thereof. The standard would have been more effective if the user could have reviewed a sample CM plan after reading the criteria for the development of a plan. At a minimum, the standard should include a sample flow chart of a simple change control process, as this is one of the most critical areas within CM to understand and document well. Finally, the standard should address the software life cycle in more detail than it currently does. It should address the life cycle at the component level, and should also address how certain CM activities may change throughout the life cycle.

3.3.2 NASA Software Configuration Management Plan Data Item Description

The NASA standard was written for a specific segment of industry. This standard has two basic strengths. First, it is well organized and uniform, making the information in the standard easy to use. Second, the standard addresses several components quite well, and certainly better than the other two standards. These components are documentation, the change control form, and resources. This standard handles documentation independently of the computer software configuration item (CSCI) in both the identification, and storage and release sections of the standard. This is a benefit to the user as it serves as a reminder to the user not to forget to address documentation. This standard also addresses the change control form information at a very in-depth level of detail, rather than just mentioning that a change control form must be used. Finally, it addresses resources such as machine and data storage resources as well as human resources. This, again, is an added benefit to the user for the same reason as cited above.

Although the standard had some strengths, it suffered from some serious weaknesses. The key weakness is that the standard instructs the user to create a separate CM plan for each CSCI, with each plan containing all of the same component areas. We do not understand why NASA would want individual CM plans for each CSCI. It seems that this would lead to a massive amount of redundancy and would add an unnecessary level of complexity to the CM process. Another key weakness is that the standard only contains a minimum level of completeness, making its possibility of usefulness as a stand-alone document quite small. The standard is incomplete in terms of missing information (refer to Appendix C for details), and the level of depth on included information. On components discussed in the standard, the level of depth is very superficial, especially in the configuration identification component, thus making the standard difficult to use for anyone who does not have a great deal of CM knowledge. Thus, it is our opinion that this standard cannot be used as a stand-alone document by anyone other than an expert in the CM field. Finally, the standard is somewhat weak in terms of tailorability. This weakness exists primarily because of its incompleteness, and the fact that it was written to a specific segment of industry. Because the standard is incomplete, tailoring it

would, in all likelihood, require significant expansion, and expansion is not a positive attribute of tailorability.

3.3.3 DoD Software Development Plan Data Item Description

This standard is the successor of 1679A. It was developed for the DoD environment, however, was written specifically to be tailored, to handle rapidly evolving software technology, and to accommodate a wide variety of state-of-the-practice software engineering techniques. This standard is responsive to the user rather than overbearing. Beyond being written for tailorability, this standard has two other strengths. The first is that it allows the user to incorporate the CM plan into the software development plan (SDP) or to treat it as a separate document. The benefit of handling the CM plan in this manner is that for those projects where CM is either tightly tied to project management and the life cycle, or where the CM function is relatively small, it allows the plan to be placed in the SDP where it is more appropriate. The second strength is that it provides a good example of a configuration control flow chart. As stated earlier, configuration control is a key CM function to understand and document. The use of the flow chart provides extra guidance to the user.

As with the NASA standard, this standard suffered from some serious weaknesses. A key weakness is that the standard only contains a minimum level of completeness, thus making its possibility of usefulness as a stand-alone document quite small. As with the NASA standard, this standard is incomplete in terms of missing information and the level of depth on included information. The same comments made on the NASA standard relating to these issues apply to this standard. A second weakness of the standard relates to tailorability. Although the standard was written to be tailorable, and as such this is a strength, because the standard is incomplete, tailoring it would, in all likelihood, require significant expansion. Finally, the standard is harder to use than others because it addresses the entire software development plan, of which the CM plan is only one small part. This standard, which is actually a data item description (DID), contains no table of contents and is 13 pages long. A user wishing to locate a CM component would have to first locate the CM section of the standard, and then the component within that section, without the aid of a cross-reference or table of contents. This decreases the ease of use. To compound matters further, this standard addresses a couple of the CM components in the software development management section of the DID, rather than in the software configuration management section of the DID. Without reading the entire DID, a user would not realize that two critical CM components (the software development library and the corrective action process) were not located with the other CM information.

3.3.4 Recommendations on Standard and Tools

Based on the evaluation of the standards, using the six criteria identified in this paper, the authors prefer use of the IEEE standard for three reasons.

First, the IEEE standard was written explicitly for use by anyone within the industry, whereas the NASA and DoD standards were written for their specific segments of industry. Being written for industry, in general, requires this standard to be more flexible and to address a wider

audience. This standard has also been written so as to not restrict any form, type or class of software.

Second, this standard was, by far, more complete than the other two standards, and is the only standard that can be treated as a stand-alone document. Furthermore, the level of depth addressed in each CM plan component, and the fact that the standard addressed a very large number of components, makes this standard far superior to the others.

Finally, the authors believe that this standard has greater potential for timely updates than the other standards. Because this standard is used by the general industry, it must maintain relevance to the current software engineering principles and practices or face obsolescence.

Some final remarks about the standards. First, if the user is an expert in CM and has written several CM plans before, we feel that the user could use any of these standards with the same relative level of effectiveness. This is because the expert user needs a quick reference guide to be used as a reminder of key components to be placed in the plan. Second, any of these standards would be adequate for a user as long as the user was willing to review the more general standards on CM concepts at the same time. This is because all of the standards on CM concepts provide a good level of detail on the components of a CM plan.

Concerning tools, we recommend that template tools be enhanced to address various levels of users. If a user was an expert in writing CM plans, they could request just the plan outline. Someone with a fair amount of knowledge may request the outline and one or two sentences describing what should go in each section. Finally, a novice user could request the outline and full descriptions of each section. These descriptions should be set up so that the user can bring them up and delete them from the screen with one keystroke command. An even better, more enhanced template would offer the user one or more generic CM plans that could be used and tailored. Finally, we would recommend that a template tool have two additional capabilities. The first is a diagramming capability. This is needed because it is important to show the change control process in schematic form, and without a diagramming tool of some sort this cannot be done. The second capability would be a mechanism for extracting directory structures and placing them in the plan. This would be used, for example, to represent the library structure.

