METHOD, PROCESS AND SYSTEM FOR OPTIMIZED OUTCOME DRIVEN WORKFLOW SYNTHESIS AND REDUCTION

This application claims the benefit of Provisional Applications 60/187,481 filed on 7 March, 2000 and 60/198,915 filed on 20 April 2000.

FIELD OF INVENTION:

This invention relates to intelligent project planning and execution and to optimized project planning procedures.

BACKGROUND OF THE INVENTION:

Project planning is a discipline focused on determining, structuring, and scheduling the minimum work necessary to produce the outcomes defined for the scope of the project in the least amount of time under known constraints (e.g., resource availability, regulatory requirements, etc.).

Planning complex projects often requires the synthesis, scheduling, and coordination of the activities of many individuals having expertise in distinct disciplines or professions.

In most cases, each discipline or profession will have developed, and formally documented, a body of knowledge that is considered to express its best practices. Generally, each body of knowledge will describe proven and optimal approaches used to achieve specific outcomes associated with the discipline or profession (e.g., the extraction of a wisdom tooth by a dental surgeon, or the design of a user interface for a computer software application by a software engineer).

The approaches described are typically represented in the body of knowledge as a series of interdependent activities.

Combining the activities from more than one body of knowledge into a coherent and optimal whole, as represented by a project work breakdown structure (WBS) and work flow, to satisfy the set of outcomes anticipated by the scope of the project can be daunting, given that the project planner must rationalize, synthesize, and set dependencies between hundreds or thousands of discrete activities from the

bodies of knowledge involved, without having the benefit of expertise in all of the disciplines or professions.

SUMMARY OF THE INVENTION

The invention comprises a method, process and system for synthesizing an optimized process flow, an activity abstraction hierarchy and an instruction set that represents the minimal work to produce at least one outcome.

In accordance with the first aspect of the present invention, there is provided a process for generating a project work breakdown structure (WBS) and related work flows, comprising the steps of, selecting an existing project WBS, the existing project WBS having related work flows, selecting at least one desired outcome for synthesis, said at least one selected desired outcome having a first associated work flow comprising a network of interdependent activities, and synthesizing the first associated work flow with the existing project WBS and its related work flows by, identifying the most downstream activity in the first associated work flow, determining whether each activity in the first associated work flow is already present in the project WBS and related work flows being generated by starting with the most downstream activity in the first associated work flow and working upstream until all activities in said the associated work flow have been compared to the activities of the project WBS and related work flows being generated, adding any activity in the first associated work flow which is not already present in the project WBS and related work flows being generated, adding activity dependencies which should exist between any of the added activities and any activity already present in the project WBS and related work flows being generated, and introducing summary activities, when required, into the project WBS being generated when lowest-level activities from the first associated work flow are added.

In accordance with the second aspect of the present invention, there is provided a process for generating a project work breakdown structure (WBS) and related work flows representing the minimal work to produce at least one desired outcome, the process comprising the steps of, viewing a set of available WBS templates, viewing a set of outcomes within and outside the scope of each WBS template from the set of available WBS templates, selecting a controlling WBS template from the set of available WBS templates for a project WBS, selecting at least one desired outcome from the set of outcomes for synthesis, said at least one selected desired outcome

having a first associated work flow, synthesizing the first associated work flow with the project WBS according to the selected controlling WBS template, viewing the project WBS and related work flows being generated, and linking each activity of the project WBS being generated with appropriate instructional content.

In accordance with the third aspect of the present invention, there is provided a system for generating a project work breakdown structure (WBS) and related work flows comprising, means for accepting as input an existing project WBS and at least one desired outcome, the existing project WBS having related work flows, means for storing the existing project WBS and related work flows, means for storing a set of activities associated with a set of pre-defined WBS templates, means for identifying lowest level activities and their interdependencies from the stored set of activities necessary to produce said at least one desired outcome, the identified lowest level activities and interdependencies defining an associated work flow, and means for synthesizing the associated work flow and appropriate summary activities with the existing project WBS and its related work flows.

In accordance with the fourth aspect of the present invention, there is provided a process for generating a project work breakdown structure (WBS) and related work flows, comprising the steps of, selecting a controlling WBS template for a project WBS, selecting at least one desired outcome for synthesis, said at least one selected desired outcome having a first associated work flow comprising a network of interdependent activities, and synthesizing the first associated work flow with the project WBS and related work flows being generated according to the selected controlling WBS template by, identifying the most downstream activity in the first associated work flow, determining whether each activity in the first associated work flow is already present in the project WBS and related work flows being generated by starting with the most downstream activity in the first associated work flow and working upstream until all activities in the first associated work flow have been compared to the activities of the project WBS and related work flows being generated, adding any activity in the first associated work flow which is not already present in the project WBS and related work flows being generated, adding any activity dependency which should exist between any of the added activities and any activity already present in the project WBS and related work flows being generated, and introducing summary activities, as appropriate, into the project WBS being generated when lowest-level activities from the first associated work flow are added.

In accordance with the fifth aspect of the present invention, there is provided a system for generating a project work breakdown structure (WBS) and related work flows comprising, means for accepting as input a controlling WBS template for a project WBS and at least one desired outcome, means for storing the controlling WBS template, means for storing a set of activities associated with a set of pre-defined WBS templates, means for identifying lowest level activities and their interdependencies from the stored set of activities necessary to produce said at least one desired outcome, the identified lowest level activities and interdependencies defining an associated work flow, and means for synthesizing the associated work flow and appropriate summary activities with the project WBS and related work flows being generated according to the controlling WBS template.

An embodiment of this invention utilizes a single set of non-redundant activities and activity dependencies, which has already been derived from an organization's current processes and procedures, to produce an optimized work flow with respect to the desired outcomes for a project. To accomplish this, the conditional execution requirements of each activity required to produce a specified outcome are recursively examined to identify the set of activities which must be completed to arrive at the outcome. Starting with the last of these activities, a determination is made as to whether the activity is already present in the subject project work plan. If the activity is not present, but should be, it is inserted into its correct position in the project's work breakdown structure and is linked into the work flow for each predecessor and successor activity already present in the project's work breakdown structure. Working upstream along the process chain from that identified last activity, the process of activity insertion/positioning and work flow linking continues until all activities in the process chain of the outcome have been considered for insertion. Higher level summary activities are also introduced into the project's work breakdown structure as the lowest-level activities are inserted by referencing a designated work breakdown structure template.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

Figure 1 is a block diagram illustrating an embodiment of the outcome-driven work planning system;

Figure 2 shows the entity relationship diagram for an embodiment of the planning system data repository;

Figure 3a is a flow chart illustrating the first part of the outcome-driven work flow synthesis process;

Figure 3b is a flow chart illustrating the second part of the outcome-driven work flow synthesis process;

