Fundamentals of Project Performance Measurement

...explains the important elements of project cost/schedule management in a concise and straightforward way without falling back on the jargon often associated with the subject.

...emphasizes the use of the earned value technique as a logical and meaningful way to present cost and schedule status for management and estimating purposes.

...is profusely illustrated, numerous examples are used to clarify concepts and cogent reasons are given for why management systems should possess specific capabilities.

Here is a text that can be read and understood easily; a rarity in today’s complex management environment.
Table of Contents

List of Figures ..................................................... vii
Preface .................................................................. ix
Chapter 1 Introduction ............................................ 1
Chapter 2 Understanding the Project ......................... 7
Chapter 3 Organizing for the Project ......................... 11
Chapter 4 Scheduling ............................................. 17
Chapter 5 Budgeting .............................................. 23
Chapter 6 Establishing the Baseline ......................... 27
Chapter 7 Detailed Planning .................................... 35
Chapter 8 Measuring Performance with Earned Value .... 41
Chapter 9 Accounting ............................................ 45
Chapter 10 Data Collection ..................................... 51
Chapter 11 Estimating Cost at Completion ................ 57
Chapter 12 Change Control .................................... 63
Chapter 13 Baseline Maintenance ............................ 69
Chapter 14 External Reporting ............................... 75
Chapter 15 Graphic Presentation of Data ................... 81
Chapter 16 Earned Value Management Systems Guidelines ... 87
Glossary .............................................................. 99
Index .................................................................. 107
About the Author ................................................ 113
List of Figures

Figure 1-1 Project Cost Report ........................................... 2
Figure 1-2 Cost/Schedule Performance ................................. 3
Figure 1-3 Project Schedule .............................................. 5
Figure 2-1 Work Breakdown Structure (WBS) ....................... 8
Figure 2-2 Contract Work Breakdown Structure (CWBS) ....... 10
Figure 3-1 Organization Breakdown Structure (OBS) .......... 12
Figure 3-2 Responsibility Assignment Matrix (RAM) .......... 13
Figure 4-1 Schedule Vertical Traceability ............................. 20
Figure 5-1 Resource Leveling ........................................... 25
Figure 5-2 Budget Allocation ........................................... 26
Figure 6-1 Performance Measurement Baseline .................. 28
Figure 6-2 Realistic Baseline ........................................... 30
Figure 6-3 Front Loaded Baseline ...................................... 31
Figure 6-4 Project Funding versus the Baseline .................. 32
Figure 7-1 Control Account Plan ...................................... 37
Figure 7-2 Control Account Plan ...................................... 40
Figure 8-1 Control Account Plan ...................................... 43
Figure 9-1 Material Time Phasing ..................................... 47
Figure 9-2 WBS/OBS/Cost Element Identification ............... 49
Figure 10-1 Control Account Status ................................... 52
Figure 10-2 Cumulative Performance ................................ 53
Figure 10-3 Performance Report ....................................... 54
Figure 10-4 Summarization of Data ................................... 55
Figure 10-5 Interpretation of Data .................................... 56
<table>
<thead>
<tr>
<th>Figure Number</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-1</td>
<td>Estimate Based on Baseline Achievement</td>
<td>59</td>
</tr>
<tr>
<td>11-2</td>
<td>Estimate Based on Continuance of Actual Performance</td>
<td>60</td>
</tr>
<tr>
<td>11-3</td>
<td>Estimate Based on Combined Cost and Schedule Performance</td>
<td>61</td>
</tr>
<tr>
<td>12-1</td>
<td>Incorporation of External Changes</td>
<td>64</td>
</tr>
<tr>
<td>12-2</td>
<td>Contract Budget Base Log</td>
<td>65</td>
</tr>
<tr>
<td>12-3</td>
<td>Internal Replanning with Management Reserve</td>
<td>66</td>
</tr>
<tr>
<td>12-4</td>
<td>Internal Replanning - Rephasing Work or Budget</td>
<td>67</td>
</tr>
<tr>
<td>13-1</td>
<td>Over Target Baseline (Cost and Schedule Variances Eliminated)</td>
<td>72</td>
</tr>
<tr>
<td>13-2</td>
<td>Contract Budget Base</td>
<td>73</td>
</tr>
<tr>
<td>14-1</td>
<td>Performance Report</td>
<td>77</td>
</tr>
<tr>
<td>14-2</td>
<td>Baseline Report</td>
<td>79</td>
</tr>
<tr>
<td>15-1</td>
<td>Cumulative Performance</td>
<td>82</td>
</tr>
<tr>
<td>15-2</td>
<td>Cost and Schedule Variance Trends</td>
<td>83</td>
</tr>
<tr>
<td>15-3</td>
<td>Actual versus Projected Performance</td>
<td>85</td>
</tr>
</tbody>
</table>
Preface

