

**Work and Resource Breakdown Structures
for Formalized Bottom-Up Estimating**

By

Parviz F. Rad

and

Denis F. Cioffi

Project Management Program

Department of Management Science

The George Washington University, Washington, D.C.

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0. Abstract

This paper introduces the concept of a Resource Breakdown Structure. Analogous to the traditional Work Breakdown Structure, the RBS lists, in a methodical fashion, the resources, with their specific cost rates, that are available for the projects contemplated within an organization. Because proper utilization of the RBS requires precision and standardization in terms of units and dimensions, we review the basic nomenclature and present an example. When combined with a deliverable-oriented WBS, an up-to-date RBS greatly facilitates both initial project planning and the inevitable iterations on the original plans. In particular, the RBS enables simple but accurate calculations of the project's costs at the various levels of the WBS and as a function of essentially any variable that the project manager desires. It is a simple but valuable tool.

1. Introduction: Breakdown Structures

This paper is not so much a research paper as a practice paper. That is, based on a combination of practical experience and academic study, we recommend a best practice: the creation and utilization of a Resource Breakdown Structure. We know of few organizations that follow this method, but in those that do, even to a limited extent, project managers can plan with greater assurance of resource reliability. By reliability we mean that the project manager can depend on the reality of a resource's at-hand existence and its estimated cost.

This practice falls at the interface between general management and project management. The project manager will use the RBS prepared previously by those charged with accounting for the organization's resources. To use it well, the RBS must be kept up to date. Its resource contents and their costs must be accurate. As we explain in the remainder of this paper, the RBS has its analog in the well-known work breakdown structure.

Managers have a long history of dividing anticipated project work into smaller and smaller parcels and presenting the resulting schema graphically. This "breaking down" of the work facilitates better management in many ways. Similarly, in-house resources should be examined in a methodical manner, at the earliest opportunity, through the creation of the RBS. This structure will greatly facilitate the resource assignments and scheduling in projects that follow.

At some point early in the planning stage, the project manager should be provided with a detailed listing of the resources available for the project, including whatever project-specific resources the manager might obtain from outside the organization. By "resources" we mean

everything that will cost money to obtain and is necessary for the completion of the project, e.g., labor, equipment, licenses, taxes, and so forth.

If this initial resource estimate is prepared correctly, the cost of each component can be understood easily. Equally important, the continual improvements that this estimate must undergo can proceed formally. The estimate will be easy to review and improve as more information becomes available. Then, as the almost inevitable changes of scope occur, further modifications to the estimate can be made formally and clearly. They can thus be justified and defended.

1a. Nomenclature, Dimensions, and Units

To maintain a consistent nomenclature (and at the risk of being considered pedantic), we pause briefly here to review the relevant concepts. The word "rate" carries its usual meaning of some quantity measured per unit time, e.g., a worker's cost rate could be measured in dollars per hour. If we need to discuss the expense of singular items, e.g., cans of paint, the cost is not a rate but simply so many dollars per can; the unit may be called "each."

"Effort" equals the product of workers and time, measured then in worker-hours, worker-days, worker-months, or worker-years. At any given point in the project, the effort divided by the

appropriate unit of time gives the number of workers, e.g., if a project requires an effort of 100 worker-years, completion over a year's duration would require 100 workers, but to be completed in six months (i.e., 0.5 years) 200 workers would be needed. We imply this "instantaneous" worker need when we discuss a project task's "intensity."

Because workers are paid, effort can be viewed as equivalent to cost. Units must be retained in such arithmetic, whether explicitly or implicitly, so the translation from effort to cost occurs through the cost rate per worker, e.g., worker-hours times dollars per hour per worker yields dollars (see Figures 1 and 2 for fanciful illustrations of these calculations).

One makes "estimates" through this conversion. That is, if in shorthand notation one speaks of estimating an element of the WBS, ultimately the cost is desired, but in the first, sometimes hidden (or skipped!) step, one must estimate the effort.

We need clarity about the terminology because this paper explains how to use the RBS in conjunction with the work breakdown structure to determine the total project cost by estimating the costs of all elements at the lowest levels of the WBS; the work follows Rad (7). We begin in the next section by describing in detail a proper work breakdown structure.

2. Work Breakdown Structure

A good WBS simplifies the project by dividing the effort into manageable pieces. (Figure 3 shows the common format, and Figure 4 gives an example.) It encourages systematic planning and reduces the possibility of omitting key project elements. A good WBS provides a common

framework for all project deliverables and for specific tasks within the project. It therefore smooths communication among those implementing the project, which in turn improves the integration of project plans for time, resources, and quality; a good WBS ultimately produces better schedules and better cost estimates. In short, a good WBS anchors a project's plans and improves planning, estimating, monitoring, and controlling.

The WBS provides a roadmap for all facets of the project, including:

- U Work Definition
- U Cost Estimates and Expenditures
- U Time Estimates and Scheduling
- U Resource Allocation and Budgeting
- U Project Plan Changes
- U Performance and Productivity

To achieve the desired consistency in the WBS, in any branch of the hierarchy, the transition from one level to the next level must follow similar criteria. That is, the characteristics that differentiate "parents" at one level from their "children" at the next lower level should be similar — if not identical — throughout the structure. Ultimately one wishes to create a WBS that highlights a logical organization of products, parts, or modules (or whatever the various project components are termed at the different levels) associated with each element of the WBS.

As project plans develop, not only can whole WBS summaries of resources be created, but departmental and divisional summaries can also be made for each WBS item. These summaries

use the relationship between the RBS and the WBS to make resource use explicit (what, where, and in what quantity), and so can improve resource forecasting, personnel projections, priority definitions, and good management in general.