Figure 4a is a flow chart illustrating the first part of the outcome-driven work flow reduction process;

Figure 4b is a flow chart illustrating the second part of the outcome-driven work flow reduction process;

Figure 4c is a flow chart illustrating shows the third part of the outcome-driven work flow reduction process;

Figure 5a is an exemplary WBS Template that is populated with sample data that is used as the "controlling WBS" in the examples of the Outcome-Driven Work Flow Synthesis and Reduction Processes;

Figure 5b is an exemplary project WBS and work flow that is populated with sample data following first execution of step 4.1;

Figure 5c is an exemplary project WBS and work flow that is populated with sample data following second execution of step 4.1;

Figure 5d is an exemplary project WBS and work flow that is populated with sample data following third execution of step 4.1;

Figure 5e is an exemplary project WBS and work flow that is populated with sample data following fourth execution of step 4.1;

Figure 5f is an exemplary project WBS and work flow that is populated with sample data following fifth execution of step 4.1;

Figure 5g is an exemplary project WBS and work flow that is populated with sample data following sixth execution of step 4.1;

Figure 6a is an exemplary project WBS and work flow for all outcomes within the scope of the controlling WBS used in examples 1 and 2 of the outcome-driven work flow synthesis process;

Figure 6b is an exemplary project WBS and work flow that is populated with sample data following first execution of step 4.1;

Figure 6c is an exemplary project WBS and work flow that is populated with sample data following second execution of step 4.1;

Figure 6d is an exemplary project WBS and work flow that is populated with sample data following third execution of step 4.1;

Figure 7a shows an exemplary project WBS and work flow used as the starting point for Example 3: Outcome-Driven Work Flow Reduction Process (i.e., before the reduction of Outcome O2);

Figure 7b shows an exemplary project WBS and work flow resulting from the execution of procedure 5 from Example 3: Outcome-Driven Work Flow Reduction Process.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description is of the best mode presently contemplated for carrying out the invention. This description is not to be taken in a limiting sense, but is merely made for the purpose of describing the general principles of the invention. The scope of the invention should be determined with reference to the claims.

This mode may be characterized as a rule-based approximation, synthesis, and reduction approach. The planner may start synthesis and reduction with either an empty plan or with a plan that approximates the anticipated final work breakdown structure and work flow required for the scope of the project being planned. The approximation can be chosen from a set of known and useful "stock" plans. A "stock" plan is a previously constructed work breakdown structure (WBS) and work flow (with component activities linked to appropriate instructional content), which have proven useful on past projects. Each stock plan describes the work necessary to achieve one or more outcome. In the synthesis and reduction approach one develops a custom work flow by synthesizing the work flows necessary to achieve desired outcomes not present in the plan and by de-synthesizing, or reducing, the plan's work flows by removing activities that are solely required for outcomes which are currently present in the plan, but which are not wanted.

A process and system is disclosed to assist work planners by assembling a work breakdown structure (WBS) and work flow for a project based on the explicit selection or de-selection of outcome(s) by a work planner from a defined set of

possible outcomes. The process and system ensure that the resulting project WBS and work flow is composed of the minimum set of activities required to produce the set of outcomes desired for the project.

The process and system further ensure that the project 's activities are organized into an activity hierarchy defined by a WBS template designated by the work planner, and that each of the project's activities is linked into an appropriate work flow, supported by appropriate instructional content.

In cases where the projects undertaken require different sets of outcomes, and where the work needed for one outcome may satisfy some or all of the work needed for another outcome, the determination of a rigorously optimized WBS and work flow to produce a desired set of outcomes (where hundreds or thousands of work steps are involved)is not typically feasible.

The present embodiment leverages the manufacturing and information technology principles of interchangeable/reusable components by recognizing that a single, non-redundant set of activities and activity dependencies can be derived from multiple formally documented bodies of knowledge and that this set of activities and activity dependencies can be used to assemble optimized project work breakdown structures (WBSs) and work flows based on the work planner's selection and/or de-selection of outcomes to be achieved by the project being planned.

In this context, an "optimized" WBS and work flow for a project means a WBS and work flow that is composed of the minimum set of activities necessary to produce the set of outcomes desired by the project.

The outcome-driven work flow synthesis process provides a system and method for the work planner or other user to implement the following:

1) View the available WBS templates;

2) View outcomes within and outside of the scope of each WBS template;

3) Choose and transmit a "controlling " WBS template selection;

4) Choose and transmit one or more selected outcome for synthesis;

5) View the resulting WBS and work flow; and

6) Link each activity in the activity hierarchy represented by a project 's WBS with the appropriate instructional content.

The outcome-driven work flow reduction process provides a system and method for the work planner or other user to do the following:

1)View the outcomes currently resulting from an existing project 's WBS and work flow;

2)Choose and transmit a selected outcome for removal from the WBS and work flow;

3)View the resulting project WBS and work flow.

Taken together, the outcome-driven synthesis and reduction processes provide work planners with the ability to construct and tailor work breakdown structures and work flows, supported by relevant activity descriptions (i. e., instructional content), by simply considering and selecting the outcomes that the project is intended to achieve.

The following terminology is grouped together here as a lexicon for use in describing embodiments of the invention.

Activity -a specific unit of work

Elementary Activity -the smallest unit of work that produces a meaningful result for the project.

Elementary Activity Dependency -An association between two elementary activities such that an execution of the first results in a state, or set of conditions, required by the second. The state resulting from the execution of an elementary activity is called a post-condition. The state required by a dependent elementary activity is called a "pre-condition".

Instructional Content Page -a document (e. g., an HTML document)used to describe the purpose or intent of, and approach to, the conduct of an activity. Each instructional content page may contain formatted text, graphics, and hyperlinks to related instructional content

Non-Elementary Activity -a named grouping of lower-level activities (non-elementary or elementary)that serves as an abstraction of its subordinate activities.

Object Class -a type of person, place, thing, concept, event, association, or condition for which information (in the form of attribute values and relationships) may be saved and upon which operations (actions)may be performed.

Outcome -a defined result of a process (e. g., a manufactured part or final product, an architectural drawing, a conceptual model, a decision made, a judgement rendered, a presentation delivered, a state of being achieved).

Project -an organized undertaking to produce or accomplish one or more desired outcome from a set of possible outcomes.

Project Activity -represents the use of an elementary activity or non-elementary activity by a project.

Project Activity Dependency -represents the use of an elementary activity dependency in the workflow for a project.

Project Planning -a discipline focused on determining, structuring, and scheduling the minimum work necessary to produce the outcome(s) defined for the scope of the project in the least amount of time under known constraints (e. g., resource availability, regulatory requirements).

WBS Activity -defines the use and positioning (i. e., vertical positioning and indention level) of an activity in a WBS template.

WBS Template -a named hierarchical structure used as a pattern for organizing project activities into a work breakdown structure (WBS).