In addition to the template, a tool could be created to actually create a plan for the user based on answers the user provided to questions. Essentially, this would be a type of knowledge-based system that developed plans based on requirements provided to it by the user. If this type of tool was created, it would have to contain flexibility for users to manually change the plan on their own, once generated, or to change the plan requirements and have the system produce a modified plan, with change bars. It is unlikely though that we will see this type of tool in the near future, since the simpler template tools are only now being developed.

4 Summary and Conclusion

This report has highlighted the role of the CM plan in the CM solution. It has also given the results of a survey as to the perceived value of a CM plan. Following that three standards were compared and a recommendation made as to which one seems most useful.

Questions asked in the survey addressed issues such as how standards aid in the development of CM plans, the benefits of separating CM procedures from the plan, and how CM plans are used (both by the CM organization and other organizations on the project). The information derived about the use of CM plans, based on the answers to the questions, is summarized as follows:

- Standards prove invaluable in assisting a person in writing a CM plan. They provide the basic framework within which to write the plan, and act as a guideline for writing the plan.
- CM procedures should be separated from the CM plan. The procedures should describe, step by step, how to do something, whereas the plan should describe what is to be done. Two key reasons the procedures should be separated are maintainability and audience focus.
- CM plans are generally updated and used throughout the entire software development life cycle. However, the heaviest use is at the beginning of the life cycle when the CM process is being defined. The CM plan is primarily used by the CM organization, however, it is also used on a limited basis by other project organizations, such as QA, project management, and contractors.
- A CM plan or standard, and preferably a standard, should exist at the company or division level. This standard should be applied to each project, and the project CM plan generated based upon the processes and methodologies endorsed in this standard.
- No significant differences were noted between a CM plan for a development project versus a maintenance project, a CM plan written for hardware versus software, or a CM plan written for a large project versus a small project. In general, the same CM plan structure can be used for all of these types of projects, with minor adjustments. It was also noted that the majority of differences between the various types of projects will exist at the procedure level.
- The CM plan is needed and provides value to a project. The primary value of the CM plan is that it documents the CM process and as such acts as the tool used to gain project and management support for the process.

The key tips in writing a CM plan were to: (1) refer to and review existing standards and plans; (2) create a template of your plan; (3) use the plan template as a guide in developing your CM process and procedures; and (4) document the process in your plan. We also noted that writing the plan was not difficult, however defining the process and writing the procedures was.

Three well-established standards were evaluated. This evaluation was done since so many people rely heavily on the use of standards in developing their CM plans. The standards were

evaluated using the following six criteria: ease of use, completeness, tailorability, consistency, correctness, and life cycle connection. A rating of 0 to 3 was given to each standard for each criterion. Summary information on the evaluation of each standard, and a recommendation to use the IEEE standard was given. Detailed information on how each standard was rated on the individual criteria was provided in Appendix C. Also, a discussion was given concerning the use of automated tools in developing a CM plan. The overall consensus was that automated tools, especially a plan template, would be of significant value. All participants in the survey stated that they would use a plan template if available.

In conclusion, it is our hope that this document will provide some insight to the reader on how and why CM plans are used, and how currently available standards can aid in the plan development process. Finally, while the CM plan itself is not difficult to write, it is critical to the entire CM process. The plan provides the focus for the process and procedures, and is the mechanism used to communicate the CM process to the other organizational groups on the project.

Appendix A Survey Data

Ten people were interviewed as part of the research for this document. These people were carefully chosen to represent both CM and non-CM personnel, different sized projects, and the commercial and DoD environments.

Of the ten people interviewed, six of them have CM experience and the other 4 have strong software development backgrounds. The average number of years of experience for the CM respondents is 8, while the average number of years of experience for the software developers is 15. The four software developers chosen have had a reasonable amount of CM exposure. They have worked on projects where CM was in place and where, as software developers, they had to interact with CM. We felt it was important to add this aspect to the survey to determine how the CM plan and procedures are used by other groups on a project.

Seven of the respondents come from large software projects, two from medium sized software projects, and one from a small software project. Software project size for this paper was based on number of people working on the project. A large project had in excess of 50 people on it, a medium project had between 16 and 49, and a small project had under 15.

Six of the people work in the DoD/Government environment and the other four work in the commercial environment. We asked these people a list of questions and recorded their responses anonymously. These questions, and the responses to them, are given in the following section.

A.1 Answers to common questions about CM plans

We asked the participants ten general questions about CM plans, focusing on the utility of CM plans today and how to make better use of them in the future. A summarization of the responses to the questions, and the authors opinions, is shown below.

Question 1: Do standards aid in the development of a CM plan?

All participants responded that yes, standards definitely help. Various reasons were cited for the help they provide a person in writing a CM plan. An overwhelming response was that standards can be used as guidelines to provide the document author with ideas as to what to consider putting in the CM plan. One person interviewed responded that his/her organization had no standards available when they wrote their plan, and suffered greatly as a result. It took them much longer to write the plan and it wasn't nearly as complete as it should have been. The additional time spent writing the plan was because they didn't know what should be in it, and they didn't know what they really needed to do to perform CM effectively. This interviewee was writing a CM plan for the first time and stressed heavily how much standards would have helped. Several people interviewed stated that standards are essential for a person who is new to the CM area and writing a plan for the first time. In addition, standards serve as an excellent checklist for the experienced person.

While all participants felt standards played a key role in CM plan development, one person did state that some standards are too bureaucratic and that these standards are better avoided than used.

Question 2: Should CM procedures be part of the CM plan or be separate?

This is perhaps the most debated issue these days. Many authors have addressed this topic in their books and have stated their opinions. Our purpose in asking this question was to determine how industry viewed this issue.

There was overwhelming agreement that the procedures should be separate from the plan. A plan describes what you will do and a procedure describes how it will be done. All agreed that the plan should reference the procedures, and one valuable insight was that the plan should also state what audience each procedure is intended for (e.g., CM personnel, developers, QA), but no one felt that the procedures should be placed directly in the plan.

There were many reasons cited by the respondents for separating the two. Primary among these reasons were the following:

Separating procedures from the plan allows people to read only what applies to them; this becomes increasingly important as the size of the project and plan get larger. It becomes very difficult to get a programmer to look through a one-hundred page plan to find the part that relates to checking code in and out, but a programmer will be quite likely to look at a three page procedure.