2a. WBS Development

The entire project sits at the top level of the WBS, which we will refer to as level zero.

Developing a WBS involves subdividing the project into three to nine deliverable elements at the next level, level one (the basis of the division is addressed below). Then each of the level one items will be divided into three to nine level two items, and each of the level two items will be divided into three to nine level three items, and so on. The WBS should emphasize real deliverables --- e.g., “approval” requires a signature on a deliverable piece of paper --- and as we noted previously, at each juncture the basis of the division should be similar, if not identical, for all children at a given level.

This process of dividing the deliverable items continues until the planners have divided the project into discrete, manageable items that require relatively simple tasks to complete. This point may vary from company to company and among project managers within the same company.

The company's operational philosophy and the size of the project also influence the degree of detail in the WBS, but the specific contents at each level are determined by the nature of the deliverables involved. Ideally, one would maintain a reasonable consistency in the details at the lowest-level elements. Not all branches need go to the same level, but the lowest-level items in

the project should possess similar significance.. Therefore, depending on the type of project, some branches may go to level two, some to level three, and some to level five or greater.

2b. Division Bases

Any given project can be subdivided from various perspectives that often reflect the different mind-sets of different managers. For example, the transition from each level in a WBS to the next level may be oriented around schedules or resources, but we argue strongly that the most useful (and admittedly the most difficult) WBS will use deliverables as the breakdown basis. Nevertheless, in the interest of completeness, in the list below we follow it with two other techniques.

A) Deliverable Basis: Product, Functional System, Physical Area

B) Schedule Basis: Task or Activity, Sequential

C) Resource Basis: Discipline, Administrative Unit, Budget Account

The so-called product basis refers to those cases where the project is divided into distinct components that ultimately come together to create the project, such as hardware, software, a physical structure, a concrete foundation, a steel roof.

A functional basis references the functional systems that are usually interwoven through the product and provide the infrastructure for the project deliverable. Examples of functional systems include the electrical system, the mechanical system, or the skeleton of a building.

The physical-area basis highlights the geographical or physical locations of the deliverable, e.g., south side, north side, top floor, or entrance.

A task or activity basis refers to actions taken by project team members in executing the project, such as coding, excavating, pouring, forming, polishing, programming, testing, and so forth. A sequential basis reflects the order in which activities are performed, such as Phase I, Phase II, Phase III. The sequence is often dictated by administrative constraints and can be arbitrary.

Using these two latter bases is akin to importing the project schedule into the WBS. We contend that managers should not use the schedule to develop the WBS, but instead should use the WBS to develop the schedule.

A discipline basis follows job classification, degree classification, or classifications of the skills of employees. Examples of personnel subdivided on a discipline basis are chemists, programmers, test technicians, engineers, and so forth.

An administrative-unit basis puts organizational elements into the WBS and indicates the administrative or organizational division lines. Examples of administrative-unit basis items are work done by employees of division A, division B, or the contract office.

The budget-account basis infuses the RBS into the WBS and follows the organization's financial structure, with items such as activities paid by Federal funds, state funds, charge account A, or fiscal account B. Again, the authors contend that funding procedures should not influence the fundamental nature of project plans, and the WBS should be used to develop the costs and resource assignments, not the other way around.

These orientations can certainly overlap in definition and usage. One person might divide a project on the basis of product, and depending on the type of project, another might view the division as having occurred on the basis of physical location. For example, a given wall inside some physical structure might be viewed as being at a particular place (location) or fulfilling a deliverable requirement (a product). Despite this different perspective, a deliverable basis presents much less opportunity for confusion because all understand the actual object being considered: in this case, a wall.

This common understanding also encourages communication and forecasting in earned-value types of calculations. Consider the following hypothetical example. Tasks A1 (a subset of deliverable A1) have just been completed in 109 percent of their estimated time, using 82 percent of their estimated resources. The essentially identical tasks A2 are scheduled for later in the project. Assume that learning and experience curves do not apply and that cost expenditures vary uniformly and linearly with progress. The estimate for A2 must be modified to reflect an 18 percent decrease in resource use with a 9 percent increase in time, which combine to change (presumably) the cost estimate in some way. This calculation rests on the clear identification of the tasks as “essentially identical,” with similar elemental representations on a consistent, well-defined WBS. With a deliverable basis, the tasks are tied to a particular object, allowing much less variation than when assigned independently of that object.

Finally, we end this section by considering a possible resource-related correction to the WBS. As a base of reference for scheduling the project, the duration of any element is the longest duration of the resources required for it. If some of the resources for a WBS element need to be applied serially, then it is generally more advisable to divide this element into several serial

elements. The rule here is, then, that within a given element, resources may be used in parallel, but not serially.

3. Resource Breakdown Structure

An RBS classifies and catalogs the resources needed to accomplish project objectives. As the Work Breakdown Structure does for the deliverable elements of a project, the Resource Breakdown Structure provides a consistent framework for dividing the resources into small units for planning, estimating, and managing. (Again we present a fanciful representation, Figure 5, and a numerical one, Figure 6. Figure 6 corresponds to the WBS of Figure 4.) In many ways, therefore, the RBS is analogous to the WBS and claims similar advantages in improving communication, integration, planning, and estimating; monitoring and controlling will be addressed in a subsequent paper.

An RBS differs from other human resource or budgeting classification methods because it applies directly to project management, not to, for example, cost accounting or personnel evaluations. Rather than developing a new RBS for each project, the organization can develop various RBSs for families of projects. As managers plan each new project, they select only those portions of the common RBS that apply to the project. Here the WBS and the RBS work together: mapping a project's WBS onto the family RBS then links project activities with specific available resources.