This book is an excellent place to start for those who wish to learn more about project performance measurement and will be useful to representatives of each of the disciplines that contribute to the success of a project. A clear understanding of the fundamentals of project performance measurement is essential to effective project management. However, this understanding is as essential for managers and staff that must use the project management system on a daily basis as it is for higher level managers and their customers. It is an engineering axiom that the better a process can be measured, the better it can be controlled. In Fundamentals of Project Performance Measurement, Bob Kemps teaches us that project performance is no exception.

Project Performance Measurement, once a little known and poorly understood project management process, has now become a way of life throughout the research and development, production, energy, and construction communities. Arguments that once raged over whether it could be done at all, now focus on how best to use the data from established performance measurement systems. Individuals once responsible for introducing performance measurement systems, often in the face of considerable opposition, are responsible for managing entire projects. Project managers that have not learned the value of these systems are finding themselves at a considerable disadvantage, not only in dealing with internal and external competition for increasingly scarce resources, but also in satisfying the needs of increasingly knowledgeable customers.

High ranking government officials can speak with ease of the output of performance measurement systems and have done so in televised congressional hearings. The governments of Australia,
Canada, Europe, Sweden, United Kingdom, and Japan, among others, have shown considerable interest in establishing performance measurement standards; and some are surpassing the United States in the quality of the implementation of those standards. Commercial enterprises at home and abroad are adopting performance measurement systems for themselves in response to market pressure to do a better job of managing projects. Even government agencies that are seeking to free their managers and contractors of some of the strict discipline of cost/schedule planning and controls continue to recognize the value of performance measurement systems.

It is against this background that Bob Kemps' primer on project performance measurement comes to us. He calls upon his many years in the field to remind us that despite the contribution that performance measurement systems have made to the art of project management, and despite the regard those systems have won for their users, there is no magic here. Fundamentals of Project Performance Measurement explains in simple terms the underlying concepts that combine to create the sound systems that produce the data so essential to the cost, schedule, and technical trade-offs of the project manager's craft. This book treats as especially important the process of combining those simple concepts and does not allow us to fall victim to the belief that it can be done easily and without the involved contributions of the entire project team or, as Bob would say, without discipline.

Gary C. Humphreys
Humphreys & Associates, Inc.
An important part of the project management is the art of making trade-offs - trading off cost, schedule, and technical performance in an effort to get the best product at the lowest cost in the shortest time. Performance measurement, however, is the art of determining, organizing, and presenting cost, schedule, and technical performance information in a way that contributes to making those trade-offs. Good performance measurement requires the effective integration of cost, schedule, and technical information. Unfortunately, many management systems that are used on large projects are not well integrated, because they were developed independently of each other to satisfy specific needs.

For example, the accounting system is designed primarily to keep track of expenses and payments, to meet payrolls, calculate taxes, etc. Cost information is primarily oriented to organizational elements. The scheduling system, on the other hand, is designed to support work planning and control, and is oriented to project tasks. Technical management is focused on specifications, performance characteristics, and technical goals, and is a product of the system engineering process.
Pulling essential cost, schedule, and technical information together in a meaningful, coherent fashion is always a challenge facing a project manager. If this cannot be done, management information will be fragmented, will not contribute effectively to project management, and may actually mislead the manager by presenting a distorted view of project status.

In the simplest terms, performance measurement is the comparison of actual performance against a baseline plan. The baseline used for performance measurement should be a single, integrated plan, because the analysis of cost performance must include schedule considerations and the evaluation of schedule performance must include technical performance considerations. Figure 1-1 illustrates the difficulty in trying to understand cost performance separately based on a commonly used budget versus actual costs presentation.
At first glance, it would appear that the project is in good shape from a cost standpoint. The chart seems to indicate that cost performance is better than planned and that an underrun is likely. Suppose, though, that the project is behind schedule. When this is taken into consideration, it is not clear that the variance between budget and actual costs represents good cost performance or simply a spending variance. The problem with the chart is that it compares apples to oranges. It compares the actual cost of work performed (ACWP) to the budgeted cost for work scheduled (BCWS). What is missing is the budgeted cost for work performed (BCWP), commonly referred to as earned value.

