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# Management Metrics, A Primer

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[Selected Slides]



# Objectives

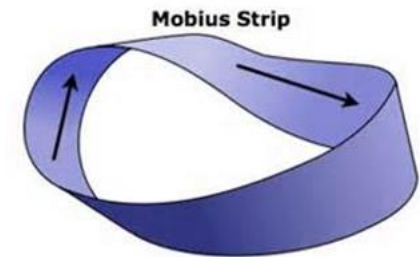
- Answer the “journalistic **questions**” about management metrics, metrics for managing.
- Use these **answers** to motivate the manager to build and use metrics for his/her organization.



Metrics for Management

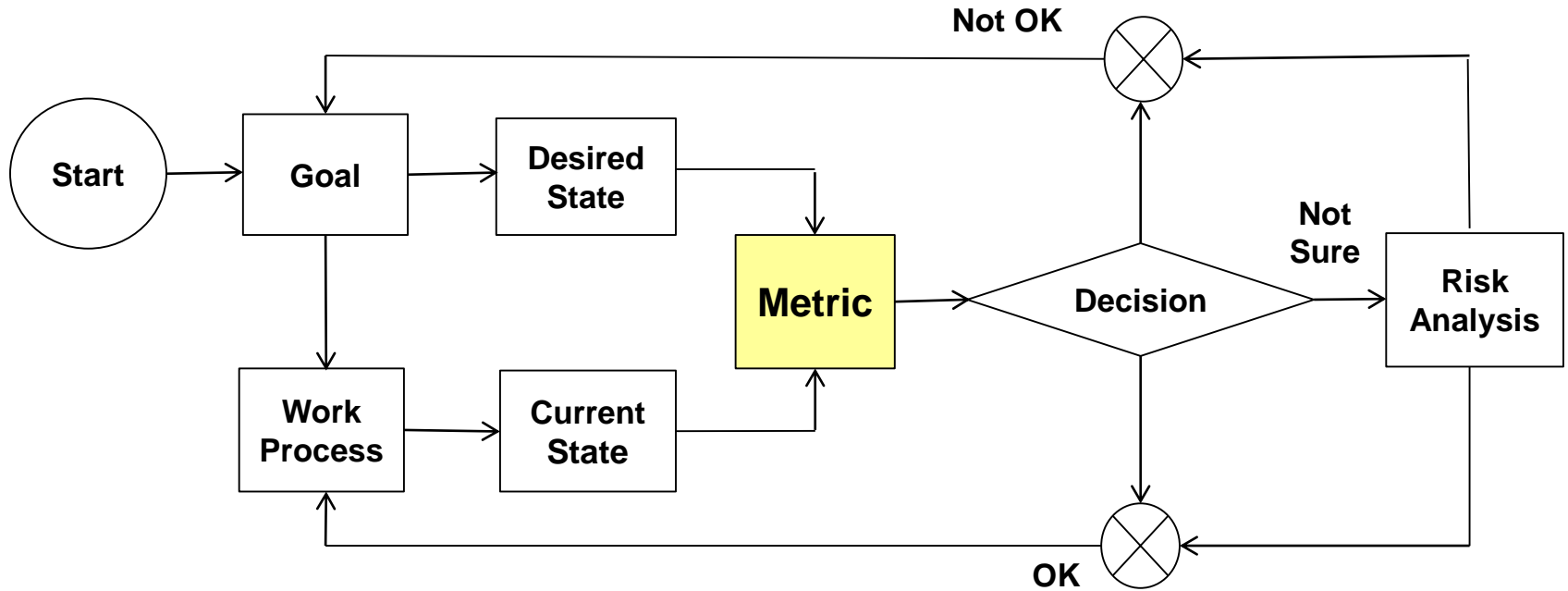
# Metric – a mathematical view

- In Mathematics, a **metric** is an abstraction of the **notion of distance**.
- Not all topologies\* have a metric space, and **not all metric spaces measure distance the same way**.



