An Overview of the Project Cycle

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Projects are formed to achieve defined objectives, which almost always include a set of technical requirements to be achieved within budget and schedule constraints. The Project Cycle is a tool that defines the typical project activities and their logical progression from the beginning to end. Many projects encounter serious difficulty and often fail because the project team ignores the proper sequencing of activities and events in the project cycle, particularly the "front-end" activities. Studies, such as the Hearth Committee report (NASA) and the Packard Presidential Commission report (DoD), emphasize the importance of not ignoring, bypassing, or improperly sequencing essential project cycle events. To comply, project managers must completely understand their project's cycle.

Many functional managers attempt to define the project cycle from their perspective. These attempts result in the Budget Cycle, the System Development Cycle, the Acquisition Cycle and many other focused views of the typical life of a project. Development of a comprehensive project cycle has been hampered by the inability of the many interest groups involved to achieve consensus. Moreover, engineers tend to be reluctant to create a typical project cycle in fear that it will reduce their freedom to be innovative during the engineering portion of the cycle.

Under contract to the U.S. Government, we have studied and evolved a baseline project cycle useful for all projects requiring concept selection, design, development, and operations. While fundamentally similar to the NASA planning process that includes Phases A, B, and C/D, it provides markedly clearer terminology, and has been carried to a depth of detail not previously available.

Project Cycle Definition

The project cycle is an illustration of the typical and necessary project events sequenced from beginning to end. There are three aspects or layers to the project cycle, each containing its own set of events. These layers are the Budget, Business, and Technical aspects.

The Budget aspect contains all events relative to securing the necessary funding required by the project. The Business aspect contains all the events relative to the overall programmatic management of the project, including the acquisition process and associated contract management. The Technical aspect contains all the technical events relative to determining and satisfying the technical requirements of the project, and validating that the project solution complies with the requirements.

The interwoven events for these three aspects constitute the total cycle. Each event or product of an event is assigned to one of four interrelated categories: Budget, Activities, Products, and Control Gates. See Figure 1, Project Cycle (Partial View), which shows these four categories of events and related products.

The "budget events" define the required planning for and securing of project funding and are keyed to important U.S. Government fiscal milestones imposed by the Office of Management and Budget (OMB).

The "activities" include all sorts of actions such as to study, analyze, evaluate, select, design, etc.

The "products" consist of activity results such as specifications, drawings and manuals; internal hardware and software such as technical feasibility models; and the deliverable hardware, software and documentation.

