Work Sampling

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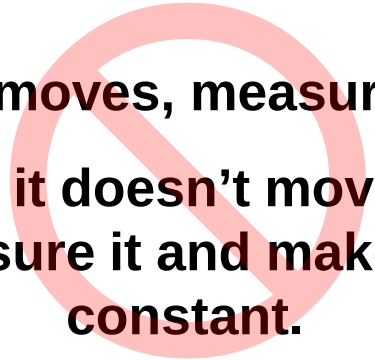
Work Measurement Activities

Determine what is to be measured and how often

Determine measurement methods

- Self recorded (time sheets, etc.)
- Time and motion studies
- Work sampling

Measure, analyze, and report



If it moves, measure it.

If it doesn't move, measure it and make it a constant.

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A Brief History of Work sampling

L.Tippet developed work sampling in England in 1927

R. L. Morrow introduced the technique in US in the 1941

C. L. Brisley used the term work sampling 1952

Estimates percent of the time spent on identified activities

Random observations to record the activities that a worker performs

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Absolute vs. Relative Precision

Acceptable relative and absolute errors set to 5%

1000 units to allocate

Allocated Based on Sample Percentages	Absolute	Relative
600	± 50	± 30
300	± 50	±15
100	± 50	± 5

Relative is more precise but the number of sample can increase dramatically. For example for a 5% error for a 10% activity

- Absolute error, sample size = 138
- Relative error, sample size = 1380

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Calculating Sample Size –
Absolute Precision

Sample Size

$$n = \frac{(z^2 * p * (1 - p))}{e^2}$$

Where:

- Z = Z value (e.g. 1.96 for 95% confidence level)
- p = percentage expressed as decimal
- e = Acceptable error percentage as a decimal (e.g., .04 = ± 4%)

Confidence	Z
99.9%	3.250
99%	2.326
95%	1.960
90%	1.645

Example

Want 95% confidence the activity is within ± 5% and we estimate the activity use 20% of the time

$n = (1.96^2 * 0.2 * (1 - 0.2)) / 0.05^2$

n = 246

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Calculate error limits for a sample size –
Absolute Precision

Since we know the sample size is calculated with

$$n = \frac{(z^2 * p * (1 - p))}{e^2}$$

We can determine the limit of error, e with

$$e = z * \sqrt{\frac{p * (1 - p)}{n}}$$

Example

What is our Limit of Error for 95% confidence when we estimate the activity use 20% of the time and we have 125 samples

e = 1.96 * $\sqrt{0.2 * (1 - 0.2)) / 125}$ = 0.09 = ± 9%

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Calculating Sample Size –
Relative Precision

Sample Size

$$n = \frac{z^2 * (1 - p)}{p * e^2}$$

Where:

- Z = Z value (e.g. 1.96 for 95% confidence level)
- p = percentage expressed as decimal
- e = Acceptable error percentage as a decimal (e.g., .04 = ± 4%)

Confidence	Z
99.9%	3.250
99%	2.326
95%	1.960
90%	1.645

Example

Want 95% confidence the activity is within ± 5% and we estimate the activity use 20% of the time

$n = (1.96^2 * (1 - 0.2)) / (0.2 * 0.05^2)$

n = 6,146

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Calculate error limits for a sample size –
Relative Precision

Since we know the sample size is calculated with

$$n = \frac{z^2 * (1 - p)}{p * e^2}$$

We can determine the limit of error, e with

$$e = z * \sqrt{\frac{(1 - p)}{p * n}}$$

Example

What is our Limit of Error for 95% confidence when we estimate the activity use 20% of the time and we have 125 samples

e = 1.96 * $\sqrt{(1 – 0.2)) / 0.2 * 125}$ = 0.35 = ± 35%

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Work Sampling Procedure

Determine the activities to be sampled

Take a preliminary sample to obtain an estimate

Compute the sample size required

Prepare a schedule for the random observations

Observe and record the activities

Determine how workers spend their time (usually as a percent)

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Example – Activities to be Sampled

Work activities we want to measure

- Work effort
- Rework effort
- Other

We want 95% confidence

We don’t want the error to be greater than ± 5%

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Preliminary Sample

Short study to establish the proportion for each of the activities

If you already have an understanding from other studies, you may skip this step.