3a. RBS Development

We reiterate that one does not plan a project while developing the RBS. Instead, the RBS tabulates the resources available to projects of a certain type. Developing the RBS starts with dividing the pool of resources into entities specific enough so that one can use this structure as a shopping catalog for resources necessary to accomplish project activities developed in the WBS.

As with the WBS, developing an RBS involves grouping all resources into between say, three and nine categories in level one. Then each of the level one items is subdivided, and so forth, as we described above for the WBS. Consistency in the division bases again remains a crucial component of the structure. Ideally, the rationale that divides one level from the next should be consistent across all children, but at a minimum the division basis at any juncture must be the same for all children of the same parent.

Again one maintains a reasonable consistency in the degree of detail of the lowest-level elements. Here the nature of the resource pool and its administrative environment determine the depths of the levels.

Again as in the WBS, the division process continues until one has identified discrete, manageable resource items. A useful guide here is to keep dividing the project until the lowest level items reflect the resource details that interest the estimators and schedulers. Again, this level of detail varies among companies and project managers.

The RBS contains both the unit of measurement for each resource explicitly (e.g., foot, pound, cubic yard, equipment-hour, labor-hour) and the cost of a single unit of the resource (e.g., \$10,000 per equipment-hour). Items that get used entirely in a project can be measured as "each," for example installed motors, doors, computers, hard disks, and so forth. The RBS may

list either direct costs or total costs, i.e., including overhead, but all resource costs should be measured identically, with or without overhead.

To remind us of the importance of this consistency in the measurement units (and many other consistencies), we have the example of the Mars Climate Orbiter, which failed in September 1999 because one navigating group worked in English units and the other in Metric units (3). Moreover, we suggest a tighter consistency than this minimum requirement of working in the same system. For example, the measurement for all time-related elements can be one of hours, days, months, or years, but the chosen unit should appear in all appropriate quantities (unless the numbers become unreasonably large or small). The same statement can be made about all other dimensions and combinations of dimensions involved in the project, e.g., length (inches, feet, yards, centimeters, meters, kilometers) or volume (gallons, cubic yards, cubic centimeters, cubic meters).

Limited resources may be indicated as part of the RBS. For example, one would mention that 14 civil engineers are available for a new project; or 2 cranes; or 35 brick layers; or 4 programmers; or 3 photographers; and so forth. On the other hand, for high-priority projects some resources may be limitless. The project environment may be such that it would allow, for example, as many CAD operators as demanded by the project; or contract officers; or safety engineers; and so forth. As with the WBS, the RBS can be presented graphically, in a tabular fashion, or using indented text.

3b. The Primary Division Basis

The best (though not necessarily the only) lines of demarcation among the elements at the first level of the Resource Breakdown Structure are

- U People (Labor)
- U Tools, Machinery
- U Materials and Installed Equipment
- U Fees, Licenses

The labor category is often referred to as human resources. It includes, for example, skill categories, professional disciplines, and work functions. All possible human resources should be listed here, regardless of their physical location, administrative attachment, or contractual circumstances.

Tools and machinery are those physical items needed by project team members to perform their duties successfully. When the project ends, the project team will remove the tools and machinery from the project environment. Examples of items in this category are testing equipment, hand tools, equipment to install project deliverables, and computers to monitor and evaluate the installation process. These items are usually leased or rented. Purchasing this type of item can be more cost effective for lengthy projects, but these items will still be removed from the project site.

When tools and machinery are rented or leased, the leasing agency sometimes rolls the wages of the operator into the rental fee of the equipment. This practice blurs the line between the human

and physical resources. For planning and cost estimating, however, some organizations treat the operators as an integral part of the physical equipment.

Installed equipment and materials are purchased for the project and ultimately installed, integrated, and embedded in the project deliverables. Examples include fiber-optic cables, furniture, tape drives, monitoring equipment, pumps, ducts, and computers.

Fees and licenses refer to those cost items that do not involve any implementation or installation but are required for the execution of the project. Examples include insurance policies, bond agreements, permit fees, license charges, and taxes.

Complications arise when the client provides some combination of equipment, funding, and personnel. Although in such cases the detailed solution varies depending on the nature of the project and the priorities of the organizations involved, the most general approach still lists all of necessary project resources in the RBS regardless of how they will be funded. Once the total project cost estimate is prepared, the client-furnished equipment and labor costs can be subtracted from the resources requested by the project manager or the contractor.

From our perspective, money is not a resource in this breakdown structure. Money represents the primary means by which resources are provided. To illustrate the validity of this concept, consider that for internal projects, money is often not the exchange medium. Although resources such as worker hours or equipment may then be granted directly, the project manager should still perceive them as resources to be husbanded.

After the mapping of the WBS onto the RBS, which is represented schematically in Figure 7, the money necessary for the project can be estimated through the sum of the products of two numbers, the resource quantities demanded by the WBS and the corresponding RBS unit costs. That is, for each element at the lowest level of the WBS, one multiplies the desired quantity of the resource by its cost per unit of appropriate measure to yield cost. Because one often considers the multiplication implicitly, the sum of the resource estimates from the WBS is equivalent to the total cost estimate.

3c. Lower-level Division Bases, with a Concentration on Human Resources

One can categorize equipment, supplies, tools, and material by size, function, cost, or technical area. Fees can be divided by type or by cost. Aside from the above general guidelines, equipment, materials, and fees are highly discipline dependent and must be dealt with on a project-by-project basis. The categorization of people deserves a bit of amplification, however, because it is common to all projects, and because people are the most important resource in any project.