Work Breakdown Structure (WBS)-a hierarchy of project activities used to view and manage the work of a project at different levels of abstraction.

Work Flow -a network of interdependent elementary activities that terminates in the elementary activity associated with the production of an outcome.

This workflow development process is designed for use on large-scale projects, including analysis of business strategies, such as where to go with new product development, or reorganization of a large-scale enterprise (e.g. large corporation). Therefore, the results of the workflow development process must be without error and must be capable of handling inputs from disparate sources, e.g., in a corporation, from a research and development unit or division, a manufacturing unit or division, a human resources unit or units, an upper management oversight unit and a reorganization plan (simultaneously with a reorganization of the corporation for carrying out the major project). The workflow development must be done in a manner such that the risk to the enterprise utilizing the work flow development

process must be minimized, as well as to the risk to a consulting company providing guidance with its work flow development process. For example, a work plan development process, if it were applied to the development of the B-2 Bomber, would have entailed the reorganization of a corporation to have a whole new large division, staffing such a division, having ongoing research and development input, designing the aircraft with thousands and thousands of specifications and requirements, a manufacturing unit, again with thousands of documented procedures, test units with thousands of tests and test documentation, acceptance tests procedures and manuals for the Air Force. These are extremely complex processes and the costs may be 100's of billions of dollars

However, it would be desirable to have a system which, in addition to the rule based structure, has an additional element or aspect which allows the work breakdown structure of the flow of the work, in the execution of the project, to be optimized. Now, there are potentially a number of different ways of optimizing the work breakdown structure, that is, the flowcharts detailing how the work needs to be done. In this embodiment, one may start with a previously developed project plan that is considered to be similar to the plan required for the anticipated project. However, the planner may find that desired outcomes are not included in the "stock" plan, and so adds them. That is, one selects one or more outcomes for synthesis. Consequently, the work flow for the selected outcome is synthesized into the current work plan. Similarly, irrelevant outcomes may be present, so the planner subtracts them. Many interdependent elementary activities may be involved in achieving the various outcomes. Adding or removing an outcome requires the readjustment of the project's work flow and work breakdown structure. One may also start with an empty plan, i.e., a plan with no outcomes, and add outcomes to that empty plan.

Figure 1 shows a computer-based system where RAM **12** and ROM **14** are shown. Other components of a computer-based system are shown including a central processing unit (CPU) **16**, a video display unit **18**, a communications port **20**, an intermediate server **22**, a remote web server **24** and a local web server **26**. The data storage repository **28** includes Activities **30**, Objects **32**, Outcomes **34**, Projects **36**, Instructional Contents **38** and Work Breakdown Structure (WBS) Templates **40**.

Figure. 2 shows the Entity Relationship Diagram (ERD) for the Exemplary Planning System Data Repository. Terms having all letters capitalized (e. g.,

ELEMENTARY ACTIVITY 58) refer to Figure. 2. Definition of terms are listed in the lexicon, above.

The OBJECTS subject area **42** contains OBJECT CLASS **44**, which is the subject of one or more OBJECT EFFECT **48** in the ACTIVITIES subject area **46**. Each OBJECT EFFECT **48** always results from one ELEMENTARY ACTIVITY **58**. Each ELEMENTARY ACTIVITY **58** always is a component of one NON-ELEMENTARY ACTIVITY **56** and may be identified as successor or predecessor on one or more ELEMENTARY ACTIVITY DEPENDENCY **50**. In the OUTCOMES subject area **60**, each OUTCOME **62** is produced by an ELEMENTARY ACTIVITY **58**. In the PROJECT WBS/WORK FLOWS subject area **64**, the PROJECT **70** is composed of one or more PROJECT ACTIVITY **68**, which may be identified as a predecessor or successor on one or more PROJECT ACTIVITY DEPENDENCY **66**. Each PROJECT ACTIVITY **68** may correspond to an ACTIVITY **52** which comprises ELEMENTARY ACTIVITY **58** and NON-ELEMENTARY ACTIVITY **56**. The INSTRUCTIONAL CONTENT subject area **72** contains CONTENT PAGE **74** which may be referenced by one or more WBS ACTIVITY **80** which is in the WBS TEMPLATES subject area **76**. Each WBS ACTIVITY **80** always references one ACTIVITY **52** and may override one or more ELEMENTARY ACTIVITY DEPENDENCY **50**. Each WBS TEMPLATE **78** may provide a controlling WBS for one or more PROJECTS **70**.

Outcome-Driven Work Flow Synthesis Process

This process is initiated when the work planner at step **96** (Figure 3a) confirms one or more OUTCOMES **62** to be produced/achieved by his or her PROJECT **70**. This process will introduce all needed ACTIVITYs **58, 56** into the PROJECT **70**, as PROJECT ACTIVITYs **68**, to form an appropriate WBS and workflow. Each PROJECT ACTIVITY **68** will also be linked to the INSTRUCTIONAL CONTENT PAGE **74** that is appropriate for the controlling WBS TEMPLATE **78** selected by the Work Planner. The choice of the WBS TEMPLATE **78** sets the context for the PROJECT **70.**

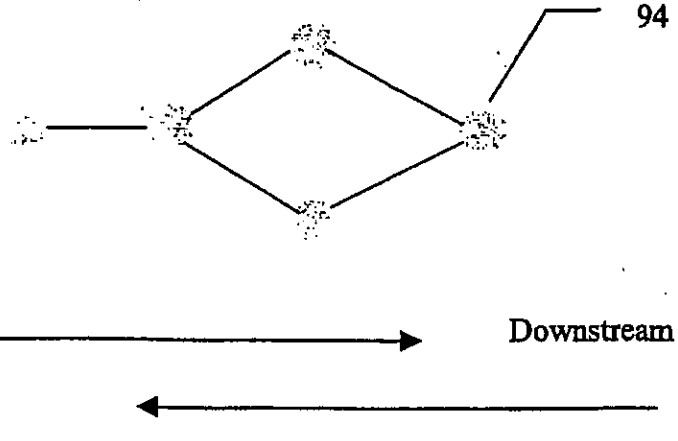
For each OUTCOME **62** selected by the Work Planner from the set of possible OUTCOMES **60**, perform the following procedures:

Procedure 1: From the Planning Data Repository, at step **98** (Figure 3a) the ELEMENTARY ACTIVITY **58** is selected that produces the OUTCOME **62** (selected in step **96**) the Work Planner wishes to add to his or her PROJECT **70**.

The selected ELEMENTARY ACTIVITY **58** will be the last point, or node, in the work flow that results in the OUTCOME **62**. The last node **94** in a work flow is commonly referred to as the "terminal", or "most-downstream" node. As an example,

where denotes ELEMENTARY ACTIVITY; and

of the five ELEMENTARY ACTIVITIES shown, the one furthest downstream, i.e., in the direction indicated by the downstream arrow, is the terminal node **94**.