Example

We take 100 samples and the results are:

Work Activity	Observations	Proportion
Work Effort	64	0.64
Rework Effort	12	0.12
Other	24	0.24
Total	100	1.00

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Example – Compute Sample Size[1]

n = number of samples

$n = (Z^2 * p * (1-p)) / e^2$

$n = (1.960^2 * 0.12 * (1 – 0.12))/ 0.05^2$

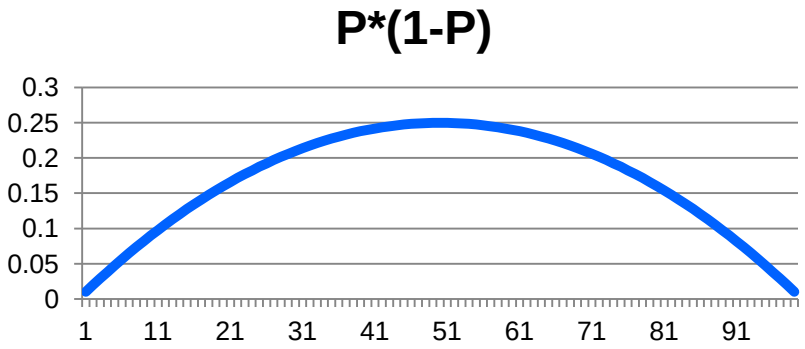
n = (3.84 * 0.12 * 0.88) / 0.0025

n = 0.404504 / 0.0025

n = 162 (sample size for Rework Effort)

n = 354 (sample size for Work Effort)

n = 280 (sample size for Other)



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Example – Compute Sample Size[2]

What should the sample size be?

- 162
- 354
- 280

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Prepare Schedule for Random Observations

Inputs

- Number of people to be sampled
- Number of samples to be taken
- Reporting period

Many different ways to create the schedule

- Use Excel
- Write a program
- Buy a device
- Buy some software

Schedule should tell you

- What days
- What times
- What people

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Observe and Record the Activities –
Take Samples

Need to reassure people sampling will be benign

- Sheet with names down the left and activities down the right
- Check each name as they are sampled
- Check the activity being observed for each name

Name	Sampled?
G. Ford	✓✓✓✓
H. Liu	✓✓✓✓
A. Park	✓✓✓✓
L. James	✓✓✓✓
P. Carne	✓✓✓✓
S. Gomez	✓✓✓✓
V. Gogh	✓✓✓✓

Activity	Samples
Work	✓✓✓✓✓✓✓✓ ✓✓✓✓✓✓✓✓
Rework	✓✓✓✓
Other	✓✓✓✓✓✓✓

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Determine How Workers Spend their Time

Work Sampling Results

Work Activity	Number	Proportion
Work Effort	208	0.59
Rework Effort	45	0.13
Other	101	0.28
Total	354	1.00

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WHERE IS THIS HEADING

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Different Methods can have Different Activity Sets

Development

- Agile
- RUP
- OO
- Structured
- Maintenance

Services

- Help desk
- Consulting
- Medical
- Legal
- Depot

Acquisition

- Software
- Hardware
- Systems
- Services

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Example - Software Development Activities

01 Requirements
02 Prototyping
03 Architecture
04 Project plans
05 Initial design
06 Detail design
07 Design reviews
08 Coding
09 Reuse acquisition
10 Package purchase
11 Code inspections
12 Ind. Verif. & Valid.
13 Configuration mgt.
14 Formal integration
15 User documentation
16 Unit testing
17 Function testing
18 Integration testing
19 System testing
20 Field testing
21 Acceptance testing
22 Independent testing
23 Quality assurance
24 Installation/training
25 Project management
26 Vacation
27 Project/team meeting
28 Away from desk
29 Non-project work
30 Requirements Rework
31 Design Rework
32 Code Rework
33 Retest
34 Other

*** Source (Items 1-25) - How Software Estimation Tools Work, Capers Jones, March 2, 1996**

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Summaries – Development Phase & Activities

Requirements	Requirements Elicitation
	Requirements Prototyping
	Requirements Analysis
	Requirements Review
	Requirements Rework
Design	Architecture
	Design Prototyping
	Initial design
	Detail design
	Design reviews
	Design Rework
Build & Unit Test	Coding
	Reuse acquisition
	Package purchase
	Code inspections
	Unit testing
	Code Rework
	User documentation