Ideally, the project manager plans, estimates, and manages all tasks and resources independent of where the resources reside, administratively or physically. But if a human resource item is part of an outside organization that the project manager intends to hire for a individual task, then that task and its associated resources should not be regarded as part of the project at hand. If the project manager does not manage a certain resource, he has no major influence in the use of the resource; aptly named, the resource and the resulting product are "outsourced."

The level of detail with which a human resource is defined in an RBS naturally depends on the organization, the project, and to some extent on the individual project manager. But with that obvious caveat stated, we now consider further the transition from one human-resource RBS level to the next, which should occur on one of the following bases:

1. Administrative Unit
2. Physical Location
3. Credential (in a particular discipline)
4. Work Function
5. Position Title
6. Skill Level

Managers sometimes divide human resources on the basis of their administrative affiliations, such as company A, Contractor X, or Organization D.

In other cases one might prefer to catalog the resources into groups based on physical location, especially as it relates to proximity to the project site, e.g., human resources from Los Angeles, Boston, Southern Plants, or Western Contractors.

The credential-discipline basis is used when people need to be identified with their degree specializations, their certifications, or by other recognized credentials. Examples of these divisions are: those with a degree in chemistry, those who hold a professional engineer's license, those who hold a CPA certification, or those with Master's degrees.

A work function basis is used when, independent of the credentials people hold, managers must know workers' functions. Examples of such divisions are programmers, test technicians, supervisors, team leaders, equipment operators, designers, estimators, project control specialists, and so forth.

Position title basis is required when, independent of credentials or job functions, people's places in the organizational hierarchy determine their duties in the project. Examples of such divisions are contract officers, program directors, department chiefs, divisional VPs, and so forth.

When it is appropriate to classify project personnel by their degree of effectiveness and skill, project managers can use the skill basis, e.g., expert, skilled, and semi-skilled.

Again we suggest maintaining a reasonable level of consistency in grouping the resources. For example, whether labor items are categorized by degree, job title, or job function, the categorization should be consistent across all labor items at that level of the RBS.

4. Estimating Costs

We now demonstrate the power of these tools, working in tandem; the diagram shown as Figure 7 captures the essentials of the process and can be used as a guide. We begin at the lowest level of the WBS, which we denote Level N. Here we calculate the cost of each element by multiplying the quantity of resources required by its unit cost, which is obtained from the RBS (Figures 5 and 6). But we do not hide the details: the category of the resource, its intensity, and its duration. For example, if a project needs three brick layers for four days to build a wall, then

the category is Brick-Layer, the intensity is 3 workers, the duration is 4 days, and the effort is 12 worker-days. At a unit cost of \$300 per worker per day, the cost is \$3600.

One could find the total cost of the project by adding all these costs together, but so many numbers are somewhat unwieldy, and such a calculation hides the additional information that will subsequently be obtained easily. In the next step, one moves up a level to determine --- now by simple addition --- the total quantity of resources necessary for all elements at level N-1, grouped by resource-category. The process repeats, proceeding from bottom to top, until each element of the WBS shows the total resources it requires, grouped by resource category. We end at level zero, having now estimated the project's total resource expenditure as well the costs of all subunits defined in the WBS.

As in any method of estimating, one must check the estimate against experiential data and the subjective knowledge of management professionals. The first key question to ask at this point is: Is the estimate for the total cost of the project reasonable? Poor overall estimates often result from inadvertent omissions in the WBS and the RBS. Therefore, correction primarily comprises filling the holes of the WBS. Correction may also include improving elemental estimates at the lowest levels, but one should not change an elemental estimate arbitrarily from what one believes is the best estimate. Further, one should not change the estimate values for those items above Level N, i.e., those items that are parents of lower-level items. Remember that all parents' estimates are derived from sums of lower-level estimates, not from direct input.

Project planning should evolve continually. As more information becomes available, the WBS, the estimates, and the schedule must be updated and (one hopes) refined. Ideally, these enhancements should be conducted frequently rather than only for specific administrative

milestones and budget deadlines. At every update opportunity, the enhanced WBS (and if necessary, an enhanced RBS) should be used to refine the elemental estimates.

Using a good WBS with an accurate RBS, one can ask detailed cost and resource questions about the project, such as: What is the total number of worker-hours needed for module A? How many worker-hours of chemists do we need for modules A, B, and C?

When these tools are combined with good temporal estimates to produce a valid schedule, one can then ask questions that involve detailed time and resource issues together, such as:

- U How many programmers do we need across the entire project in July? How many engineers do we need for module C during July?
- U Would the demand for client-side programmers be reduced next July if we postpone module B by three months?
- U How many more analysts would we need next February if the scope of module D is doubled?
- U How would doubling the scope of module G affect project cost, schedule, and resource requirements?
- U If Module F were to be delayed six months, what would the resulting cost and schedule look like?

5. Conclusion

Among other factors, project success depends on clear planning, good communication, and regular updating. In this paper we have focused on the importance of well-defined, accurate, consistent, and complete work and resource breakdown structures. With these two planning tools, a manager can make a systematic and accurate estimate of the project's required resources — and therefore its cost.

Once deliverable-oriented WBS elements have been developed for a project, producing a cost estimate becomes a simple matter of mapping the WBS onto the RBS and assigning the appropriate resources to individual WBS elements. This methodical approach may initially require some extra effort, but if an organization regularly produces and maintains its RBS families, the process becomes second nature. The project manager's anxiety about cost estimating will decrease, and the organization will achieve significant efficiencies in planning, scheduling, and monitoring.

Acknowledgment: We thank Arisara Ongthongkum for providing the original versions of the “Internet Café” Resource and Work Breakdown Structures.