Procedure 2: At step **100** (Figure 3a) determine whether the ELEMENTARY ACTIVITY **58** selected in step **98** has already been included in the PROJECT **70** as a PROJECT ACTIVITY **68**. If it has been included, then at step **150** select the next desired OUTCOME **62**. If it is found, return to step **98**. If it is not found, end the process, at step **152**. If it has not already been included, insert an entry into the Node Processing Table **114** at step **102** representing the ELEMENTARY ACTIVITY **58**, as illustrated in the sample table below, and then continue.

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	12387	N	N	N

The columns in the Node Processing Table (NPT) **114** (Figures 3a, 3b) are defined as follows: "Entry Seq #" records the insertion order, or sequence, of entries (i. e., rows) in the Node Processing Table. "Node ID" records the unique identifier for an ELEMENTARY ACTIVITY **58** that participates as a node in the OUTCOME 's **62** workflow. "Grouping Indicator" indicates whether the ELEMENTARY ACTIVITY **58** is classified as a "grouping" activity. A grouping activity is one that collects, or groups, other OUTCOMEs **62**. Grouping activities are treated in a specialized way in the Outcome-Driven Work Flow Synthesis Process. "Processed Indicator" indicates whether all processing related to the node has been completed. This column is set to "N" when entries are inserted into the table, and is changed to "Y" when all processing related to the node has been completed. The column "Removal Indicator" is not used for Outcome-Driven Work Flow Synthesis. Instead, this column is used in the Outcome-Driven Work Flow Reduction process. The default value for this column is "N".

Procedure 3:. At step **104** the first entry in the Node Processing Table **114** is selected. As discussed above, this entry will identify the most downstream node **94**.

Procedure 4: Perform the following procedures 4.1 through 4.4 (Figure 3b) until all nodes have been processed:

Procedure 4.1: At step 106 (Figure 3b) a PROJECT ACTIVITY 68 record is inserted, corresponding to the ELEMENTARY ACTIVITY 58 referenced by the current node being processed, into the PROJECT 70 by performing the Activity Insertion, Positioning, and Content Linking process (described below).

Procedure 4.2: If the ELEMENTARY ACTIVITY 58 referenced by the current node being processed at step 108 (Figure 3b) is not classified as a "grouping" ELEMENTARY ACTIVITY 58 (i. e., the Grouping Indicator in the Node Processing Table ="N"), then at step 110 (Figure 3b) select its relevant upstream nodes. At step 112 (Figure 3b) insert an entry into the Node Processing Table for each relevant upstream node that is not already determined to be in the Node Processing Table 114 at step 154. For purposes of this step a "relevant upstream node " is defined as an ELEMENTARY ACTIVITY 58 that is identified as a predecessor of the ELEMENTARY ACTIVITY 58 referenced by the current node by an instance of ELEMENTARY ACTIVITY DEPENDENCY 50 where the following criteria are satisfied:

(1) If the ELEMENTARY ACTIVITY 58 corresponding to the most downstream node is within the scope of the controlling WBS (i. e., it is referenced by a WBS ACTIVITY 80 that is a component of the controlling WBS TEMPLATE 78) then the candidate predecessor must also be referenced by a WBS ACTIVITY 80 that is a component of the controlling WBS TEMPLATE 78.

This criterion ensures that PROJECT ACTIVITYs 68 included in a PROJECT 70 are limited to those that correspond to an ELEMENTARY ACTIVITY 58 that is explicitly included in the controlling WBS TEMPLATE 78 (i. e., is within the scope boundary established by the controlling WBS TEMPLATE 78).

(2) The ELEMENTARY ACTIVITY DEPENDENCY 50 identifying the candidate predecessor must not be overridden by a WBS ACTIVITY 80 for the controlling WBS TEMPLATE 78 associated with the current node, if one exists; and

(3) A PROJECT ACTIVITY 68 corresponding to the candidate predecessor must not already exist for the PROJECT 70.

Procedure 4.3: At step **116** (Figure 3b) set the Processed Indicator for the current node to "Y" in the Node Processing Table. This also pertains to grouping ELEMENTARY ACTIVITIES from step **108**.

Procedure 4.4: At **118** select the next unprocessed node in the Node Processing Table (i. e., lowest entry sequence number where the Processed Indicator ="N") - this is referred to as the "current node " in the subsequent steps. If an unprocessed node is found, repeat the processing starting back at step **106**. If no unprocessed node is found, then select the next desired outcome (step **150**, Figure 3a) and continue according to step **150**. Eventually all nodes and all outcomes will be processed and the processing will end.

Activity Insertion, Positioning, and Content Linking

When inserting a PROJECT ACTIVITY **68** into the PROJECT **70** that is within the scope of the controlling WBS TEMPLATE **78**, check if a PROJECT ACTIVITY **68** corresponding to its parent WBS ACTIVITY **80** (as defined by the controlling WBS TEMPLATE **78**) is already included in the PROJECT **70**. If so, position the PROJECT ACTIVITY **68** being inserted one level below its parent in its correct position relative to any of its siblings which are already included in the PROJECT **70**. If the parent is not currently included in the PROJECT **70**, determine all missing higher-level NON-ELEMENTARY ACTIVITYs **56** based on the PROJECT 's **70** controlling WBS TEMPLATE **78**. All missing higher-level NON-ELEMENTARY ACTIVITYs **56** must be included in the PROJECT **70** by inserting corresponding PROJECT ACTIVITY 's **68** into the PROJECT **70**, in their correct relative positions to their siblings. Once all the missing ancestry (i. e., higher-level activities)has been included in the PROJECT **70**, insert the PROJECT ACTIVITY **68** that corresponds to the ELEMENTARY ACTIVITY **58** one level below its parent in its correct relative position to any of its siblings which are already included in the PROJECT **70**. Link each PROJECT ACTIVITY **68** inserted into the PROJECT **70** to the CONTENT PAGE **74** referenced by the WBS ACTIVITY **80** in the PROJECT 's **70** controlling WBS TEMPLATE **78** that references the ACTIVITY **52** corresponding to the inserted PROJECT ACTIVITY **68**.

When inserting a PROJECT ACTIVITY **68** into the PROJECT **70** that is not within the scope of the controlling WBS TEMPLATE **78**, check if a PROJECT

ACTIVITY 68 corresponding to its parent NON-ELEMENTARY ACTIVITY 56 is already included in the PROJECT 70. If so, position the PROJECT ACTIVITY 68 being inserted one level below the PROJECT ACTIVITY 68 corresponding to its parent NON-ELEMENTARY ACTIVITY 56, as the last PROJECT ACTIVITY 68 in that parent (positioning relative to siblings will not be known).