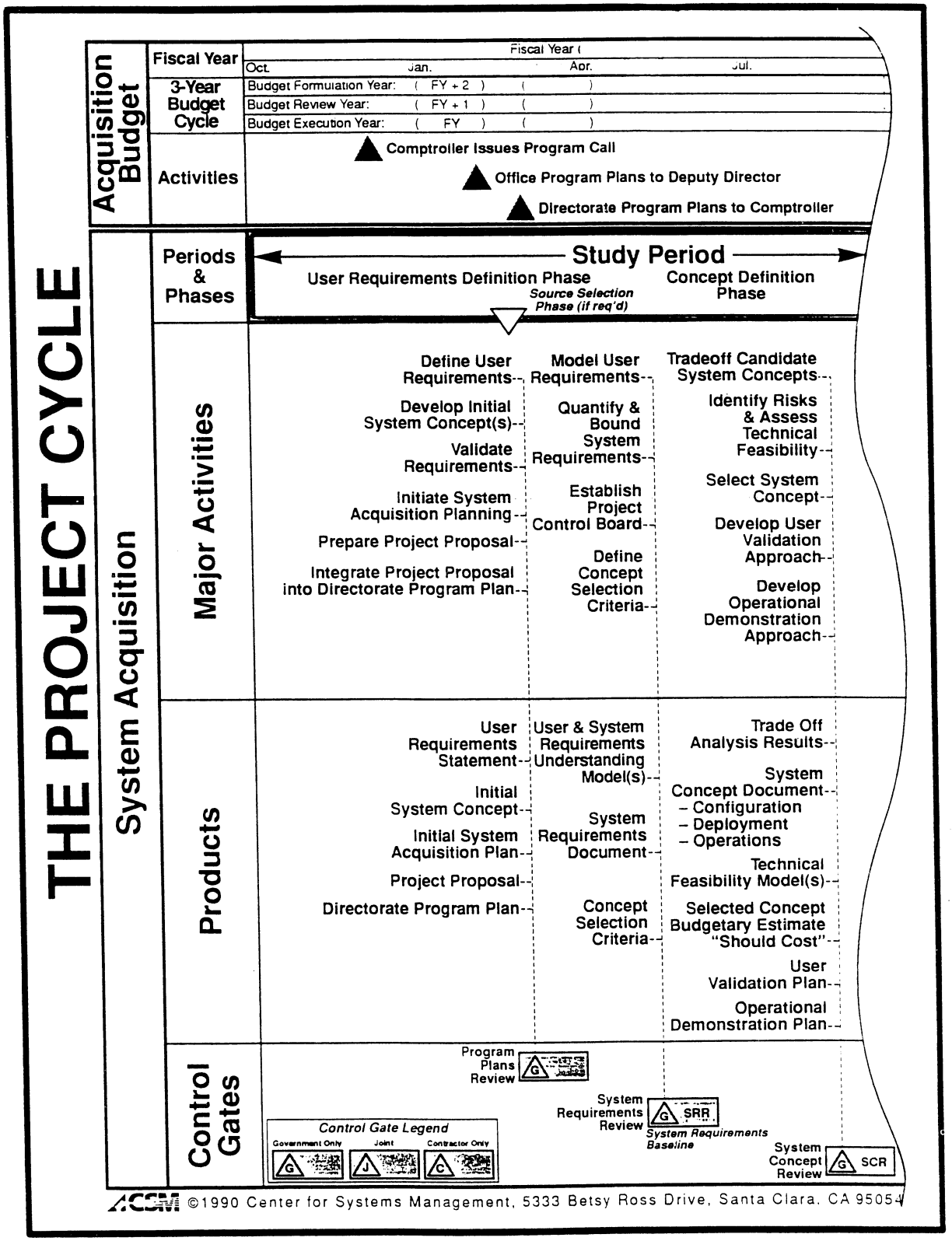

Figure 1 - Project Cycle (Partial View)

The "control gates" are predetermined, formal status and decision checkpoints which must be satisfied, or else the project is not sufficiently prepared to move on to future events without increased risk.

Project Cycle Periods and Phases

The project cycle is usually divided into periods and then further subdivided into phases. Our typical cycle is divided into the Study Period, the Acquisition Period, and the Operations Period. These periods depict the three major periods of a project that progresses from an identified user need, through concept determination, contractor participation for development, and ultimately to user operation.

The "Study Period" consists of four phases. They are the User Requirements Definition Phase (commonly known in NASA as pre-Phase A), the Concept Definition Phase (commonly known as Phase A), the System Performance Definition Phase (commonly known as Phase B), and the Acquisition Planning Phase.

The "Acquisition Period" consists of the Source Selection Phase and the System Development Phase (commonly known as Phases C/D).

The "Operations Period" consists of the Deployment Phase and the Operations and Maintenance Phase. It is sometimes called Phase E.

The objective of the "User Requirements Definition Phase" at the start of the Study Period is to determine exactly which of the user's total requirements will be included and satisfied by the proposed project. Usually, user requirements are more comprehensive than can be reasonably or economically incorporated into a single project. Considerable analysis, negotiation and decision making must occur to identify the project's subset of the user's requirements, which are then recorded in the project's System Requirements Document and signed off by both the user and the project manager. In addition,executive approvals for the project and initial project funding are secured. The need to control requirements, of course, is understood.

The prime objective of the "Concept Definition Phase" is to select the preferred concept from possible candidates, and then to develop the budgetary "should cost" estimate and the "should take" schedule, and then to identify and resolve any areas of high risk. The System Performance Specification and the Interface Specifications are developed during the System Performance Definition Phase so that the selected system can be competed for the marketplace. During the Acquisition Planning Phase the approach to the acquisition is developed and documented in the Acquisition Plan, and a credible, qualified bidder's list is prepared. If the project can be performed totally internal to NASA, the justification for this approach will be determined in this phase.