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Worker Cost

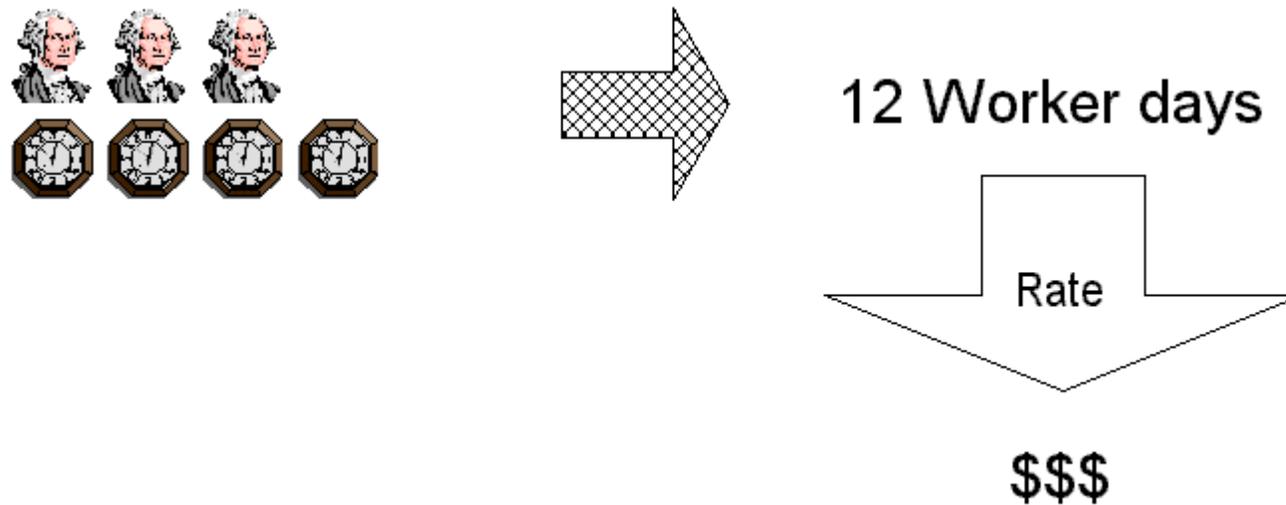


Figure 1. A schematic representation of estimating the cost of using personnel over some duration. Three George Washington workers used for four days yields 12 worker days of effort. Multiplying by the cost rate yields the cost for that effort.

Equipment Cost

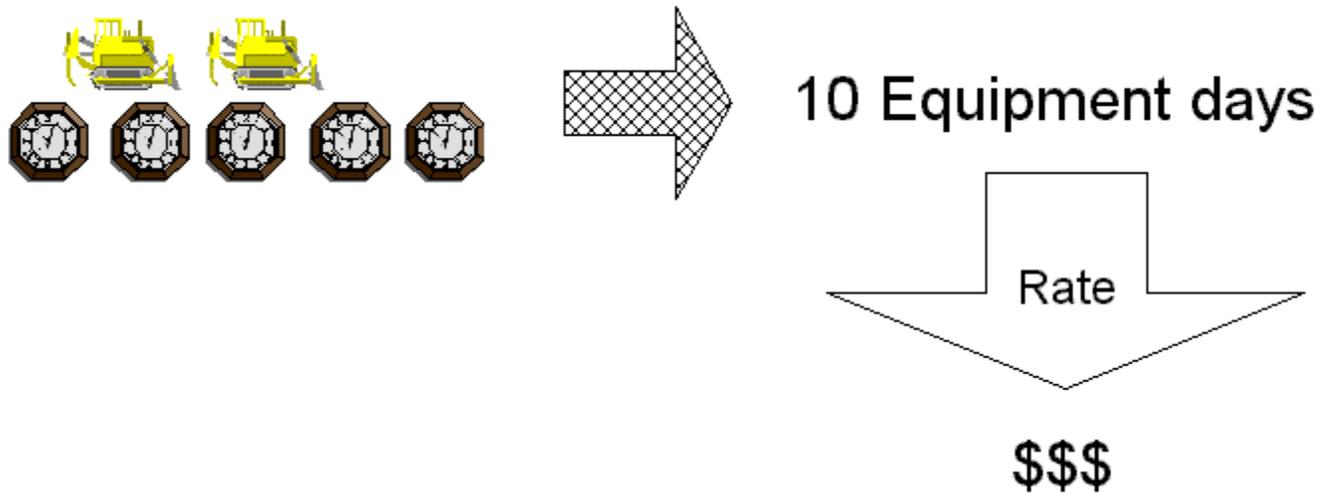


Figure 2. Bulldozers have replaced the personnel of the previous figure, and now the effort is measured in equipment days. Again the cost-rate factor yields cost.