\* **Topology** is concerned with properties of geometric figures that remain invariant when the figures are deformed in any way that does not create new points or fuse existing points.

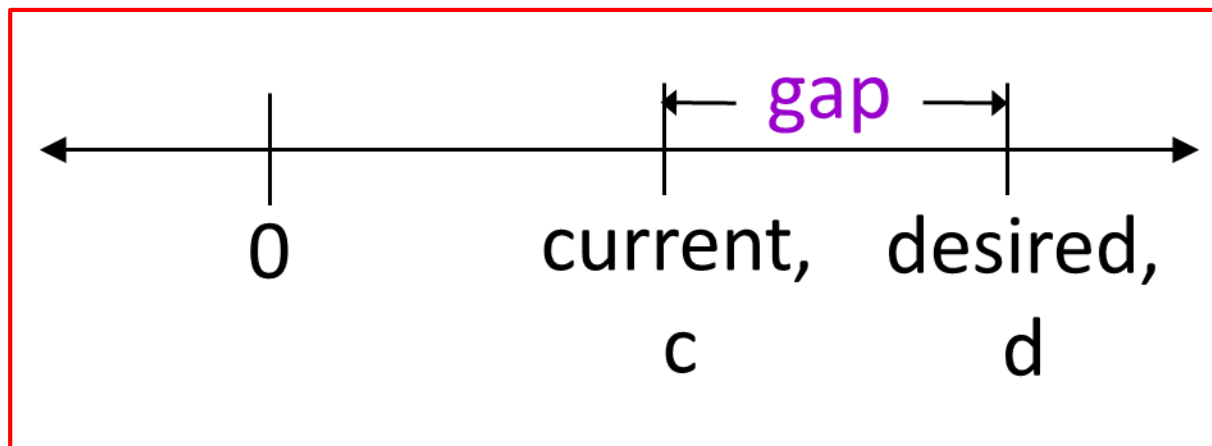
# Management metric – flow diagram



- A management metric assigns a measure to the **performance gap**.

# What is a management metric?

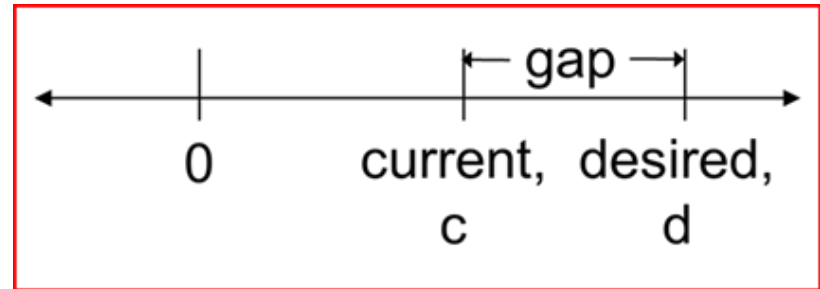
- A **mathematical function** that assigns a measure to the “gap” between the output’s current state (**c**) and the goal’s desired state (**d**).



# Math for metrics – getting started

- **Absolute Error**

- $\Delta_{AE} = |d - c|$ .



- **Relative Error**

- $\Delta_{RE} = |(d - c)/d|$  where  $d \neq 0$ .

- **Relative Change**

- $\Delta_{RC} = (c - d)/|d|$  where  $d \neq 0$ .

# Management metrics – 2 types

- **Subjective**

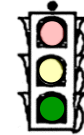
- Produced by a state of mind
- Particular to an individual
- Example: “We are safe.”

- **Objective**

- Material object, not mental concept
- Actual existence
- Not influenced by emotion or opinion
- Example: “No accidents occurred.”