If not, insert both the PROJECT ACTIVITY 68 corresponding to the ELEMENTARY ACTIVITY 58 and a PROJECT ACTIVITY 68 corresponding to its NON-ELEMENTARY ACTIVITY 56 parent to the end of the PROJECT's 70 WBS 78 under a top-level PROJECT ACTIVITY 68 named "Activities to be Manually Positioned".

Create a PROJECT ACTIVITY DEPENDENCY 66 to document each dependency between a PROJECT ACTIVITY 68 inserted into the PROJECT 70 and any of its predecessor and successor PROJECT ACTIVITYs 68 that have already been included in the PROJECT 70, based on any ELEMENTARY ACTIVITY DEPENDENCYs 50 related to the ELEMENTARY ACTIVITY 58 that corresponds to the PROJECT ACTIVITY 68. However, do not create a PROJECT ACTIVITY DEPENDENCY 66 to document a dependency in any case where the ELEMENTARY ACTIVITY DEPENDENCY 50 for the pairing has been overridden by a WBS ACTIVITY 80 that is a component of the PROJECT s 70 controlling WBS TEMPLATE 78.

Outcome-Driven Work Flow Reduction Process

This process is initiated when the work planner chooses to remove an OUTCOME 62 that is currently planned for his or her PROJECT 70. Once initiated, this process will remove any PROJECT ACTIVITYs 68 in the subject OUTCOME's 62 work flow that does not participate in any This process is initiated when the work planner chooses to remove an OUTCOME other planned OUTCOME's 62 work flow currently in the PROJECT 70.

Procedure 1. From the Planning Data Repository 28, at step 160 (Figure 4a) select the PROJECT ACTIVITY 68 corresponding to the ELEMENTARY ACTIVITY 58 that produces the OUTCOME 62 the work planner wishes to remove from the PROJECT 70.

The selected PROJECT ACTIVITY **68** will be the last point, or node, in the work flow that results in the OUTCOME **62** to be removed. As above, the last node **94** in a work flow is commonly referred to as the "terminal", or "most-downstream" node.

Procedure 2. At step **162** insert an entry into the Node Processing Table **114** (Figure 4a) representing the PROJECT ACTIVITY **68**, as illustrated in the sample table below, and then continue with step **164**.

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	12387	N	N	N

The columns in the Node Processing Table (NPT) **114** (Figures 3a, 3b, 4a, 4b, 4c) have already been defined, above..

Procedure 3. At step **164** (Figure 4a) select the first entry in the Node Processing Table **114**. As discussed above, this entry will identify the most downstream node **94** (above).

Procedure 4. Perform procedures 4.1 through 4.4 (Figures 4b, 4c) until all nodes have been processed.

Procedure 4.1: Set the removal Indicator in the Node Processing Table for the current node to "Y" in step **190** if one of the following is true:

(1) The ELEMENTARY ACTIVITY 58, corresponding to the PROJECT ACTIVITY **68**, at step **166**, identified by the current node, produces an OUTCOME **62**, at step **166**, which was identified at step **192**, as being selected for removal; or

(2) The ELEMENTARY ACTIVITY **58** corresponding to the PROJECT ACTIVITY **68** identified by the current node, , does not produce an OUTCOME **62** and the PROJECT ACTIVITY **58** does not have any immediate successor PROJECT ACTIVITY's **68** in the PROJECT **70** that have not been marked for removal in the Node Processing Table **114**, as determined at step 194.. This test insures that a PROJECT ACTIVITY **68** that is part of the work flow of another OUTCOME **62** currently included in the

PROJECT 70 does not get removed, as determined at step 194. If all the successors have not been marked for removal in the Node Processing Table 114, the procedure continues to step 170 (Figure 4c).

Procedure 4.2: If the ELEMENTARY ACTIVITY 58 identified by the current node being processed at step 170 (Figure 4c) is not classified as a "grouping" activity and it has been marked at step 172 (Figure 4c) for removal,. At step 174 (Figure 4c) select all of its predecessors according to the PROJECT ACTIVITY DEPENDENCYs 66 and at step 176 (Figure 4b) insert an entry into the Node Processing Table 114 for each selected predecessor that is determined, at step 178, to not already have an entry in the Node Processing Table 114

Procedure 4.3: At step 180 (Figure 4c) set the Processed Indicator for the current node to "Y" in the Node Processing Table 114.

Procedure 4.4: At step 182 select the next unprocessed node in the Node Processing Table (i.e., the lowest entry sequence number where the Processed Indicator = "N"). This is now the current node. If an unprocessed node is found at step 184, then return to step 166 (Figure 4c) and continue from that step 166.

Procedure 5: At step 186 remove each PROJECT ACTIVITY 68 corresponding to an ELEMENTARY ACTIVITY 58 that is designated for removal in the Node Processing Table from the PROJECT 70 according to the Activity Removal process. As this removal process proceeds, when removing a PROJECT ACTIVITY 68 from a PROJECT 70, check if it is the last PROJECT ACTIVITY 68 for its parent in the PROJECT's 70 WBS. If so, remove the PROJECT ACTIVITY 68 and its parent from the PROJECT 70. When removing the parent, check if it was the last child for its parent in the PROJECTs 70 WBS. If so, remove it and its parent. Continue this child/parent removal process until a parent PROJECT ACTIVITY 68 that has other children is found or the last ancestor of the current PROJECT ACTIVITY 68 has been removed from the PROJECT 70. The processing ends at step 188.

EXAMPLE 1: Outcome-Driven Work Flow Synthesis Process.

For this example, the user has selected one outcome, outcome "O3", for synthesis and has selected the exemplary WBS controlling template shown in Figure 5a as the controlling WBS for the project. The procedures identified below

correspond to the numbered procedures in the description of the Outcome-Driven Work Flow Synthesis Process, above.

Procedure1: Elementary activity EA Bl.3 produces the outcome that the user wants to add to the project (i. e., outcome O3), so elementary activity EA B1.3 is selected from the Planning System Data Repository. See Figure 5a.

Procedure 2: Since a project activity corresponding to elementary activity EA B I .3 has not already been included in the project, an entry is inserted into the Node Processing Table:

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	N	N

Procedure 3: The first entry is selected (shaded row) in the Node Processing Table.

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	N	N

Procedure 4: The results of executing procedures 4.1- 4.4 until all entries in the Node Processing Table have been processed are as follows:

Following first execution of procedure 4.1

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	N	N

Elementary activity EA B1.3 was identified as the elementary activity that produces selected outcome O3. At the conclusion of the first execution of step 4.1 the state of the Node Processing Table is shown above and the Project WBS/Work Flow is shown in Figure 5b.