When earned value is taken into consideration, the cost picture clears up because the cost and schedule components can be addressed separately. Figure 1-2 illustrates the variance attributable to cost performance and the variance attributable to schedule performance.
The chart now shows that the project is both behind schedule and underrunning cost, and the cost underrun is only about half that depicted in Figure 1-1. Earned value is the key to understanding project status because it represents the amount of work performed. In developing an estimate of the final project cost, earned value also provides the point of departure for determining the amount of work remaining.

As with cost performance measurement, schedule performance cannot be fully evaluated by itself. Technical problems, such as test failures or performance shortfalls, are responsible for most schedule and cost problems; consequently, technical performance cannot be ignored, as problems may not surface until too late to take effective action. However, most cost and schedule control systems operate on the assumption that technical requirements are being met when credit is taken for work accomplished. This is not always the case and an early warning system of technical performance measurement helps to identify potential schedule and cost problems and their impact on project objectives.

Schedule reports do not always present a clear picture of project status even though a variety of indicators may be provided. Examples are tasks completed, milestones accomplished, tasks ahead of schedule, tasks behind schedule, float available, etc. In many cases, however, there is no bottom line that indicates the project is “x” number of days ahead or behind schedule.

Figure 1-3 illustrates a situation where some tasks are on schedule, some are ahead of schedule, and some are behind schedule, making overall project status virtually impossible to determine.

Another problem is that firm schedule baselines can be difficult to maintain. Replanning activities tend to eliminate schedule variances by continually rescheduling project activities, including the work that has fallen behind schedule. Without a stable baseline, meaningful perfor-
mance measurement cannot take place and performance trends cannot be developed. The same comment pertains to budget discipline. If budgets are to be used for measuring cost performance, the budget assigned to a task cannot be arbitrarily changed whenever it becomes apparent that the work will overrun. Even worse, if the added budget should be “borrowed” from downstream work, this robbing of Peter to pay Paul can delay visibility of cost problems until too late to do anything about them other than request more funds. Chasing baseline changes is not a substitute for performance measurement.

Given the types of problems described above, it is no wonder that many project managers are flying by the seat of their pants and have little understanding of where the project stands at any given point in time. This may not be too serious on small efforts, but on large projects, a project manager is constantly working a myriad of problems. Conse-
sequently, it is difficult to track or determine the cost of schedule impacts of those critical tasks on the project. A systematic, organized process for collecting performance information and presenting it in a clear manner on a regular basis is essential to the project management process. This book is intended to define the basic elements of an effective performance measurement system.
Index

A
accomplishment criteria 19, 43–44
accounting 91, 94
adjustment 48
system 1, 45
activity
See tasks
actual cost 3, 23, 37, 45, 47–49, 51, 53, 58–61, 71, 76–77, 81–84, 88–89, 95
actual cost of work performed (ACWP) 3
actual costs 90
analysis 2, 51, 76, 81, 88, 96
critical path 20
ANSI/EIA-748 38, 88
apportioned effort 39, 95
authorized unpriced work (AUW) 26, 73, 94, 97
average performance to date 59

B
bar charts 92
baseline 2, 7, 66, 72, 84, 93, 96
adequate 30
changes 5, 66, 78
curve 30, 65
discipline 12, 70
front loaded 31
initial 27
maintaining 70
maintenance 69
over target 72–73, 97
plan funding 31
realistic 15, 33
reconcile 90, 96
report 78
schedule 78
allocation 15, 27
and work tie 66
at completion 58, 71, 76
authorized 23
baseline 5, 24, 89, 96
control log 36
distributed 26, 73
external 32
factoring 71
for work remaining 61, 84
internal 24
moving 66
operating 70–71
planning 25
project 23, 71
realistic 33
set equal to earned value 83
total 23, 33, 58, 60, 64, 71, 77
total allocated 30–32, 71–73, 81
total authorized 33, 58, 71, 82
versus funding 32
budgeted cost for work performed (BCWP) 3
budgeted cost for work scheduled (BCWS) 3
budgeted cost of work remaining (BCWR) 58