# “Subjective” metrics – example

## 3.16.3 - Technology Division - Product Effectiveness (Value-Added) (NA)

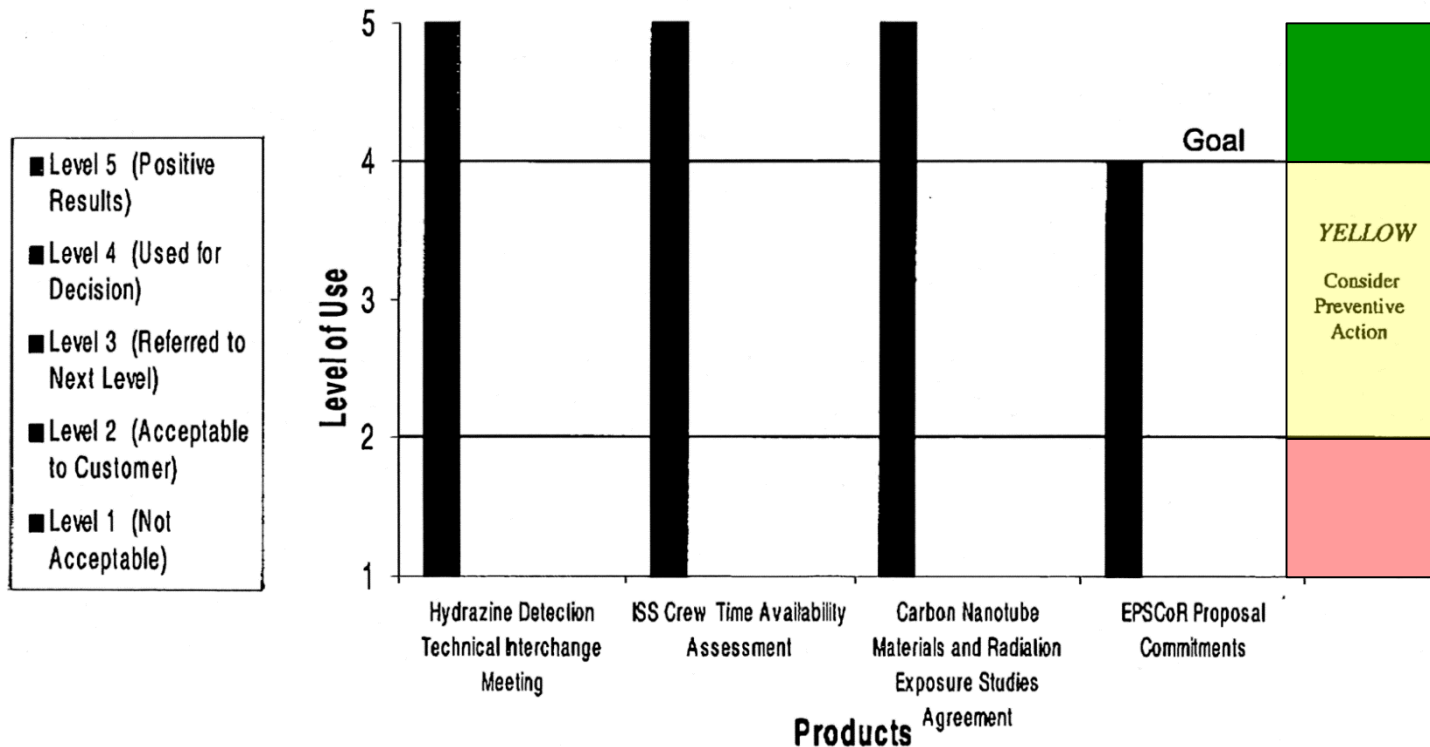


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Chart Owner:

Last Update: 08/21/00

Metric Summary: The Technology Division continues to provide effective products which meet or exceed the goal established.





# “Objective” metrics – 3 types

## 1. **Effectiveness** (~ Quality)

- How well results accomplished the stated **purpose**.



## 2. **Efficiency** (~ Quantity)

- How well **resources** were used or consumed.

## 3. **Appeal** (~ Acceptance)

- How well **human preference** was satisfied.

# Effectiveness metrics – 2 types

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- **Technical characteristics**

**Physical** characteristics (e.g., size, shape) and functional capability.

“On the drawing.”