Work Breakdown Structure

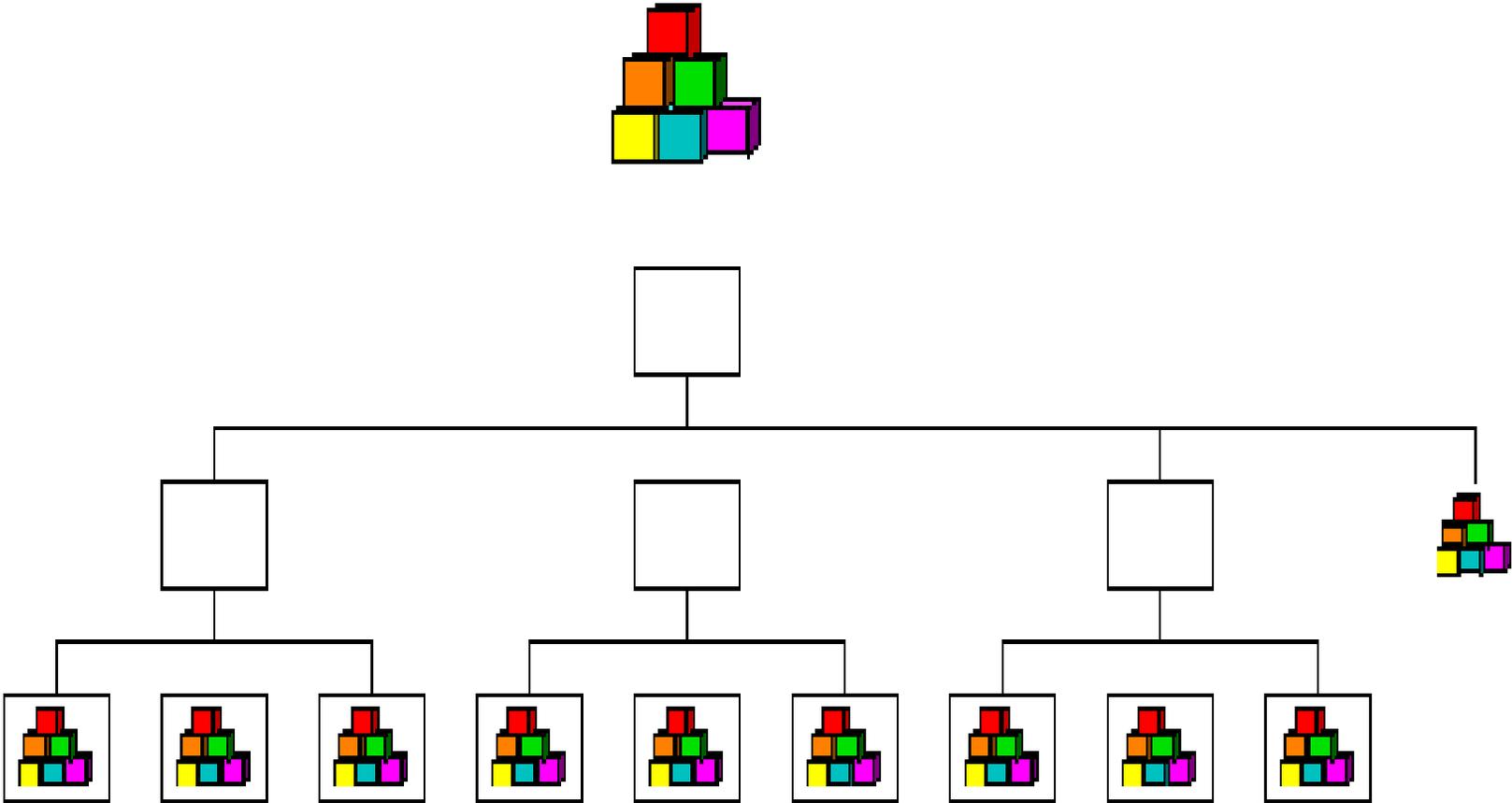


Figure 3. A schematic representation of the familiar Work Breakdown Structure. The one big deliverable at the top has been broken into many smaller deliverables.