Maintainability is much easier with the procedures separated; the procedures change frequently, and if they are in the plan, the plan will have to be updated frequently. However, if the procedures are not part of the plan, the plan can be left at a higher level, and thus become more static.

The plan is more of a philosophy document used as a check to verify that you are doing things right, whereas the procedures provide specific steps (working instructions) on how to do something.

The plan is for a broad audience but individual procedures are written for very specific audiences.

One suggestion made was to put the basic steps of a procedure on a laminated card, and then have laminated cards available to project personnel for each CM procedure that they might use. Applying an idea like this would be even more important if the procedures are placed in the plan. Essentially, the less you force someone to read, the more likely they will be to follow specific instructions.

Question 3: Is the CM plan updated throughout the project life cycle?

Eight of the ten respondents stated that they update their plans throughout the project life cycle. The other two stated that developing the plan was a one-time event. In one of these cases,

the plan was created to document the CM process, and once documented the procedures were created and used to do the actual work. Since the process was at a high level, there was never any real reason to change it. What changed in this case were the procedures. In the other case, the plan was written and never updated; however, if the project had to change the way it performed CM, a deviation form would be created documenting how the project was deviating from the written plan.

Those that did state that they update their plans noted that updates were not done frequently. They also stressed that updates should be kept to a minimum and should only be done when there are major structural or process changes. The general feeling was that it was good to update the plan, if updates were not carried to an extreme. All stated that their plans did not require many updates because they broke their procedures out from their plans.

Two respondents stated that they update their plans primarily because the contract requires this to be done. They did not gain much benefit by the plan updates because the day-to-day work was done according to procedures; however the updates satisfied the contract, and also gave some visible insight to higher levels of management as to how CM functions .

Question 4: Was the CM plan used after it was developed? If so, by whom and how?

Most respondents stated that the CM plan was used primarily in the initial stages to establish the process by which CM would be done, and to document this process for approval. The plan provided the author with a structure to work against to ensure that he/she did not forget to handle any of the key CM functions. After this, it basically took up shelf space, as the procedures became heavily used. No organization used the plan in their day-to-day operations, however all stated that if the procedures were part of the plan this would change. Half of the respondents did state that they did use their plans occasionally to review their approaches and basic philosophies, and to determine what impact a large change in one CM process might have on other CM processes.

Regarding use of the plan, we found that on occasion CM plans are used by organizations other than CM. QA uses the plan to perform audits on CM and also to coordinate with CM on how QA becomes involved in code reviews and other similar functions. The plan is also used by management and software team leaders to determine staffing, and establish agreement on how CM will be performed on the project. Finally, the contracting agency uses the plan in their audits of the project.

Question 5: Is there a need for a CM plan at the Company/division level as well as at the project level?

Most respondents stated that they felt there was a need for either a generic plan or standard at the company level, or if the company was large, at the division level. In addition, most respondents leaned towards having a standard rather than a plan. They felt that since much of the information is project specific, a standard would be better. All respondents stated that if

there was a plan at the company level it would have to be written so that it could be easily tailored for the individual projects.

Those that felt it was important to have a company-wide standard or plan stated that the reasons for this were that the plan/standard would dictate to the projects the company's policy for CM and the way the company wanted CM handled, and would give the projects a foundation upon which to build their individual plans. This foundation would include processes and methodologies endorsed by the company.

One respondent did not feel there would be a great deal of value in having a plan at the company level unless all of the projects in the company worked with the same product line. However, if they shared the same product line, this respondent felt that perhaps even many of the procedures could be created at the company level.

Question 6: Are there significant differences between a CM plan written for a development project and a CM plan written for a maintenance project?

The overwhelming response to this question was "no." The respondents felt that the CM plan for both was basically the same, and that the differences between the two were minor and could easily be handled with one format or template for a CM plan. The respondents noted that the majority of the differences would be in the CM procedures, but that procedures would probably be different even for two development projects. One respondent noted that good CM methodology is the same regardless of what it is applied to, and that the plan should document this methodology. The largest differences noted by another respondent were that development must address prototyping and maintenance must address emergency fixes. While both of these events can occur both in development and maintenance, they commonly occur in one or the other more frequently and thus, must be much better thought through.

Of the ten people interviewed, four have written plans for both development and maintenance projects.

Question 7: Are there significant differences between a CM plan written for hardware versus software?

Again, the majority of the respondents answered "no," stating that it was the procedures that would most likely be different. One respondent noted that hardware control is becoming much more like software control, and the largest difference in this respondent's opinion was in the type of person you hire to actually control the hardware or software, not in the documentation of this control. This respondent also noted that at the finer level of details there is quite a bit of difference, but that these details should be located in procedures, not in the process methodology. Another respondent stated that a plan can be easily tailored to address both hardware and software just by separating the various sections for both.

Of the ten people interviewed, three have written plans for both hardware and software.

Question 8: Are there significant differences between a CM plan written for a large project versus a small project?

Most of the respondents answered this question by stating that there are some differences, but that the same plan template or example can be used for each with minor alterations. The largest differences noted were that as a project gets larger, it generally becomes more complex and requires more coordination. With the increased complexity and need for coordination, the plan must also grow to address these issues.

One respondent pointed out that in a small project there is often no need for a separate CM organization, and that the CM plan is often folded into the project management plan. Also noted by several of the respondents was that small projects don't necessarily need to address all of the components that would need to be addressed in a larger project. For example, a small project may not need much, if anything, in terms of status accounting reports, an identification tracking scheme, or retention policies. Most respondents stated that a small project would likely concentrate on items such as a simple change/version control process, simple configuration identification criteria, and configuration release policies. As with the prior two questions, most respondents felt that the largest differences between a small and large project would be in the level of detail that the procedures would contain, and the overall number of procedures that would need to be developed to perform CM on the project. Any changes to the plan itself could easily occur by removing unnecessary sections of the plan template for a small project.

Of the ten people interviewed, two have written plans for both large and medium sized projects, one has written plans for both small and medium sized projects, and one has written plans for both small and large sized projects.