- **Operating characteristics**

**Non-physical** characteristics being operating behaviors and outcomes (examples on next page).

“Inferred by the drawing.”

# Operating characteristics – 9 types

<p><b>Safety:</b> Freedom from accident and loss</p>	<p><b>Usability:</b> Human interfaces</p>	<p><b>Supportability and Serviceability:</b> Service throughout the planned life cycle</p>
<p><b>Reliability:</b> Likelihood of having an uptime (failure-free) state for a stated duration or load</p>	<p><b>Maintainability:</b> Likelihood of returning to an uptime state due to maintenance or repair</p>	<p><b>Availability:</b> Likelihood a repairable item has an uptime state; <math>A = f(R, M)</math></p>
<p><b>Producibility:</b> Ease and economy of producing or manufacturing</p>	<p><b>Affordability:</b> Total cost of ownership and not only system acquisition cost</p>	<p><b>Disposability:</b> Disassembly and disposal (environmental stewardship)</p>

# Where should metrics be used?

- Metrics are needed:

- With **imperfect** systems.
- When desired state is critical.
- When management has a high desire to obtain the desired state.



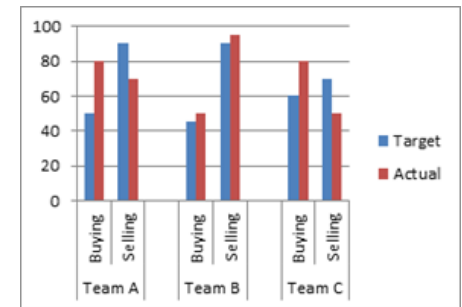
- Metrics are not needed

- With **perfect** or low-risk systems.

# Why do metrics?

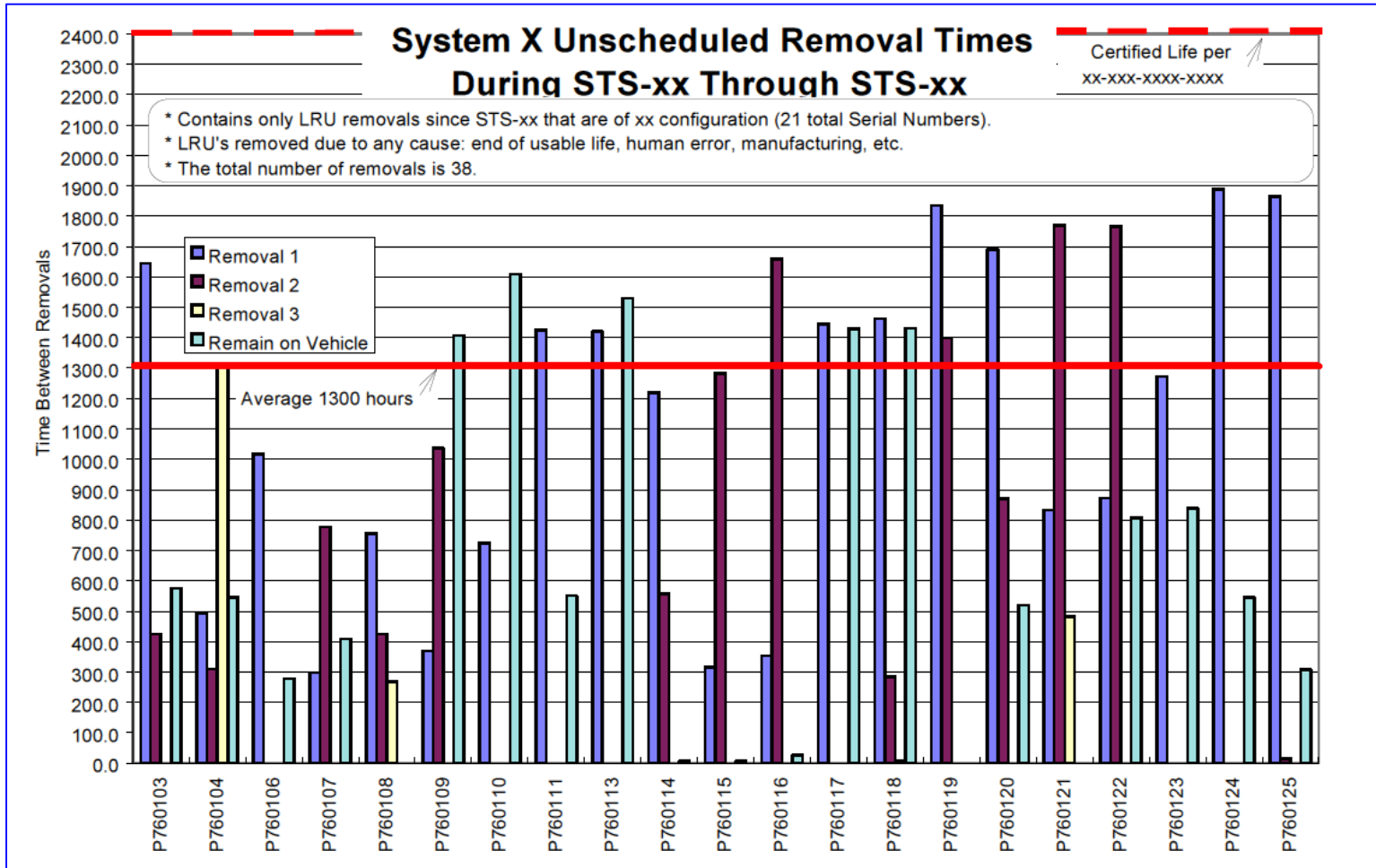
- To **quantitatively characterize** the performance gap and to **support** the decision to...