Following first execution of procedure 4.2

Procedure 4.2 identified EA B1.2 as a "relevant" upstream node for the current node (EA B1.3)and inserted an entry reflecting this into the Node Processing Table (below)

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	N	N
2	EA B1.2	N	N	N

Following first execution of procedure 4.3

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	N	N

Procedure 4.3 set the value of the Processed Indicator cell in the Node Processing Table for the current node to "Y".

Following first execution of procedure 4.4

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	N	N

Procedure 4.4 selected the next unprocessed node in the Node Processing table (selected node is indicated as the shaded row in the Node Processing Table). This action caused node EA B1.2 to become the "current" node.

Following second execution of procedure 4.1

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	N	N

Procedure 4.1 caused EA B1.2 to be inserted into the Project WBS/Work Flow in its correct position according to the controlling WBS template, and to be linked to its successor, EA B1.3. See Figure 5c.

Following second execution of procedure 4.2

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	N	N
3	EA B1.1	N	N	N

Procedure 4.2 identified EA B 1.1 as a "relevant" upstream node for the current node (EA Bl. 2) and inserted an entry (Entry Sequence # 3 in the node processing table, above) reflecting this relevant identification into the Node Processing Table.

Following second execution of procedure 4.3

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	N	N

Procedure 4.3 set the value of the Processed Indicator cell in the Node Processing Table for the current node to "Y".

Following second execution of procedure 4.4

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	N	N

Procedure 4.4 selected the next unprocessed node in the Node Processing table (selected node is indicated as the shaded row in the Node Processing Table). This action caused node EA B1.1 to become the "current" node.

Processing of procedures 4.1 through 4.4 will continue in the same manner as described above until all relevant upstream nodes have been introduced into the Project WBS/Work Flow according to the Activity Insertion, Positioning, and Content Linking process This example illustrates, below, the internal states of the Node Processing Table and Project WBS/Work Flow for each remaining iteration of 4.4.

Following third execution of procedure 4.1:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	N	N

See Figure 5d for the Project WBS/Work Flow.

Following third execution of procedure 4.2:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	N	N
4	EA A2.1	N	N	N

Following third execution of procedure 4.3:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	N	N

Following third execution of procedure 4.4

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	N	N

Following fourth execution of procedure 4.1:

Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	N	N

Figure 5e shows the Project WBS/Work Flow at this point in the algorithmic process.

Following fourth execution of procedure 4.2:

Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	N	N
5	EA A1.3	N	N	N

Following fourth execution of procedure 4.3:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	N	N

Following fourth execution of procedure 4.4:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	N	N

Following fifth execution of procedure 4.1:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	N	N

Figure 5f shows the Project WBS/Work Flow at this point in the algorithmic process.

Following fifth execution of procedure 4.2:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	N	N
6	EA A1.2	N	N	N

Following fifth execution of procedure 4.3:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	N	N

Following fifth execution of procedure 4.4:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	N	N

Following sixth execution of procedure 4.1:

Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	N	N

Figure 5g shows the Project WBS/Work Flow at this point in the algorithmic process.

Following sixth execution of procedure 4.2:

Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	N	N
7	EA A1.1	N	N	N

Following sixth execution of procedure 4.3:

Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	Y	N
7	EA A1.1	N	N	N

Following sixth execution of procedure 4.4:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	Y	N
7	EA A1.1	N	N	N

Following seventh execution of procedure 4.1:

Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	Y	N
7	EA A1.1	N	N	N

Figure 5h shows the Project WBS/Work Flow at this point in the algorithmic process.

Following seventh execution of procedure 4.2:

Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	Y	N
7	EA A1.1	N	N	N

Following seventh execution of procedure 4.3:

Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	Y	N
7	EA A1.1	N	Y	N

Following seventh execution of procedure 4.4:

Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA B1.3	N	Y	N
2	EA B1.2	N	Y	N
3	EA B1.1	N	Y	N
4	EA A2.1	N	Y	N
5	EA A1.3	N	Y	N
6	EA A1.2	N	Y	N
7	EA A1.1	N	Y	N

Procedure 4.4 detected no remaining unprocessed nodes in the Node Processing Table. This condition causes the termination of synthetic processing.

EXAMPLE 2 of the Outcome-Driven Work Flow Synthesis Process

In this example, after having selected outcome O3 and seeing the results in the Project WBS/Work Flow from EXAMPLE 1, above, the user decides to add Outcome O4. This illustrates how to synthesize an additional outcome into an existing Project WBS/Work Flow. It also shows the special processing associated with an Elementary Activity classified as a "grouping" activity. The notation follows that of EXAMPLE 1, above. Figure 6a provides an exemplary Project WBS and work scope of the controlling WBS used for this example.

Procedure 1

Elementary activity EA C 1.3 produces the outcome that the user (work planner) wants to add to the project (i. e., Outcome O4), so it is selected from the Planning System Data Repository **28** (Figure 1).

Procedure 2

Since a project activity corresponding to elementary activity EA C 1.3 has not already been included in the project, an entry is inserted into the Node Processing Table as follows:

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	N	N

Procedure 3

The first entry is selected in the Node Processing Table. This is illustrated by the shading the entry in the exemplary Node Processing Table as follows:

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	N	N

Procedure 4

The results of executing procedures 4.1 -4.4 until all entries in the Node Processing Table have been processed are as follows:

Following first execution of procedure 4.1

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	N	N

Elementary activity EA C1.3 was identified as the elementary activity that produces the selected outcome O4. At the conclusion of the first execution of procedure 4.1 the state of the Node Processing Table and Project WBS/Work Flow is as shown above and on Figure 6b.

Following first execution of procedure 4.2

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	N	N
2	EA C1.2	N	N	N

Procedure 4.2 identified EA C1.2 as a "relevant" upstream node for the current node (EA C1.3) and inserted an entry reflecting this into the Node Processing Table.

Following first execution of procedure 4.3

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	Y	N
2	EA C1.2	N	N	N

Procedure 4.3 set the value of the Processed Indicator cell in Node Processing Table for the current node to "Y".

Following first execution of procedure 4.4

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	Y	N
2	EA C1.2	N	N	N

Procedure 4.4 selected the next unprocessed node in the Node Processing Table (selected node is indicated as the shaded row in the Node Processing Table). This action caused node EA C1.2 to become the "current" node.

Following second execution of procedure 4.1

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	Y	N
2	EA C1.2	N	N	N

Procedure 4.1 caused EA Cl. 2 to be inserted into the Project WBS/Work Flow in its correct position according to the Controlling WBS TEMPLATE, and to be linked to its successor, EA C1.3. Since none of EA C1.3's predecessors are present in the Project WBS/Work Flow, it could not be linked to its predecessors at this Point. See Figure 6c.

Following second execution of procedure 4.2

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	Y	N
2	EA C1.2	N	N	N
3	EA C1.1	Y	N	N

Procedure 4.2 identified EA C1.1 as a "relevant" upstream node for current node (EA C1.2) and inserted an entry reflecting this into the Node Processing Table.