Question 9: Is there any real value in writing a CM plan? If so, what is this value?

All of the respondents stated that there was value in writing the CM plan, however, the amount of value felt by each was different. A few respondents felt that the plan was very valuable throughout the entire life cycle. Others felt that it was only valuable at the beginning of the project, and once produced, had basically served its purpose.

The most common reasons stated regarding the value of the plan were the following:

The plan documents the CM process and as such acts as the tool used to gain project and management support for the process.

The plan forces you to define and describe the process.

The plan causes you to think about what you will do and how you will do it.

The plan serves as a contract vehicle for the project.

Although all respondents stated that there is a value in writing a CM plan, one respondent did note that if the plan is only theory then it becomes totally worthless.

Question 10: What makes a CM plan hard to write?

Most of the respondents stated that the CM plan itself is not hard to write; the difficult part is determining how to perform CM and what processes you will implement. Once you know what you are going to do, documenting it is easy. However, several respondents did note some reasons for the difficulty in writing the plan.

One reason cited was that it is difficult to get input and cooperation from software engineering and software development while developing the plan; and if you don't have their input and agreement, you can't write an acceptable plan or develop an acceptable process. Another reason cited was that the timeline to write the plan is generally short, and you need to have your process well-defined before you can begin writing the plan. It is often the case that the process is not well-defined before management is wanting you to document it. A third reason cited was that it is difficult to write the plan so that it can be effectively implemented, and also be easily used by all parties. A final comment was that the plan itself was not difficult to write, but enforcing it and getting people trained in the procedures were the most critical barriers to making the plan effective.

It is clear that lack of a defined CM process makes it impossible to write the CM plan. But, given a well-defined process, it is not difficult to write the plan. When writing the plan it is necessary to keep the audience in mind and ensure that the plan is written in such a manner that it will be accepted, enforceable, and easy to use.

Appendix B OUTLINE OF A MODEL CM PLAN

1.0 INTRODUCTION

1.1 Purpose
1.2 Scope
1.3 Definitions
1.4 References
1.5 Tailoring

2.0 SOFTWARE CONFIGURATION MANAGEMENT

2.1 SCM organization
2.2 SCM responsibilities
2.3 Relationship of CM to the software process life cycle
2.3.1 Interfaces to other organizations on the project
2.3.2 Other project organizations CM responsibilities

3.0 SOFTWARE CONFIGURATION MANAGEMENT ACTIVITIES

3.1 Configuration Identification
3.1.1 Specification Identification
- Labeling and numbering scheme for documents and files
- How identification between documents and files relate
- Description of identification tracking scheme
- When a document/file identification number enters controlled status
- How the identification scheme addresses versions and releases
- How the identification scheme addresses hardware, application software system software, COTS products, support software (e.g., test data and files), etc.

3.2.2 Change Control Form Identification
- Numbering scheme for each of the forms used

3.2.3 Project Baselines
- Identify various baselines for the project
- For each baseline created provide the following information:
  -- How and when it is created
  -- Who authorizes and who verifies it
  -- The purpose
  -- What goes into it (software and documentation)

3.2.4 Library

- Identification and control mechanisms used
- Number of libraries and the types
  - Backup and disaster plans and procedures
  - Recovery process for any type of loss
  - Retention policies and procedures
    --What needs to be retained, for who, and for how long
    -- How is the information retained (on-line, off-line, media type and format)

3.2 Configuration Control

3.2.1 Procedures for changing baselines (procedures may vary with each baseline)

3.2.2 Procedures for processing change requests and approvals-change classification scheme

- Change reporting documentation
- Change control flow diagram

3.2.3 Organizations assigned responsibilities for change control

3.2.4 Change Control Boards (CCBs) - describe and provide the following information for each:

- Charter
- Members
- Role
- Procedures
- Approval mechanisms

3.2.5 Interfaces, overall hierarchy, and the responsibility for communication between multiple CCBs, when applicable

3.2.6 Level of control - identify how it will change throughout the life cycle, when applicable

3.2.7 Document revisions - how they will be handled

3.2.8 Automated tools used to perform change control

3.3 Configuration Status Accounting

3.3.1 Storage, handling and release of project media

3.3.2 Types of information needed to be reported and the control over this information that is needed

3.3.3 Reports to be produced (e.g., management reports, QA reports, CCB reports) and who the audience is for each and the information needed to produce each report

3.3.4 Release process, to include the following information:

- What is in the release
- Who the release is being provided to and when
- The media the release is on
- Any known problems in the release
- Any known fixes in the release
- Installation instructions

3.3.5 Document status accounting and change management status accounting that needs to occur

3.4 Configuration Auditing

3.4.1 Number of audits to be done and when they will be done (internal audits as well as configuration audits); for each audit provide the following:

- Which baseline it is tied to, if applicable
- Who performs the audit
- What is audited
- What is the CM role in the audit, and what are the roles of other organizations in the audit
- How formal is the audit

3.4.3 All reviews that CM supports; for each provide the following:

- The materials to be reviewed
- CM responsibility in the review and the responsibilities of other organizations

4.0 CM MILESTONES

- Define all CM project milestones (e.g., baselines, reviews, audits)
- Describe how the CM milestones tie into the software development process
- Identify what the criteria are for reaching each milestone

5.0 TRAINING

- Identify the kinds and amounts of training (e.g., orientation, tools)

6.0 SUBCONTRACTOR/VENDOR SUPPORT

- Describe any subcontractor and/or vendor support and interfacing, if applicable

Appendix C INDIVIDUAL CRITERION EVALUATIONS

Three well established standards were evaluated by the authors using six different criterion. For each criterion used, the criterion was defined, the rationale for rating described, and how the criterion applied to the standards in general, and each standard individually, was provided. The standards compared were: the IEEE Standard for Software Configuration Management Plans (IEEE Std 828-1990), the NASA Software Configuration Management Plan Data Item Description (NASA-Sfw-DID-04), and the DoD Software Development Plan Data Item Description associated with DoD-STD-2167A (DI-MCCS-80030A).

C.1 Ease of Use

C.1.1 Definition of Term

Ease of use, in general, is measured by the time and effort required to learn how to use a standard, and the recurring effort required to further use the standard.