The objective of the "Source Selection Phase" is to select through fair and open competition the best value through the comprehensive, analytical evaluation of contractor proposals. The system concept is designed, produced, verified and delivered during the "System Development Phase." The events of this phase ensure that the concept is in full com-pliance with all contractual requirements.

The main objective of the "Deployment Phase" is to transfer the system from the contractor's facility to the operational location, and then to establish full operational capability of the system. The system is operated and evaluated in terms of the success of the system in meeting the original project objectives during the "Operations and Maintenance Phase."

The Technical Aspect of the Project Cycle

The Technical Aspect of the Project Cycle can be viewed as a "V" formation within the project cycle (see Figure 2, Overview of Technical Aspect of the Project Cycle). While budget and business events can typically be compressed and accelerated, the technical events are the most significant force in the project cycle, and ultimately they drive the length and cost of the project.

The beginning and the end of the cycle deals with the user's requirements and the user's satisfaction, respectively. These are the highest

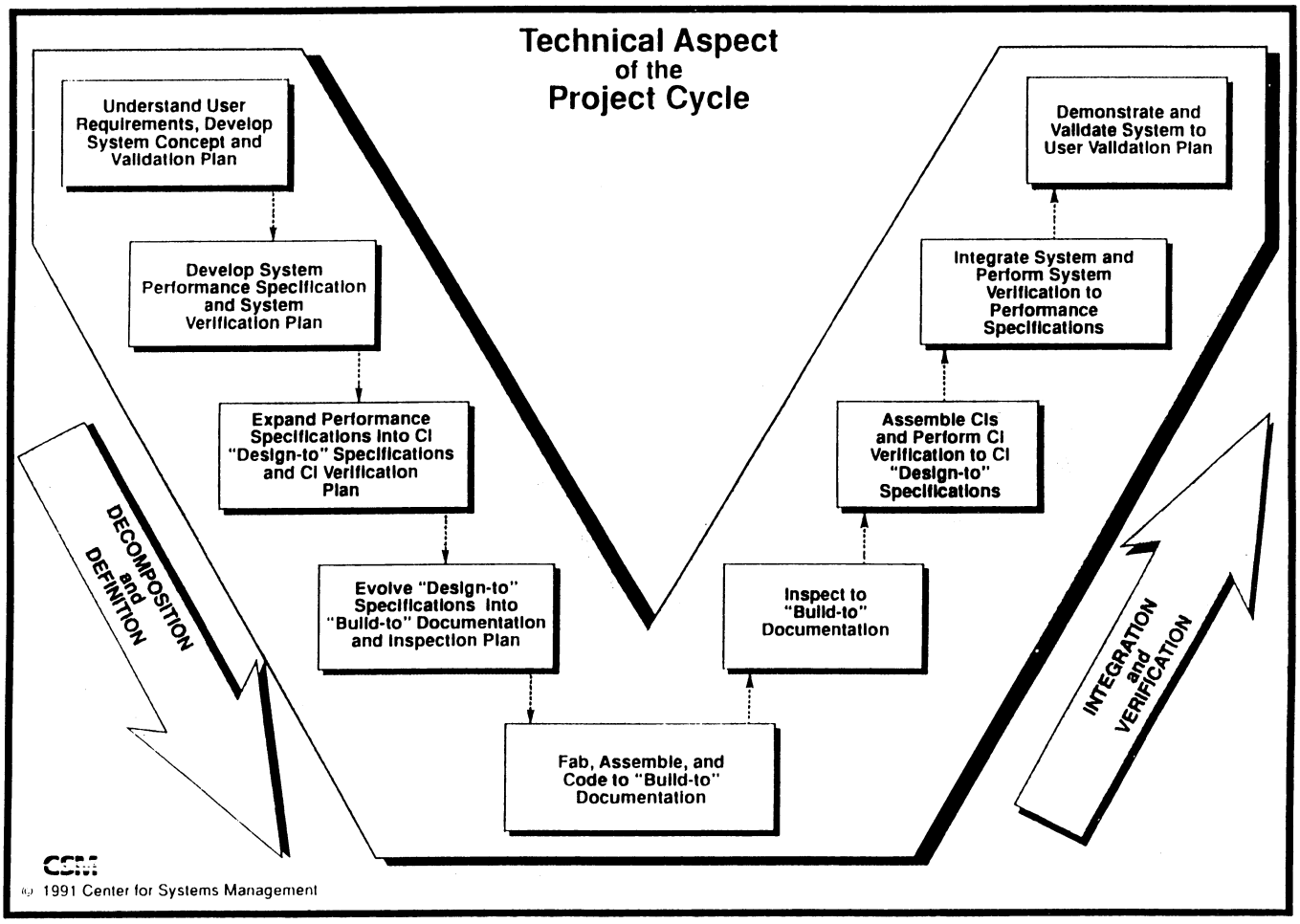

Figure 2 - Overview of the Technical Aspect of the Project Cycle

levels of the "V." In the center of the cycle, at Critical Design Review (CDR), the events of the project are at the lowest level, dealing with hardware and software process details such as fastening, bonding, and coding. The left side of the "V," descending from the highest point to the lowest point, is defined as Decomposition and Definition. The right side of the "V", ascending to the fully operational system, is called Integration and Verification. System engineering is responsible for the technical management of the entire "V."

Typically, the upper portion of both sides of the "V" is managed by the government, with contractor participation. The center level of the "V" is managed by the contractor's systems engineers, with design engineering participation and government oversight. The lower portion of the "V" is managed by the contractor's design engineers, with oversight by the contractor's systems engineers.

Only the core of the "V" is presented in Figure 2. The process illustrated here is similar to the traditional waterfall model of system decomposition and integration. However, this model provides improvement in the understanding process. Detailed hardware, software and operational analysis is recommended at each step in the decomposition to assess solution feasibility and risk, and to provide necessary data to select between various options (see Figure 3). As the project progresses from one step in the "V" to the next, only the decisions on the core are put under configuration management.

Off-core details are illustrated by the process of requirements flowing down to successively