WBS Example

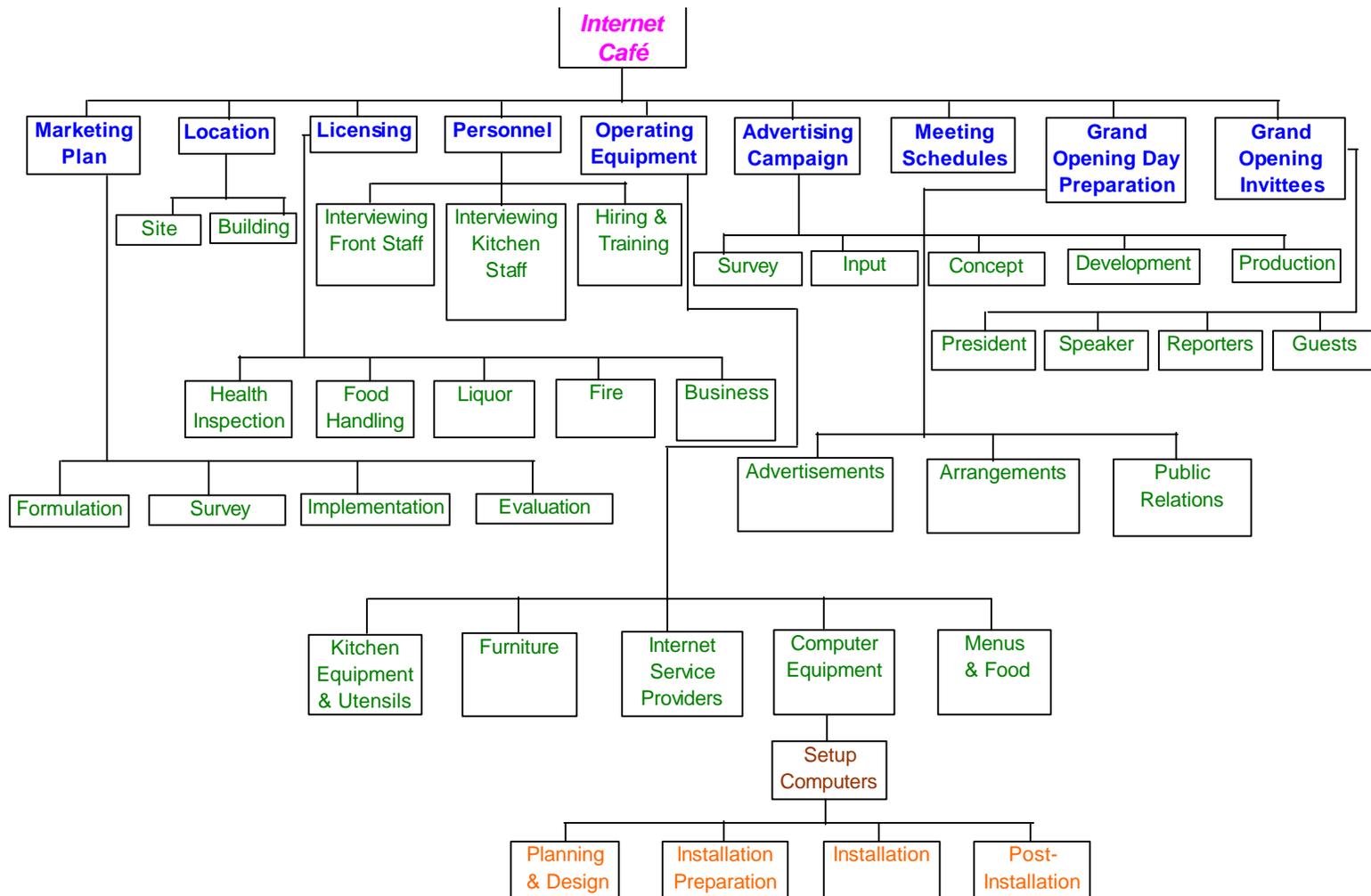


Figure 4. An example of a deliverable-oriented WBS.

Resource Breakdown Structure

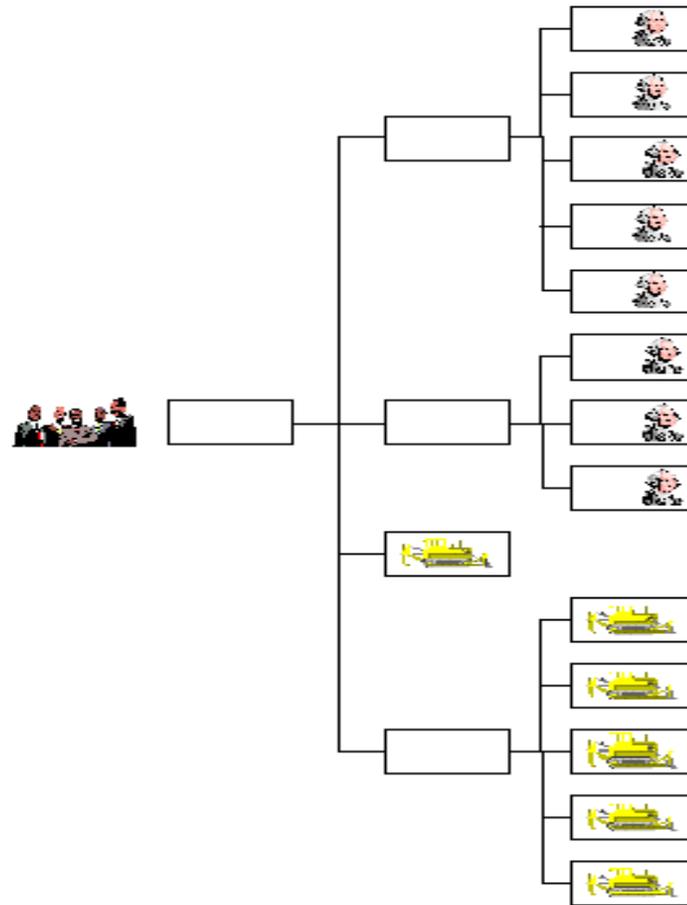


Figure 5. A schematic representation of a Resource Breakdown Structure. The George Washingtons represent generally available personnel, and the bulldozers represent equipment resources.

Figure 6

Internet Café Project (Costs include overhead)

		Units of Measure	Cost/Price (Dollars)
1.0 Personnel			
1.1 Management			
1.1.1	General Manager	Hr.	15.00
1.1.2	Engineering/Design Manager	Hr.	50.00
1.1.3	Construction Foreman	Hr.	15.00
1.1.4	Analyst	Hr.	60.00
1.1.5	Marketing Manager	Hr.	10.00
1.1.6	Business Lawyer	Hr.	80.00
1.2 Design			
1.2.1	Mechanical Engineers	Hr.	40.00
1.2.2	Computer Engineers	Hr.	40.00
1.2.3	Computer Installer	Hr.	12.00
1.2.4	Electricians	Hr.	12.00
1.2.5	Carpenters	Hr.	12.00
1.2.6	Painters	Hr.	7.00
1.2.7	Architects	Hr.	40.00
1.2.8	Survey Staff	Hr.	5.00
1.2.9	Questionnaire writers	Hr.	10.00
1.2.10	Workers	Hr.	7.00
1.3 Front Staff			
1.3.1	Asst. Manager	Hr.	11.00
1.3.2	Waiters / Waitress	Hr.	2.13
1.3.3	Bartenders	Hr.	5.75
1.4 Kitchen Staff			
1.4.1	Chef	Hr.	12.00
1.4.2	Asst. Chefs	Hr.	7.50
1.4.3	Dishwashers	Hr.	5.25
2.0 Equipment			
2.1 Computer			
2.1.1	Internet Server	18 payments, monthly	115.00
2.1.2	Workstations	18 payments, monthly	35.00
2.1.3	Printers	6 payments, monthly	50.00
2.1.4	Scanners	4 payments, monthly	25.00
2.1.5	Computer Tables & Chairs	Each	50.00
2.2 Kitchen			
2.2.1	Chinaware	Each	4.00
2.2.2	Silverware	Each	10.00
2.2.3	Glasses	Each	1.00
2.2.4	Coffee cups & Saucers	Each	1.50