Ease of use is described by many different attributes, but perhaps the most significant attribute of this criterion is the ability of a first time CM user and an expert in the field to be able to easily use the standard to the degree that each needs it. A person who is writing a CM plan for the first time, and is not familiar with CM concepts, needs a great deal of information and help in developing the CM plan. A person who has written many CM plans and just needs some simple guidance only needs a few reminders about key elements in a CM plan. A standard that is easy to use would be adaptable to both these situations. It would allow the expert user to glance through the standard quickly, locating the information needed while still providing a great deal of information for the first time user.

Ease of use also implies that the standard be well organized and written, and that specific information can be quickly located. The specific attributes for this criterion that must be met for each of the ratings are shown in the next subsection.

C.1.2 Rationale for Rating

Ease of use is determined by the attributes listed below. These attributes are placed in four categories. The first category contains those attributes that must be met for a standard to receive a rating of 1. The second category contains additional attributes that must be met for a standard to receive a rating of 2. The third category contains additional attributes that must be met for a standard to receive a rating of 3. Finally, the fourth category contains attributes that would be desirable in a standard but that don't have to be met for a standard to be rated a 3. These are attributes that a standard can do without, but shouldn't. A rating of 0 implies that the standard did not meet the minimum attributes.

The minimum attributes a standard must have to be “easy to use” are:

- A user should gain an increased understanding of how to write a CM plan.
- The standard is structured and formatted (laid out) to make information easily accessible.
- Key words are used prominently and sections and paragraphs are built around these key words.
- A user does not have to read a passage of text multiple times to understand it.

The additional attributes that must be met for a standard to be rated good are:

- The standard is easy to read--it is clear and concise, and is well written grammatically.
- The standard assumes little or no prior user knowledge in the development of CM plans; it is appropriate for more than one audience.
- Definitions of terms used in the standard are grouped together in one logical place.
- The material is well organized so that a user can easily locate a section of information. It takes a user no longer than three minutes to locate specific information.
- All information related to one topic is located in one location--the user does not have to look in more than one location in the standard for information on a topic.
- Themes throughout the standard are clear to the user.
- Sections of the standard are short so that a user looking for a specific piece of information does not have to look through pages of material to find a specific reference in a section.
- The standard satisfies its requirements and fulfills the user’s needs.

The additional attributes that must be met for a standard to be rated excellent are:

- It takes a user no longer than one minute to locate specific information.

Important concepts are explained well and the text is structured to emphasize the important information.There are two desirable, though not rated, attributes of this criterion. They are:

- An indexing scheme for quick access to subject matter is included; this index allows the user to look up any keyword and quickly locate all references to it throughout the standard; this index must include, at a minimum, all headings, acronyms, and defined terms.
- The standard does not require a high level of CM knowledge nor does it assume a low level of knowledge--instead, it provides a quick reference for the expert user and a tutorial for the first time user.

C.1.3 Application to Standards

C.1.3.1 General Comments

The three standards are well structured and formatted. Each uses section headings well to control the flow of logic throughout the standard. They are all easy to read, clear, concise, and well organized. Additionally, they all keep information related to one topic in one location within the standard, thus making it easier to read and use.

The major drawback in this area relates to the need to reference more general standards for descriptions of many of the plan components. It appears, for example, that both the NASA and DoD standards were written with the assumption that the user would be using the more general standards for supplemental information. Thus, these standards are not easily used as stand-alone documents, especially for a novice user. The IEEE standard, however, does function well as a stand-alone document. This is because it provides a greater amount of detail and depth on each of the CM plan components. This point is further demonstrated by the fact that the IEEE standard is 15 pages in length while the NASA standard is nine pages and the DoD standard (that portion dealing with CM) is four pages.

C.1.3.2 IEEE Comments

The IEEE standard was extremely easy to use. Not only did the standard meet the attributes required to be rated excellent, but in a several areas it provided added value. First, the standard made it easy for the user to recognize those items in a CM plan that were required versus optional by using the words “shall” and “required” to indicate required items. Another attribute of the standard is that it is very good at providing examples of types of items when an item is required (e.g., types of items to be controlled for each identified software library, a list of possible interfaces with the minimum information that must be defined for each). Finally, the standard very effectively maps one CM activity to another. For example, the standard maps change controls, identified in the configuration control section of the standard, to the software libraries, identified in the configuration identification section of the standard.

However, while the standard met all of the attributes required to be rated excellent, there were several areas where it could have been better. The first area is in terms of its definitions. While it had a section for definitions, and did provide some definitions, it also listed quite a few terms that needed to be defined but then referenced another IEEE standard for these definitions. All terms really should have been defined in this document rather than being externally referenced. The second area deals with the level at which the standard was written. Although this standard could easily be used by both a novice and an expert, it could have been even more effective if it would have provided a quick reference section for the expert to use. The effect of this would be that the expert would not have to glance through all the information to find the few key words that are used as content reminders for the plan. It also could have added yet more content to some of the sections to provide a better basis for the novice user (e.g., a better description of the identification tracking scheme, a description of how to track and use change control forms). Finally, it should have provided examples of CM plans or parts thereof. This would have made using the standard that much better. There were CM plan examples in the

general standard for software configuration management, however one or more of these should have been in this standard.

C.1.3.3 NASA Comments

The NASA standard was easy to use and fairly complete. This standard would have been rated good instead of average except for two flaws. The first is that it is somewhat difficult to use this standard as a stand-alone document. Thus, it failed the attribute of satisfying its requirements and fulfilling the user's needs. If a user had good knowledge in the CM area, the NASA standard would be a very good reference. However, if the user is a novice, it would be difficult, and probably impossible, to write a complete CM plan based only on the information provided in this standard. This also made it difficult for the standard to meet the attribute of being appropriate for more than one audience. The second flaw is that the standard had no definitions of terms, so once again, it assumed a fair amount of knowledge on the user's behalf.

Positive aspects of this standard are that it was well organized, with all the information related to one topic placed in one location; it was easy to read and relatively short, thus a user would not have to spend much time reviewing it; and it was formatted in a manner that made locating a key component very easy.