- Continue as is,
- Make adjustments (changes), or
- Obtain more information to make a risk-informed decision.
- Graphs can be misleading.

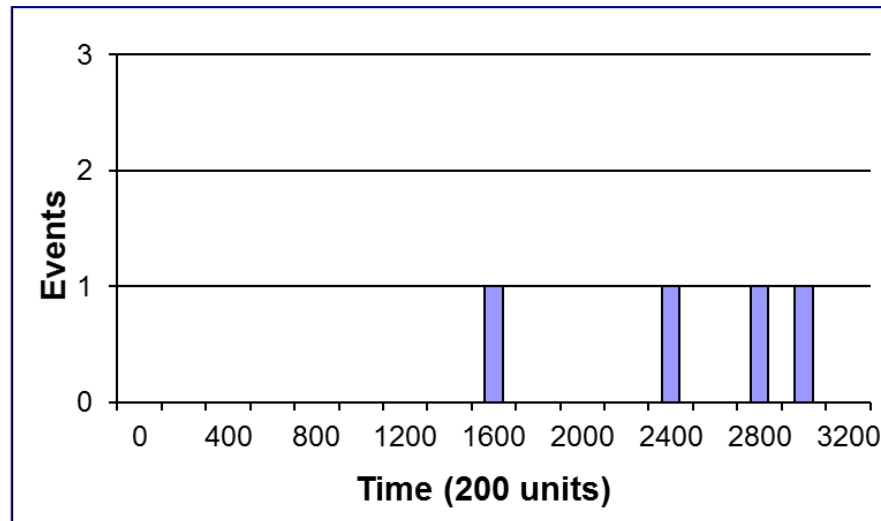
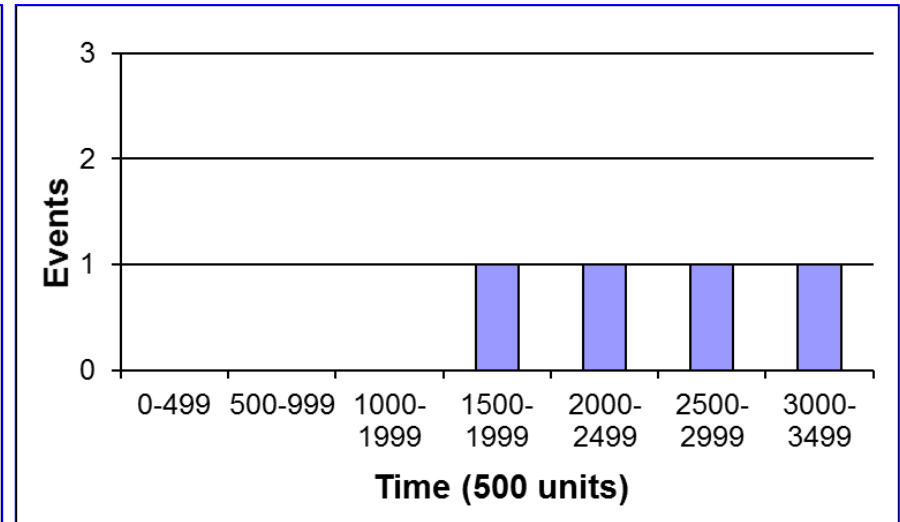
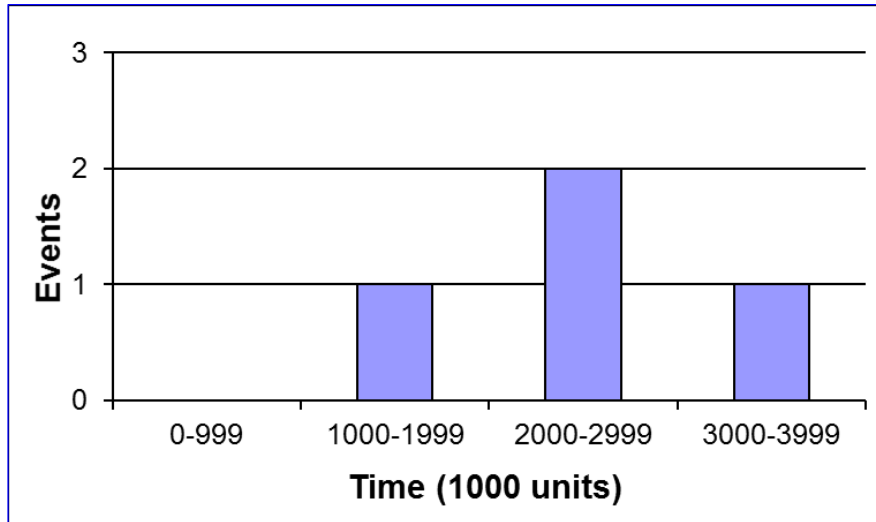


# Great graph; why metric formulas?

Desired state = 2400 hr; Avg current state = 1300 hr)



# Example What is the trend? ( $d = ?$ )



# Trending without graphs

- All graphs used the **same data!**
- To test for a trend in discrete events without graphing, use the **Laplace Test**, a test statistic.

$$z = \left[ \left( \frac{\sum_{i=1}^n t_i}{n} \right) - T / 2 \right] / T \sqrt{1 / (12n)}$$

- $t_i$  is the time from the start time to the time of the  $i^{\text{th}}$  event.
- $n$  is the number of events.
- $T$  is the time from the start time to the end time of the observation period.



# Graphs instead of metric formulas?

- Sometimes “a picture is worth a 1000 words” – and sometimes it can be misleading or confusing.
- When there is sufficient amount of data, **do both**:
  - Plot the data
  - Treat the data.



# When are metrics collected?

- **During the game (Formative)**
  - In process; is inferential.
- **End of the game (Summative)**
  - End of process; is descriptive.
- **Not at all (not in the game?)**
  - “Not keeping score” still allows activity to be reported, or
  - Use subjective (self-rating) metrics.



# How many metrics are needed?

- Consider a **dashboard**, a combination of metrics, for your organization.
- Performance is seldom assessed by a **single metric**. Consider ...