Integrate & Test	Function testing
	Integration testing
	System testing
	Field testing
	Formal integration
	Retest
Deliver	Acceptance testing
	Independent testing
	Package and Deliver
	Installation/training
Support	Quality assurance
	Configuration mgt.
	Ind. Verif. & Valid.
Management	Project plans
	Monitor and control
	Project/team meeting
Other	Non-project work
	Away from desk
	Vacation
	Other

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Map Activities to your Processes and Models

Ties performance to your processes and to model parts

- Helps understand where performance was affected by process change
- Performance modeling
  - Understand performance affects of proposed changes
  - If adopting a process, can use as initial estimate of performance
- Build a performance database for comparison

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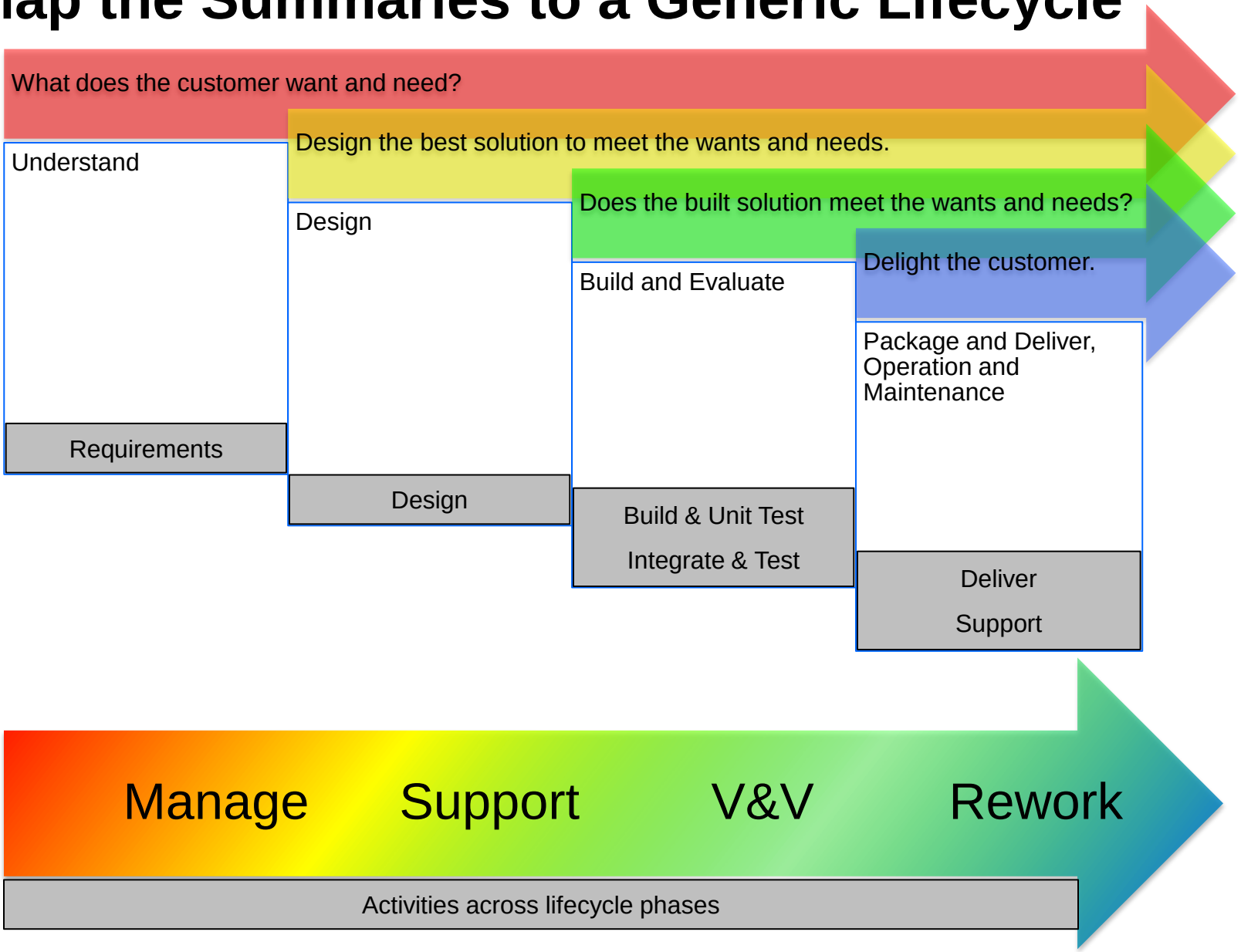
Map the Summaries to a Generic Lifecycle



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