C.1.3.4 DoD Comments

The DoD DID was fairly easy to use but not very complete. It only provided a very high level of information on each of the four key CM components (configuration identification, control, status accounting, and auditing). This DID is an excellent reference for the CM expert but is not usable as a stand-alone document by anyone but an expert because it lacks too much pertinent information. Thus it fails the attributes of assuming little or no prior user knowledge in the development of CM plans and being appropriate for more than one audience. Another drawback to this DID is that there is no table of contents or index. Thus, a user that wanted to locate a piece of information would have to leaf through the entire DID until that information was located. This could take several minutes. The end result is that the DID is not well organized, thus harder to use. To add to this complexity in use, there is no definition of terms in the DID. Consequently, an uninformed user would have to reference other material to support this DID. Finally, this DID is not easy to use because all of the information related to the CM function is not located together within the DID. While the majority of the CM information is located in one area of the DID, two key components are addressed in the section relating to software development management. These are the software development library and the corrective (change) action process, including the change report. These two components clearly should have been addressed in the section related to configuration management.

There were a couple of positive aspects of this DID. They are that it is structured well, using sections as keys to important material, and sections are kept short so that they cannot become confusing.

C.2 Completeness

C.2.1 Definition

In general, a standard is complete if the user does not have to look elsewhere for information or ask for other assistance in developing the configuration management plan. However, this is a somewhat vague definition of completeness. So that completeness can be objectively measured for each of the three standards, specific attributes have been established. These attributes are shown in the next subsection.

C.2.2 Rationale for Rating

Completeness is determined by the attributes listed below. These attributes are placed in the same four categories as the first criterion. Again, a rating of 0 implies that the standard did not meet the minimum attributes.

The minimum attributes a standard must have to be “complete” are:

- The standard provides a description of the following components of a CM plan:
  - Document introduction and purpose
  - CM organization and responsibilities
  - Configuration Identification
    - Naming and numbering/freshening scheme for documents and files
    - Identification and descriptions of baselines
  - Configuration control
    - Procedures for handling changes to baselines
    - Information on all CCBs
  - Configuration status accounting records and reports
  - Description of configuration audits that will involve CM
  - Description of CM scheduling/milestones
- The purpose and audience of the standard is clearly defined.
- The standard is clear, concise, unambiguous, meaningful, and simple.

The additional attributes that must be met for a standard to be rated good are:

- The standard provides a description of the following components of a CM plan:
  - Interfaces between CM and other organizations
  - Configuration Identification

- Description of identification tracking scheme
- How the identification scheme addresses versions and releases
- Library description
- Backup, recovery, and retention policies

- Configuration Control
  - Change request processing to include change classification scheme
  - Change reporting
  - Document revisions
- Reviews to be supported by CM
- Description of the version release process
- Subcontractor/vendor support

- The standard does not contain information that does not apply to the creation of a CM plan (e.g., it should not be a tutorial on general CM concepts, it should not discuss the entire software development life cycle).
- All information in the standard is necessary and is also sufficient.
- There is no missing information.
- All external references are defined.
- Each component described in the standard is covered in adequate depth (i.e., the user should not have to reference any other document for information on any of these components).
- The standard is well thought out, not thrown together.
- The standard is comprehensive in that it addresses the handling of items such as documents and vendor software as well as application source code files.

The additional attributes that must be met for a standard to be rated excellent are:

- The standard provides a description of the following components of a CM plan:
  - Relationship of CM to the software process life cycle
  - How the identification scheme addresses hardware, system software, COTS, etc.
  - Library disaster procedures
  - Non-CM organizations assigned responsibilities for change control
  - Interfaces between multiple CCBs and the overall hierarchy
  - How change control can change throughout the life cycle
  - Use of automated tools to perform CM
  - Relationship between CM milestones and the life cycle/development process

- CM training
- The standard provides examples of CM plans, or major portions thereof, to assist the user.

There are four desirable, though not rated, attributes of this criterion. These are:

- The standard contains a complete index that includes references to all headings, acronyms, and terms that were defined in the standard.
- The standard provides a template of a basic CM plan.
- The standard addresses the handling of more than one client (e.g., how releases are done for multiple clients, how variants of the system are managed).
- The standard provides new ideas, understanding, or improvements to the software engineering practice of CM plan development.

C.2.3 Application to Standards

C.2.3.1 General Comments

In the area of completeness, one of the standards was rated good, another was rated average, and the third was rated fair. The primary reason for these ratings was because information that was deemed critical for each category was missing in one or more of the standards. For example, two of the standards did not address backup, recovery and retention. If these necessary concepts are not addressed in the standard, they cannot be expected to be addressed in the CM plan produced from the standard. A second key reason for these ratings was because two of the standards contained incomplete information on the topics they did address.

C.2.3.2 IEEE Comments

The IEEE standard was rated good for this criterion and was very close to receiving an excellent rating. There were many positive points about this standard in the area of completeness. First, the standard provided a good level of depth on each of the CM plan components it discussed. Second, the standard addressed all CM components that would be necessary in a CM plan and would receive a rating of excellent in this one attribute. Important to this coverage was that the standard very adequately addressed topics not covered well in other standards or many CM plans, such as baselines and changes to them, interface control, subcontractor/-vendor control, and multiple levels of change control boards (CCBs). Additionally it provided detailed coverage of topics not required of even an excellent standard. These topics were tailoring and CM plan maintenance. A final positive aspect of this standard is that it provided a template for a CM plan upon which a user could immediately begin building their own plan.

Aspects of this criterion that were not addressed well by this standard are lack of examples, lack of added emphasis on several components, and minimal emphasis on automated tools. The first point, lack of examples, is the only reason this standard did not receive a rating of excellent. This standard would have been rated excellent if it had included a sample change control diagram or a sample completed CM plan. Ironically, there were three sample CM plans included in the general standard for CM concepts (IEEE Std-1042-1987). The authors would

suggest moving one of the samples to this standard. We do not, however, recommend including all three samples as we believe that this would add unnecessary volume to the standard and would provide minimal additional benefit.