# Pick one: “I need you to be...”

## 1. Effective

- Complete task “x” with no errors.

## 2. Efficient

- Produce “y” units per hour, cost.

## 3. Appealing

- Check your work, support last minute changes, be team oriented, be safe...



# Example – aggregating unlike scales

Performance criteria		1 2 3 4 5 6 7							Date:		
		Effectiveness	Efficiency	Quality	Productivity	Quality of work life	Innovation	Profitability, budget accountability	Group:		
Measures, ratios, indexes, objectives	Accomp.	.. as a % ...	% def. ...	O/I Index ...	Survey ...	# Prop. acc. ...	15% ROI Price rec.				
		5 ...	90% ...	.025 ...	.85 ...	6 ...	75 ...	19% .99	← Actual performance this period		
	5 .	100%	0	1.3	10	120	19% .	10			
	.				9			9			
	.		.01	1.2	8		.	8			
	3 .	90%			7	100	.	7			
	.		.02	1.15	6		.	6			
	.	80%			5		15% .	5			
	2 .		0.25	1.1	4	70	.	4			
	.	75%		1.0	3		.	3			
	1 .		.03		2	40	.	2			
	.			.95	1	10	.95	1			
	0 ...	60% ...	.05 ...	.90 ...	0 ...	5 ...	15% 1.10	0			
	10	7	4	0	6	5	9	← Equivalent score			
	30	5	30	10	10	10	5	← Subjective weightings			
	300	35	120	0	60	50	45	← Add this row to get			
								610			
								Performance indicator			

Sink, D.S., *Productivity Management: Planning, Measurement and Evaluation, Control and Improvement*, 1985, pp. 198-202.



# Method – aggregating unlike scales

- The “**Objectives Matrix**” method:
  - Combines multiple-unlike measures based on **any scale** into one score.
  - **Different weights** can be assigned to each performance area.
  - The resulting composite value can be **trended over time**.
  - Called multicriteria performance / productivity measurement technique.

# Who should make the metrics?

- The manager!
- Why, because...
- Making (not buying) your management metrics:
  - Provides “expert/information power”
  - Can be revealing...



# One reason to do your own metrics

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“What is most remarkable is that the mere effort to measure a difficult-to-measure construct can lead to a much deeper understanding and more effective management of that dimension or asset.”

Source is Dean Spitzer, author of *Transforming Performance Measurement*, AMACOM, 2007. (Balestracci, D., “Measurement As a Framework for Strategy,” [Qualitydigest.com](http://Qualitydigest.com), May 08, 2013).

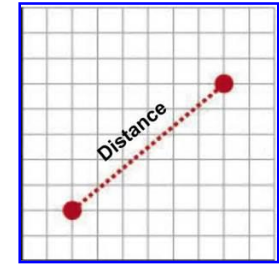




# Benchmarking: Do your metrics ...

- Measure distance or length?

- **Distance** is between two points.



- For management, the two states are:

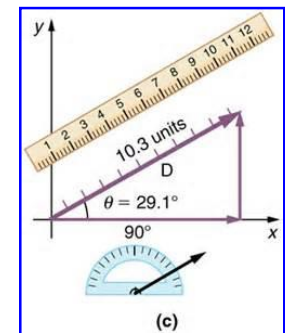
- What you **want**, and

- What you **have**.

- **Length** is a measure from zero.

- It does not compare states.

- It only measures one state.



# Benchmarking: Do your metrics ...

- Focus on what should be measured, and not what can be measured?
- Objectively measure all areas of organizational performance?
  - Effectiveness,
  - Efficiency, and
  - Human Appeal?



# A management metric is not a...

- Statistic, a function of the sample data.
- Trend when it uses length (not distance).
- Figure of merit, aggregated quantities used to characterize performance and options.
- Risk measure, Prob. of Failure x Impact.
- Any single count or measure or just lengths.

Why? Because a **metric** is a function of **two** points (states) and **not one**.

# Contact Information

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