	2.2.5	Pots & Pans	Each	15.00
	2.2.6	Stoves	10 payments, monthly	50.00
	2.2.7	Ovens	Each	200.00
	2.2.8	Coffee machine	Each	50.00
	2.2.9	Refrigerator	18 payments, monthly	80.00
	2.2.10	Dining Tables & Chairs	Each	100.00
3.0 Tools				
	3.1	Hand Tools	Hr.	5.00
	3.2	Survey Equipment	Hr.	2.00
	3.3 Advertisements			
	3.3.1	Radio	Each	50.00
	3.3.2	Newspapers	Each	200.00
4.0 Materials				
	4.1 Decoration			
	4.1.1	Paint	Gallon	12.00
	4.1.2	Wall Papers	Sq. Ft.	0.50
	4.1.3	Glue	Gallon	8.00
	4.1.4	Frames	Each	10.00
	4.1.5	Flowers	Each	0.50
	4.2 Electrical			
	4.2.1	Wire	Foot	0.20
	4.2.2	Light Bulbs	Each	1.00
	4.2.3	Switches	Each	1.00
	4.2.4	Air Conditioner / Heater	10 payments, monthly	100.00

Elemental Estimate

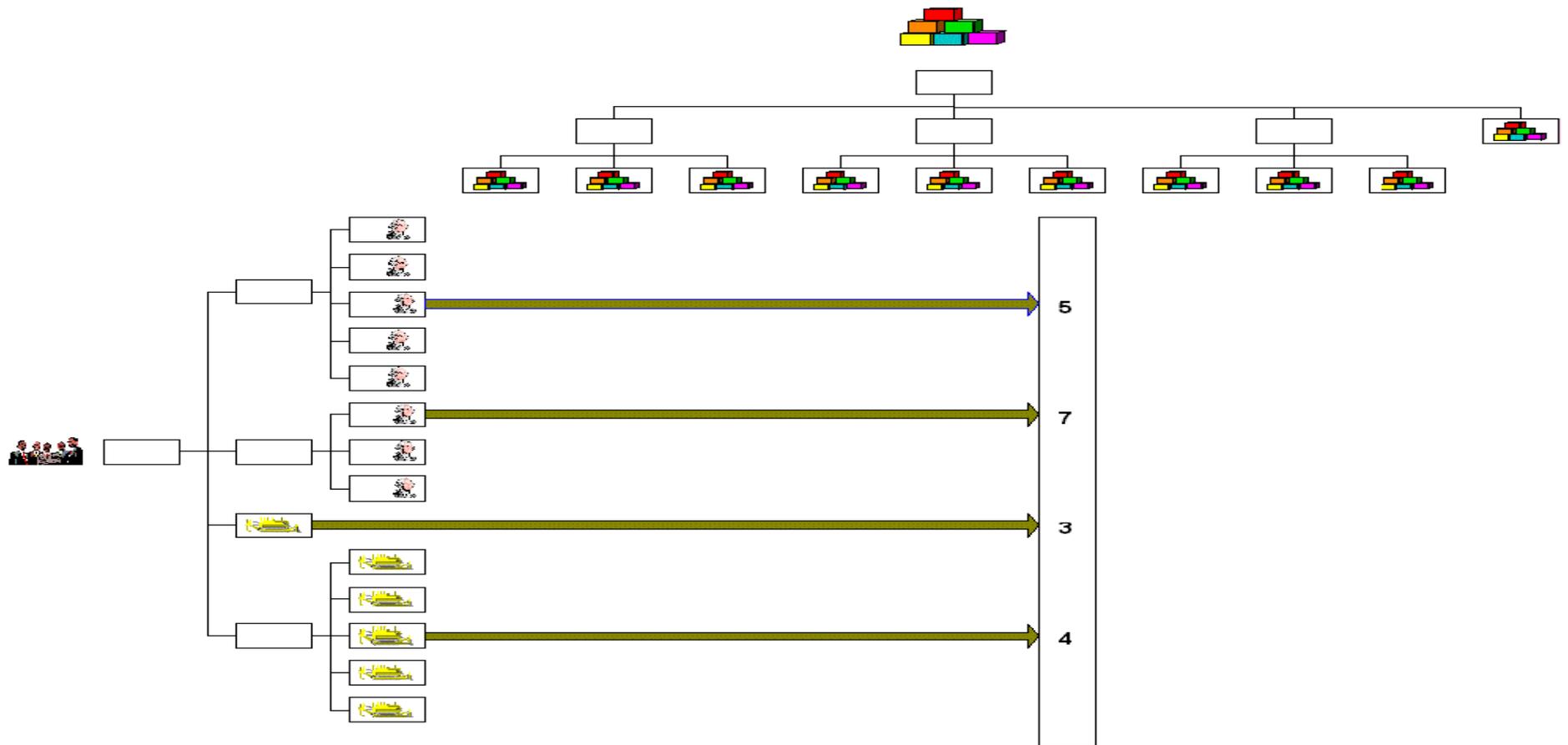


Figure 7. A schematic representation of a using particular portions of the Resource Breakdown Structure with the Work Breakdown Structure to estimate the total effort needed for a specific lowest-level element. The cost then comes directly from multiplying the effort by the cost rate. This calculation is performed only at the lowest levels of the WBS. Any number at a higher level is the sum of its branch at levels below.