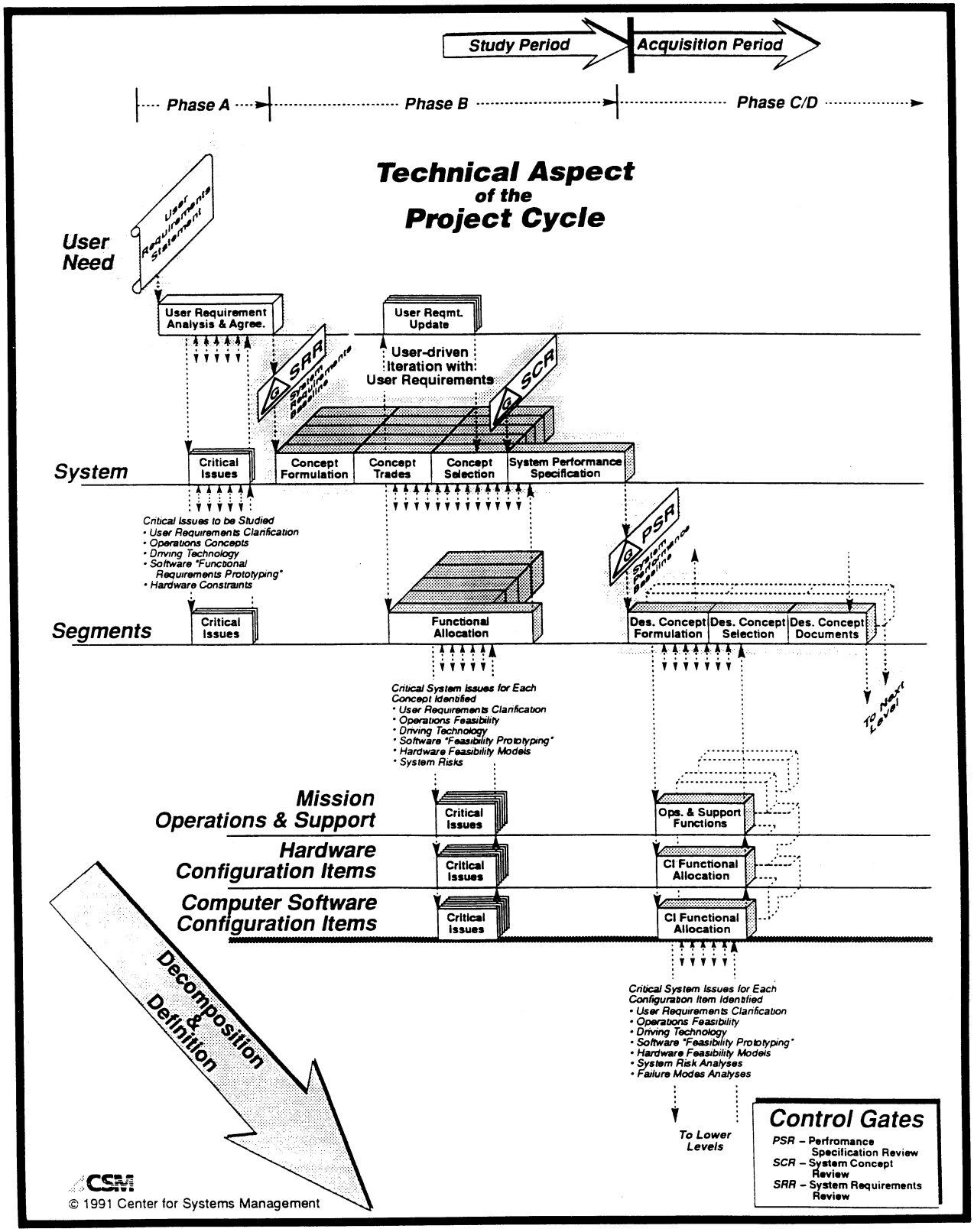

Figure 3 - Details of the Technical Aspect of the Project Cycle (Partial View)

lower levels, performing trade-off analyses to determine the best approach at each level (as depicted in Figure 3). This progressive and iterative process is repeated until the lowest level decisions have been made with valid rationale, all traceable to the original user requirements. Management of the Decomposition and Definition process demands both requirements traceability and baseline configuration management. The management of Integration and Verification requires compliance verification and full accountability of all specified requirements. Systems engineering is responsible for this management.

As the project proceeds through the "V," it progresses in time and maturity. The maturity is measured by the evolving technical baseline, which is progressively placed under formal configuration control by the government project manager.

At the beginning of the "V," the approved baseline is the user's agreed upon requirements. At Full Scale Development (Phase C/D contract award), the approved baseline is the System Performance Specification. At PDR (Preliminary Design Review), the approved baseline becomes the approved "Design-to" specifications. At CDR (Critical Design Review), the approved baseline becomes the "Build-to" documentation. Baseline evolution and approval continues throughout the project cycle.

Project management is the most complicated of all management processes. It encompasses detailed sets of interrelated activities that involve many different specialty disciplines. These include funding, contracting, systems engineering, design engineering, production, quality, procurement, systems acquisition, systems integration, systems verification, configuration control, subcontracting, and many others. The interactive complexity is so great that it is difficult for even the most experienced team to operate proactively and efficiently without drawing on a baseline project cycle as a reference starting point.

While there are those who proclaim that a defined project cycle inhibits the creativity of project participants, just the opposite is realized. By having defined a typical cycle that is tailored to the project and then further expanded into the strategic network and project plan, the project team is not distracted by day-to-day project activities. A defined process releases contributors to concentrate on content, rather than process.

A defined project cycle illustrates the generic budget, business and technical events required to be successful. The project cycle should be tailored to the type of project and is the skeleton around which the strategic and tactical approaches to the project can develop into a logical network. By having a defined process, the team is free to be innovative and, therefore, more successful.