C
change
authorization 64
contract 96
control 63, 88, 90, 96
control board 64
control log 64
customer directed 63
external 63, 69–70
internal replanning 63, 65
process 69
retroactive 90, 96
completed unit 42
completed work 41
compliance evaluation 88
contract budget base (CBB) 23, 26, 33, 71–73, 81–82, 97
log 64
contract performance report (CPR) 48, 79, 94
contract target cost 26, 71, 73
negotiated 73
contract target price 26
cost
contract work breakdown structure (CWBS) 9–10
cost
and subcontractors 48
and systems integration 21
attributes 35
budget 25, 94
close out 70
manager 14, 21, 35–36, 43, 46, 49, 51–52, 70–71, 76
plan 21, 35–36, 43, 51–52, 65
replanning 14, 70
size 14, 35
status 52
corrective action 51, 96
cost
defined 4
earned value management
implementation guide 90
earned value management system (EVMS) 23
    criteria 38, 87
guidelines 38, 87–88, 90–97
engineering change proposals 64
equivalent unit 42
estimate
    at completion 4, 57–58, 76–78, 81, 84–85, 88, 90, 93, 96
comprehensive 62
    cost 59
engineering 61
    for authorized work 73
grass roots 61
mathematrical 62
parametric 61
range 61
realistic 58
to complete 26, 58, 84
estimated actuals 48, 95
estimated completion date (ECD) 59, 61, 81–83

F
fabrication orders 36
fee 24, 26, 49
float 4, 18
front loading 14, 31, 84
functional organizations 13, 46
funding 31, 91, 96
    stability 32
    versus budget 32

G
Gantt charts 17–18

H
horizontal traceability 20

I
indirect costs 24, 49, 89, 91, 94, 96
integrated baseline review (IBR) 88
integrated master plan (IMP) 19
integrated master schedule (IMS) 19
integrating
    management subsystems 9, 88, 91
internal replanning 63, 65, 69–70, 97
invoice 48, 95

L
labor 25, 48–49, 88–89, 93
    charges 45
    cost variance 46
    hours 48
    performance 26
    rate variance 46
    rates 46
learning curves 94
letter of acceptance 88
level of effort 38–39, 89, 94
line of balance 17

M
management reserve 24, 26, 65–66, 69–71, 73, 77–78, 81, 83–84, 89, 94
manufacturing resource planning (MRP) 17–18
material 25, 48, 88–89
    costs 26, 46–47, 51, 89, 93, 95
    lot quantities 46, 89, 95
    performance measurement 47
    price variance 46–47, 95
    raw 46, 48, 95
receipt 46–47, 95
units 42, 89, 95
usage variance 46–47, 95
work in process 46
milestone 18–19, 29, 39, 49, 78, 81–82, 84, 92–93
charts 17
completed 4, 42
interface 20
progress indicators 42
significant 18, 30
value 42
most likely 21

N
negotiated contract cost 23, 89, 97
negotiated costs 73
network
See schedule

O
optimistic 21
organization breakdown structure (OBS)
and accounting 45, 94
and control account 13–14
and WBS 11
defined 11
reporting 54, 75, 85, 90
other direct costs 25, 48, 89
over target baseline (OTB) 72–73, 97

P
performance measurement 1, 41, 44, 51, 58, 69, 84, 88, 95–96
defined 2
material 47
objective indicators 43–44
system 23, 47, 66, 69
techniques 42
performance measurement baseline (PMB) 19, 25–27, 33, 35, 58, 77–78, 81, 88, 90, 97
performance targets 35
PERT 92
PERT-Cost 37–38
pessimistic 21
planning package 19, 39, 89, 93–94
planning process 7, 27
profit 24, 26, 49
progress 47, 51, 78, 81, 92
indicators 42
measure 18–19, 36, 88
physical 42, 95–96
progress payments 32, 48–49, 95
project
budget 23, 33, 60, 64, 71
development 7, 18
incrementally funded 31
large 12, 14, 18, 27, 35
performance 59, 81
planning 7, 14
progress 58
risk 24
scope 7
status 2, 58, 75–76, 81
tasks 1
purchase order 36, 46–48