Following second execution of procedure 4.3

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	Y	N
2	EA C1.2	N	Y	N
3	EA C1.1	Y	N	N

Procedure 4.3 set the value of the Processed Indicator cell in the Node Processing Table for the current node to "Y".

Following second execution of procedure 4.4

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	Y	N
2	EA C1.2	N	Y	N
3	EA C1.1	Y	N	N

Procedure 4.4 selected the next unprocessed node in the Node Processing table (selected node is indicated as the shaded row in the Node Processing Table). This action caused node EA C 1.1 to become the "current" node.

Following third execution of procedure 4.1

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	Y	N
2	EA C1.2	N	Y	N
3	EA C1.1	Y	N	N

Procedure 4.1 caused EA C1.1 to be inserted into the Project/WBS Work Flow in its correct position according to the Controlling WBS Template, and to be linked to its successor, EA C1.2 and to its predecessor, EA B1.3. See Figure 6

Following third execution of procedure 4.2

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA Cl.3	N	Y	N
2	EA Cl.2	N	Y	N
3	EA Cl.1	Y	N	N

Procedure 4.2 detected that EA Cl.1 was a "Grouping" activity and, as a result, did not attempt identification of relevant upstream nodes. No entries were inserted into the Node Processing Table and EA Cl.1 remains the current node

Following third execution of procedure 4.3

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA Cl.3	N	Y	N
2	EA Cl.2	N	Y	N
3	EA Cl.1	Y	Y	N

Procedure 4.3 set the value of the Processed Indicator cell in Node Processing Table for the current node to "Y".

Following third execution of procedure 4.4

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA C1.3	N	Y	N
2	EA C1.2	N	Y	N
3	EA C1.1	Y	Y	N

Procedure 4.4 detected no remaining unprocessed nodes in the Node Processing Table. This condition causes the termination of synthesis processing.

EXAMPLE 3: Outcome-Driven Work Flow Reduction Process

Procedure 1

Project activity EA A2.5 produces the outcome that the user (work planner) wishes to remove from the project (i.e., O2), so it is selected from the Planning System Data Repository.

Procedure 2

An entry is inserted into the Node Processing Table as follows:

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	N	N

Procedure 3

The first entry is selected in the Node Processing Table (shaded).

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	N	N

Procedure 4

Procedures 4.1 through 4.4 are executed until all entries in the Node Processing Table have been processed.

Following first execution of procedure 4.1

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	N	Y

Project activity EA A2.5 was identified as the activity that produces selected outcome O2. At the conclusion of the first execution of procedure 4.1 the state of the Node Processing Table is as shown.

Procedure 4.1 set the Removal Indicator for the current node to "Y" because the project activity identified by the current node produces the outcome selected for removal.

Following first execution of procedure 4.2

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	N	Y
2	EA A2.4	N	N	N

Procedure 4.2 identified EA A2.4 as a predecessor to the current node (EA A2.5) according to the project activity dependencies, and inserted an entry reflecting this into the Node Processing Table

Following first execution of procedure 4.3

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	N	N

Procedure 4.3 set the value of the Processed Indicator of the current node in the Node Processing Table to "Y".

Following first execution of procedure 4.4

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	N	N

Procedure 4.4 selected the next unprocessed node in the Node Processing Table (selected node is indicated as the shaded row in the Node Processing Table). This action caused the node EA A2.4 to become the "current" node.

Following second execution of procedure 4.1

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	N	Y

Procedure 4.1 set the Removal Indicator for the current node to "Y" because the project activity identified by the current node does not produce an outcome and does not have any immediate successors in the Project WBS/Work Flow that have not been marked for removal in the Node Processing Table (EA A2.5 is its only successor and EA A2.5 has been marked for removal in the Node Processing Table).

Following second execution of procedure 4.2

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	N	Y
3	EA A2.3	N	N	N

Procedure 4.2 identified EA A2.3 as a predecessor to the current node (EA A2.4) according to Project Activity Dependencies, and inserted an entry reflecting this into the Node Processing Table.

Following second execution of procedure 4.3

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	N	N

Procedure 4.3 set the value of the Processed Indicator of the current node in the Node Processing Table to "Y".

Following second execution of procedure 4.4

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	N	N

Procedure 4.4 selected the next unprocessed node in the Node Processing Table (shaded row). Thus EA A2.3 becomes the current node.

Following third execution of procedure 4.1

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	N	Y

Procedure 4.1 sets the Removal Indictor to "Y" because the project activity identified by the current node does not produce an outcome. It does not have any immediate successors in the Project WBS/Work Flow that have not been marked for removal in the Node Processing table. EA A2.4 is its only successor and it has already been marked for removal.

Following third execution of procedure 4.2

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	N	Y
4	EA A1.3	N	N	N

Procedure 4.2 identified EA A1.3 as a predecessor to the current node (EA A2.3) according to the project activity dependencies and therefore inserted an entry into the Node Processing Table.

Following third execution of procedure 4.3

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	Y	Y
4	EA A1.3	N	N	N

Procedure 4.3 set the value of the Processed Indicator for the current node being processed to "Y".

Following third execution of procedure 4.4

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	Y	Y
4	EA A1.3	N	N	N

Procedure 4.4 selected the next unprocessed node (shaded) so that EA A1.3 is the current node.

Following fourth execution of procedure 4.1

Sample Node Processing Table - 114

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	Y	Y
4	EA A1.3	N	N	N

Procedure 4.1 does not set the Removal Indicator for the current mode to "Y" because the project activity identified by the current mode has immediate successors in the Project WBS/Work Flows that have not been marked for removal in the Node Processing Table (i.e., EA A2.1 and EA A2.2).

Following fourth execution of procedure 4.2

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	Y	Y
4	EA A1.3	N	N	N

Procedure 4.2 does not insert entries into the Node Removal Table for EA A1.3's predecessors because EA A1.3 has not been marked for removal.

Following fourth execution of procedure 4.3

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	Y	Y
4	EA A1.3	N	Y	N

Procedure 4.3 set the value of the Processed Indicator for the current node in the Node Processing Table to "Y".

Following fourth execution of procedure 4.4

Sample Node Processing Table - **114**

Entry Seq. #	Node ID	Grouping Indicator	Processed Indicator	Removal Indicator
1	EA A2.5	N	Y	Y
2	EA A2.4	N	Y	Y
3	EA A2.3	N	Y	Y
4	EA A1.3	N	Y	N

Procedure 4.4 detected no remaining unprocessed nodes in the Node Processing Table. This condition causes the termination of procedure 4's iteration. Processing proceeds with procedure 5 which is the deletion of nodes marked for removal. See Figure 7b.

Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

CLAIMS

WHAT IS CLAIMED IS:

1. A process for generating a project work breakdown structure (WBS) and related work flows, comprising the steps of:

(a) selecting an existing project WBS, said existing project WBS having related work flows;

(b) selecting at least one desired outcome for synthesis, said at least one selected desired outcome having a first associated work flow comprising a network of interdependent activities; and

(c) synthesizing said first associated work flow with said existing project WBS and its related work flows by:

(c_1) identifying the most downstream activity in said first associated work flow;

(c_2) determining whether each activity in said first associated work flow is already present in the project WBS and related work flows being generated by starting with the most downstream activity in said first associated work flow and working upstream until all activities in said first associated work flow have been compared to the activities of the project WBS and related work flows being generated;

(c_3) adding any activity in said first associated work flow which is not already present in the project WBS and related work flows being generated;

(c_4) adding activity dependencies which should exist between any of said added activities and any activity already present in the project WBS and related work flows being generated; and

(c_5) introducing summary activities, when required, into the project WBS being generated when lowest-level activities from said first associated work flow are added.

2. The process of claim 1, further comprising the steps of:

(d) selecting at least one undesired outcome for de-synthesis, said at least one selected undesired outcome having a second associated work flow comprising a network of interdependent activities; and

(e) de-synthesizing said second associated work flow from the project WBS and related work flows being generated by:

(e_1) identifying the most downstream activity in said second associated work flow;

(e_2) determining whether each activity in said second associated work flow is also part of the work flows associated with desired outcomes which are already present in the project WBS and related work flows being generated by starting with the most downstream activity in said second associated work flow and working upstream until all activities in said second associated work flow have been evaluated;

(e_3) removing any activity and activity dependency which are not needed as part of the work flows associated with the remaining desired outcomes for the project WBS and related work flows being generated; and

(e_4) removing summary activities, as appropriate, from the project WBS being generated as lowest-level activities from said second associated work flow are being removed.

3. A process for generating a project work breakdown structure (WBS) and related work flows representing the minimal work to produce at least one desired outcome, said process comprising the steps of:

(a) viewing a set of available WBS templates;

(b) viewing a set of outcomes within and outside the scope of each WBS template from said set of available WBS templates;

(c) selecting a controlling WBS template from said set of available WBS templates for a project WBS;

(d) selecting at least one desired outcome from said set of outcomes for synthesis, said at least one selected desired outcome having a first associated work flow;

(e) synthesizing said first associated work flow with the project WBS according to said selected controlling WBS template;

(f) viewing the project WBS and related work flows being generated; and

(g)linking each activity of the project WBS being generated with appropriate instructional content

4. A system for generating a project work breakdown structure (WBS) and related work flows comprising:

(a) means for accepting as input an existing project WBS and at least one desired outcome, said existing project WBS having related work flows;

(b) means for storing said existing project WBS and related work flows;

(c) means for storing a set of activities associated with a set of pre-defined WBS templates;

(d) means for identifying lowest level activities and their interdependencies from said stored set of activities necessary to produce said at least one desired outcome, said identified lowest level activities and interdependencies defining an associated work flow; and

(e) means for synthesizing said associated work flow and appropriate summary activities with said existing project WBS and its related work flows.

5. The system of claim 4, further comprising means for linking instructional content with each activity.

6. The system of claim 5, further comprising means for viewing outcomes of a generated project WBS and related work flows.

7. The process of claim 3, further comprising the step of selecting at least one undesired outcome from said set of outcomes for de-synthesis after step (f), said at least one selected undesired outcome having a second associated work flow.

8. The process of claim 7, further comprising the step of de-synthesizing said second associated work flow from the project WBS and related work flows being generated by referencing said selected controlling WBS template.

9. A process for generating a project work breakdown structure (WBS) and related work flows, comprising the steps of:

(a) selecting a controlling WBS template for a project WBS;

(b) selecting at least one desired outcome for synthesis, said at least one selected desired outcome having a first associated work flow comprising a network of interdependent activities; and

(c) synthesizing said first associated work flow with the project WBS and related work flows being generated according to said selected controlling WBS template by:

(c_1) identifying the most downstream activity in said first associated work flow,

(c_2) determining whether each activity in said first associated work flow is already present in the project WBS and related work flows being generated by starting with the most downstream activity in said first associated work flow and working upstream until all activities in said first associated work flow have been compared to the activities of the project WBS and related work flows being generated; (c_3) adding any activity in said first associated work flow which is not already present in the project WBS and related work flows being generated;

(c_4) adding any activity dependency which should exist between any of said added activities and any activity already present in the project WBS and related work flows being generated; and

(c_5) introducing summary activities, as appropriate, into the project WBS being generated when lowest-level activities from said first associated work flow are added.

10. The process of claim 9, further comprising the steps of:

(d) selecting at least one undesired outcome for de-synthesis, said at least one selected undesired outcome having a second associated work flow comprising a network of
interdependent activities; and

(e) de-synthesizing said second associated work flow from the project WBS and related work flows being generated by:

(e_1) identifying the most downstream activity in said second associated work flow;

(e_2) determining whether each activity in said second associated work flow is also part of the work flows associated with desired outcomes which are already present in the project WBS and related work flows being generated by starting with the most downstream activity in said second associated work flow and working upstream until all activities in said second associated work flow have been evaluated;

(e_3) removing any activity and activity dependency which are not needed as part of the work flows associated with the remaining desired outcomes for the project WBS and related work flows being generated; and

(e_4) removing summary activities, as appropriate, from the project WBS being generated by referencing said selected controlling WBS template as lowest-level activities from said second associated work flow are being removed.

11. A system for generating a project work breakdown structure (WBS) and related work flows comprising:

(a) means for accepting as input a controlling WBS template for a project WBS and at least one desired outcome;

(b) means for storing said controlling WBS template;

(c) means for storing a set of activities associated with a set of pre-defined WBS templates;

(d) means for identifying lowest level activities and their interdependencies from said stored set of activities necessary to produce said at least one desired outcome, said identified

lowest level activities and interdependencies defining an associated work flow; and

(e) means for synthesizing said associated work flow and appropriate summary activities with the project WBS and related work flows being generated according to said controlling WBS template.

12. The system of claim 11, further comprising means for linking instructional content with each activity.

13. The system of claim 12, further comprising means for viewing outcomes of a generated project WBS and related work flows.

ABSTRACT OF THE DISCLOSURE

A process and system is disclosed to assist work planners by assembling a work breakdown structure (WBS) and work flow for a project based on the explicit selection or deselection of outcome(s) by a work planner from a defined set of possible outcomes. The process and system ensure that the resulting project WBS and work flow is composed of the minimum set of activities required to produce the set of outcomes desired for the project. The process and system further ensure that the project's activities are organized into an activity hierarchy defined by a WBS template designated by the work planner, and that each of the project's activities is linked into an appropriate work flow, supported by appropriate instructional or descriptive content.