The second point, lack of added emphasis on several components, can best be described by reference. While the standard did address identification tracking, it did not elaborate well on the entire tracking scheme. The user would know, by inference, that a tracking scheme needs to be described but the standard did not explicitly state this. The standard also did not place enough emphasis on change processing classification. It discussed classification generally in terms of priority and urgency but did not express the need for a classification scheme in terms of high, medium, low or 1, 2, 3, for example, with associated definitions. Also, the standard only addressed documentation at the overall level as part of a CM. It would have been more effective to re-addresses or remind the user of documentation when the standard discussed identification and change control procedures.

Finally, the standard would have been even more outstanding if it would have discussed the use of automated tools at a more detailed level. Though it did discuss automated tools in one section, an expanded discussion of automated tools describing how they can be applied in the various functional areas (e.g., change control, status accounting) would have been great.

C.2.3.3 NASA Comments

The NASA standard was only rated average for this criterion because it did not address many of the components required for a CM plan to be rated good, nor did it provide all the information required to make it a complete document. Examples of CM plan components that it did not address, but should have, are software libraries, a version release process, backup, recovery and retention, change classification, subcontractor/vendor support, and the use of automated tools. This standard is not considered complete because the detail of information provided on the CM components addressed is insufficient. The standard is written, for the most part, in an outline form providing no explanation of the items listed in the outline. It appears as though the authors of this standard never intended for it be used without the accompanying guidebook on the general CM concepts (NASA D-GL-11 VO.2). Because there was very little detail in this standard it can only be effectively used by an expert in CM as a quick reference guide.

Although the standard was only rated average, there were three positive aspects about it that should be noted. First, this standard included a section on resources beyond what is typical. That is, it addressed resources such as machine and data storage resources as well as the commonly addressed human resources. Second, it contained a very complete section on configuration control forms, addressing this component at a level of detail much greater than the other two standards. This level of detail provided added benefit to the user versus being excessive information on a topic. Finally, the standard handled the identification, storage and release of documentation separately from the CSCIs. This adds benefit to the standard in that it reminds the user not to forget to address documentation.

C.2.3.4 DoD Comments

The DoD DID was only rated fair for this criterion because it did not address one of the components required for a CM plan to be rated average. This component is the identification and description of baselines. A CM plan cannot be considered adequate without defining and describing baselines, as baselines provide the fundamental structure upon which all changes occur. This is especially true in the DoD environment. Thus, it is critical that the standard address baselines. In addition to the problem of not addressing all required components, this DID is considered incomplete because the level of detail provided for the addressed CM components is insufficient. As with the NASA standard, it appears as though the authors of this DID intended that it be used in conjunction with DoD-STD-2167A and MIL-STD-973 or MIL-STD-483A. Because there was very little detail in this DID it can only be effectively used by an expert in CM as a quick reference guide.

One positive aspect of this DID is that it provided a good example of a configuration control flow chart. This chart would be of significant benefit to a user of a standard, especially a non-expert user. This was the only standard that provided a sample chart.

C.3 Tailorability

C.3.1 Definition

A standard is considered to be tailorable if it can be customized to the needs of any project. The attributes for tailorability are shown in the next subsection.

C.3.1.1 Rationale for Rating

Tailorability is determined by the attributes listed below. These attributes are placed in the same four categories as the first criterion. Again, a rating of 0 implies that the standard did not meet the minimum attributes.

The minimum attributes a standard must have to be “tailorable” are:

- A CM component that does not apply to a particular project can be easily removed from the plan (i.e., the standard addresses each component in only one section versus scattering the discussion of that component throughout the entire plan/standard).
- CM components can be reorganized within the plan to accommodate the project.

The additional attributes that must be met for a standard to be rated good are:

- The standard can be adapted, though perhaps not easily, to any application domain.
- The standard can be adapted, though perhaps not easily, to any process model or life cycle phase.
- The standard can be adapted, though perhaps not easily, for use with hardware, software and firmware.

- The standard addresses subcontractors and vendors, but does so in such a manner that a plan can be tailored not to address them if they do not apply to the project.

The additional attributes that must be met for a standard to be rated excellent are:

- The standard can be easily adapted to any application domain without resorting to extensive expandability (i.e., it can be tailored by removing rather than adding information).
- The standard can be easily adapted to any process model or life cycle phase without resorting to extensive expandability.
- The standard can be easily adapted for use with hardware, software, and firmware without resorting to extensive expandability.
- The standard can be tailored easily, completely, and consistently--this requires a coherent and easy-to-use organization that has no redundancy.

C.3.2 Application to Standards

C.3.2.1 General Comments

Each of the standards met the minimum qualifications to be considered tailorable, and one standard met the qualifications to be rated excellent. The other two standards met all of the qualifications to be rated good, with the exception of one attribute. Thus, overall the authors would state that all the standards lent themselves well to tailorability.

C.3.2.2 IEEE Comments

The IEEE standard was rated excellent for this criterion. This standard was intentionally written to be tailorable and explicitly addresses tailorability as part of the standard. The standard contains a complete section on tailoring that addresses both upward and downward tailoring. Although the standard handles upward tailoring, it is the authors opinion that there will be very little need to tailor up from this standard for most projects, because the standard is so complete. Thus, the attributes dealing with resorting to minimum expandability are still met by this standard. This standard also addresses the tailoring of a document to handle hardware, firmware, and subcontractors and vendors quite clearly. Additionally, this standard contains specific instructions that forbid a user from removing any of the required information without stating specifically why it was removed. This standard has no negative aspects related to this criterion.

C.3.2.3 NASA Comments

The NASA standard was rated average, and would have been rated good except that it does not address subcontractors and vendors, thus it failed this attribute. Because the standard is well organized, it would be easy to remove a CM component that did not apply to a project, or to reorganize the CM components to accommodate a project. This standard can also be adapted, though perhaps not easily, to any application domain, process model, or life cycle, and can be adapted for use with hardware and firmware. The reason that the tailoring may not be easy is because the standard is incomplete. Thus, any adaptation will, in all likelihood, require a considerable amount of upward tailoring.

C.3.2.4 DoD Comments

The DoD standard was rated average, and would have been rated good except that it also did not address subcontractors and vendors. The same comments that apply to the NASA standard apply to the DoD standard.