R
replanning 4, 14, 31, 66, 70, 82, 84
reporting 54
appropriate level of detail 76
baseline 78
performance 9, 75–76, 78, 81
periods 42, 53, 78
schedule 4, 78
research and development 18
resource
  allocation 35, 84
  availability 35
  consumption 27
  expenditures 93
  leveling 24
  phasing down 30
  plan 30, 39
  redistribution 66
responsibility assignment 9, 13, 27, 35, 88
responsibility assignment matrix (RAM) 91
risk 21, 24, 78
rolling wave 44
rubber baseline 14, 78

S
Sarbanes-Oxley Act 57
schedule 35, 65, 70, 88–89, 91–92
  ahead 76
  analysis 20
  and control account 21
  baseline 4, 19, 78
  behind 3–4, 7, 53–54, 61, 82–83
  detail 19, 21, 37, 44, 92
  development 7, 21
  extension 64, 82
  feasible 7
  horizontal traceability 20
  intermediate 19
  master 18–19, 36, 92
  network 17–18
  performance 1–4
  process 17
  progress 19, 41
replanning 4
reports 4, 78
resource loaded 24, 37
risk 21
status 79
system 1, 78, 92
system characteristics 18
targets 33, 64
techniques 17
vertical traceability 20
work tasks 27
schedule performance index (SPI) 60–61
schedule risk assessment (SRA) 21
scope of work 21, 27, 33, 35, 64, 88, 92
shop orders 36
subcontract 25
  flow down 48
  reporting lag time 48
summary level planning packages (SLPP) 26, 39, 93
system engineering 1

T
tasks
  ahead of schedule 4
  and work packages 36
  behind schedule 4
  completed 4
  critical 6
  defining 8
  discrete 18–19
  duration 21, 42
  interdependencies 18, 20, 92
  on schedule 4
project 1
work 35–36

technical
goals 1, 19, 64, 92
management 1
performance 1–2, 4, 78
problems 4
requirements 4
risk 21
thresholds 76
to complete performance index (TCPI) 77, 84
total float 18
trends 81–82

U
undistributed budget 24–26, 73, 89, 94

V
variance
analysis 51, 76, 81, 88, 96
at completion 77
cost 3, 25, 38, 42, 51, 53–54, 58, 69–70, 76–78, 81–84, 90, 93
labor cost 46
labor rate 46
material price 46–47, 95
material usage 46–47, 95
thresholds 76
vertical traceability 20

W
work authorization 36, 64, 88, 91, 93
work breakdown structure (WBS)

and accounting 45, 94
and changes 65
and control account 13–14
and OBS 11
and scheduling 17, 21
and subcontractors 48
define 88
defined 8, 90
dictionary 91
example 8
levels of indenture 14
reporting 54, 75, 85, 90
work definition 8, 17
factors 12
work in process 41, 46, 52, 69
measurement 41, 93
work order 36
work package 19, 36–38, 42, 45, 52, 89, 91, 93–94, 97
and measuring performance 44, 51
authorization 36
closed 41
examples 36
manufacturing 39
short duration 36, 41, 93
zero budget 70
work performed 23
work remaining 4, 19, 26, 28, 58, 69, 84
work teams 13, 46
About the Author

Robert R. Kemps is the recipient of the Federal Government's Distinguished Career Service Award bestowed upon him by the Department of Energy in August, 1989. After 36 years of combined military and civil service, he retired. At that time, he was the director of Project and Facilities Management for DOE, where he was responsible for department policies related to project and construction management, including the DOE Cost/Schedule Control Systems Criteria (C/SCSC).

For eleven years, Robert Kemps was the Department of Defense focal point for C/SCSC and cost reporting requirements. He wrote and was a major contributor to DOD documentation during that period.

The author has been involved with development of project management practices for the federal government since the middle sixties. With his extraordinary talent and invaluable experience he published the first edition of Fundamentals of Project Performance Measurement while an engagement director with Humphreys & Associates, Inc. The latter is a management consulting firm specializing in integrated project management systems with its corporate office located in Orange, California.

Mr. Kemps retired from the U.S. Air Force in September, 1973, as a Lt. Colonel and Master Navigator after 20 years of military service, which included assignments at Headquarters Air Force Systems Command and in the Office of the Secretary of Defense. He served for six years as a member of the board of directors of the Performance Management Association, which later became the PMI College of Performance Management.