C.4 Consistency

C.4.1 Definition

A standard is considered to be consistent if it is structured and there is uniformity throughout the document. The attributes for consistency are shown in the next subsection.

C.4.2 Rationale for Rating

Consistency is determined by the attributes listed below. These attributes are placed in the same four categories as the first criterion. Again, a rating of 0 implies that the standard did not meet the minimum attributes.

The minimum attributes a standard must have to be “consistent” are:

- A standardized representation format is used for the production of the document.
- Naming and use of terms is standardized.
- The same CM component or term is not referenced by more than one unique name, and is not defined by more than one set of characteristics.

The additional attributes that must be met for a standard to be rated good are:

- A structured format is used for the production of the document.
- Unique names given to CM components or terms are commonly known and used in industry.
- Uniformity is achieved throughout the standard.
- The standard is consistent with other standards for the project life cycle.

There is only one additional attribute that must be met for a standard to be rated excellent. It is:

- The standard is consistent with other known CM standards in industry.

C.4.3 Application to Standards

C.4.3.1 General Comments

Each of the standards received a rating of excellent for this criterion. All standards were very consistent within themselves. More importantly, they were all consistent with other known standards in the industry. This consistency to other known standards exists primarily because all three standards addressed the same key components. These were CM organization, configuration identification, configuration control, configuration status accounting, configuration auditing, and configuration management milestones.

C.4.3.2 IEEE Comments

The IEEE standard, like the other standards, met all of the attributes of consistency. Perhaps the attribute that lent the standard towards being the most consistent was its uniform structuring. One unique characteristic about the IEEE standard is that it contained a section on consistency criteria for the CM plan. This section contains a list of three criteria. This was the only standard that addressed consistency explicitly for the plan, as well as being consistent itself. This standard had no negative aspects related to this criterion.

C.4.3.3 NASA Comments

The NASA standard was also rated excellent in this category. Again, as with the IEEE standard, the attribute that lent this standard most towards being consistent was its uniform structuring. This standard also had no negative aspects related to this criterion.

C.4.3.4 DoD Comments

The DoD standard was also rated excellent. The same comments that apply to the NASA standard apply to the DoD standard.

C.5 Correctness

C.5.1 Definition

A standard is considered to be correct if it contains only valid information. The attributes for correctness are shown in the next subsection.

C.5.2 Rationale for Rating

Correctness is determined by the attributes listed below. These attributes are placed in the same four categories as the first criterion. Again, a rating of 0 implies that the standard did not meet the minimum attributes.

The minimum attributes a standard must have to be “correct” are:

- The standard does not provide any incorrect information.
- The standard does not contain any contradictory information.

The additional attributes that must be met for a standard to be rated good are:

- The standard contains only that information that is necessary to clearly explain a topic. Any less than is needed forces the user to look elsewhere making the standard ineffective. Discussion of non-related information, or excessive supporting material on a topic is unnecessary and makes it difficult for the user to concentrate on the key items in the standard.
- The approach taken in the standard makes sense both technically and practically.

The additional attributes that must be met for a standard to be rated excellent are:

- There is evidence of correctness to back up the standard (i.e., it should have been successfully applied to case studies).

There is one desirable, though not rated, attribute of this criterion. It is:

- The standard represents the state-of-the-art in CM and does not contain outdated guidance.

C.5.3 Application to Standards

C.5.3.1 General Comments

One standard was rated excellent in this category and the other two were rated average. The only reason for this difference in ratings was that the two lower rated standards did not contain a sufficient amount of information. Other than failing this attribute, all three standards met all the remaining attributes for both a good and excellent rating.

C.5.3.2 IEEE Comments

The IEEE standard was rated excellent for this criterion. Not only was the information contained in the standard correct, but the correct level of information was also provided. There were a couple of topics where a little more information would have increased the value to the user, however, the information provided was still complete enough to clearly and correctly explain each topic.

The one thing the standard could have done better is to attempt to represent the state-of-the-practice a bit more. For example, the standard could have placed more emphasis on how automated tools could be used for each of the CM activities, and could have more clearly addressed the relationship of CM to the project life cycle.

C.5.3.3 NASA Comments

The NASA standard was rated average for this criterion. As stated above, the only reason for this low rating is that the standard does not contain all the information needed by any user to develop a CM plan. This lack of information makes the standard incorrect, by default. Had the standard passed this attribute, it would have been rated excellent.

C.5.3.4 DoD Comments

The DoD standard was also rated average for this criterion for the same reason as the NASA standard. The comments that apply to the NASA standard also apply to the DoD standard.

C.6 Life Cycle Connection

C.6.1 Definition

A standard is considered to be connected to the life cycle if it refers to how CM connects to the life cycle. This criterion only has two attributes. These attributes only apply to a “good” or

“excellent” standard. There are no attributes associated with an “average” standard for this criterion.

C.6.2 Rationale for Rating

Life cycle connection is determined by the attributes listed below. These attributes are placed in the categories for a good and excellent standard. A rating of 1 implies that the standard did not meet the attributes associated with being a good standard. There is no rating of 0 for this category.

The attribute that must be met for a standard to be rated good is:

- The standard addresses how the CM plan fits into and evolves throughout the overall project life cycle.

The additional attribute that must be met for a standard to be rated excellent is:

- The standard addresses how the individual CM plan activities fit into the overall project life cycle.

C.6.3 Application to Standards

C.6.3.1 General Comments

All three standards were rated average in this category. This means that the attributes for life cycle connection did not apply to any of the standards. The standards did not meet the first attribute, of addressing how the CM plan fits into and evolves throughout the overall project life cycle, because none of the standards addressed the evolution of the CM plan throughout the life cycle. Additionally, the NASA and DoD standards did not address the life cycle at all, while the IEEE standard addressed life cycle, but not the evolution of the CM plan through the life cycle. The standards did not meet the second attribute, of addressing how the individual CM plan activities fit into the overall project life cycle, either. It is obvious that if they didn’t address the life cycle at a higher level that they would not have addressed it at this level either.

Because none of the standards met the attributes of either the good or excellent rating, as stated above, and there were no attributes associated with the average rating, there is no need to discuss each standard individually with regard to this criterion.

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