ANALYTIC SERVICES INC.

Informing decisions that shape the Nation's future

Resilience Profiles:
One Approach Does Not Fit All

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Resilience Definition

Definition from National Infrastructure Advisory Council (NIAC) 2009 report on *Critical Infrastructure Resilience:*

> ***Infrastructure resilience is the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event.***

"The ability to reduce…"

Resilience not determined by system's response to any particular event.

"anticipate"

Suggests resilience as a spectrum extending from pre- through post-event.

"… a potentially disruptive event"

May be possible to prevent an event from becoming disruptive through effective resilience.

Resilience Capabilities

- **Anticipation**
  - Prevention and Protection
- **Absorption**
  - Absorption of impact that cannot be mitigated through Prevention and Protection
- **Adaptation**
  - When impact exceeds that which can be absorbed
- **Rapid recovery**
  - Informed restoration of critical functionality

Resilience Profile Concept

- **Three cases:**
  - Cellular Network **Anticipation – Absorption – Adaptation – Recovery**
    - Inexpensive, exposed towers - could be replaced relatively quickly
    - Land-line network offers an alternative
  - Washington Monument **Anticipation – Absorption – Adaptation – Recovery**
    - Perpetual presence is the primary function
  - Air Traffic Control System **Anticipation – Absorption – Adaptation – Recovery**
    - Complex system
    - Failure could result in widespread disruption to the population and economy
    - No alternative system in place

Candidate Optimal Profile Determiners

- **Mission**
  - Fault Tolerance
  - Threat Transference
  - Stability of Mission

- **Environment**
  - Accessibility
  - Exposure
  - Cost to defend vs. costs to replace
  - Replaceability
  - Threat environment predictability

- **Culture**
  - Acceptability of Fortification
  - Hierarchical Decision Making
  - Interdependency

Subject to further study and verification

Electrical Power Distribution Example

		Proactive	Reactive
Proactive/Reactive		100%	
		50%	50%
Does the system have low fault tolerance? (Mission)	Yes	63%	37%
Is the system readily accessible? (Environment)	Yes	50%	50%
Is the threat environment predictable? (Environment)	No	38%	62%
Are costs-to-protect high compared to cost-to-replace? (Environment)	Yes	25%	75%

		Anticipation	Absorption
Defense Approach		12.5%	12.5%
Would high-profile defenses trigger threat transference? (Mission)	No	16%	9%
Is the system exposed and unprotectable? (Environment)	Yes	13%	13%
Is the threat environment predictable? (Environment)	No	9%	16%
Would visible defenses be culturally acceptable? (Culture)	No	6%	19%

		Adaptation	Recovery
Response Approach		37.5%	37.5%
Is the mission stable? (Mission)	Yes	28%	47%
Is the system easily replaceable? (Environment)	Yes	19%	56%
Is decision making maintained high in the hierarchy? (Culture)	No	28%	47%
Is the system autonomous? (Culture)	No	19%	56%

	Anticipation	Absorption	Adaptation	Recovery
Summary	6%	19%	19%	56%

Sample Calculations

	Anticipation	Absorption	Adaptation	Recovery
Cellular Tower Network	0%	0%	25%	75%
Air Traffic Control System	37%	13%	25%	25%
Washington Monument	0%	75%	6%	19%
Hydroelectric Dam	37.5%	37.5%	6%	19%
Electric Power Distribution System	6%	19%	19%	56%
First Responder Services	12.5%	12.5%	75%	0%
Nuclear Power Plant	37.5%	37.5%	6%	19%

Sample Calculation Discussion

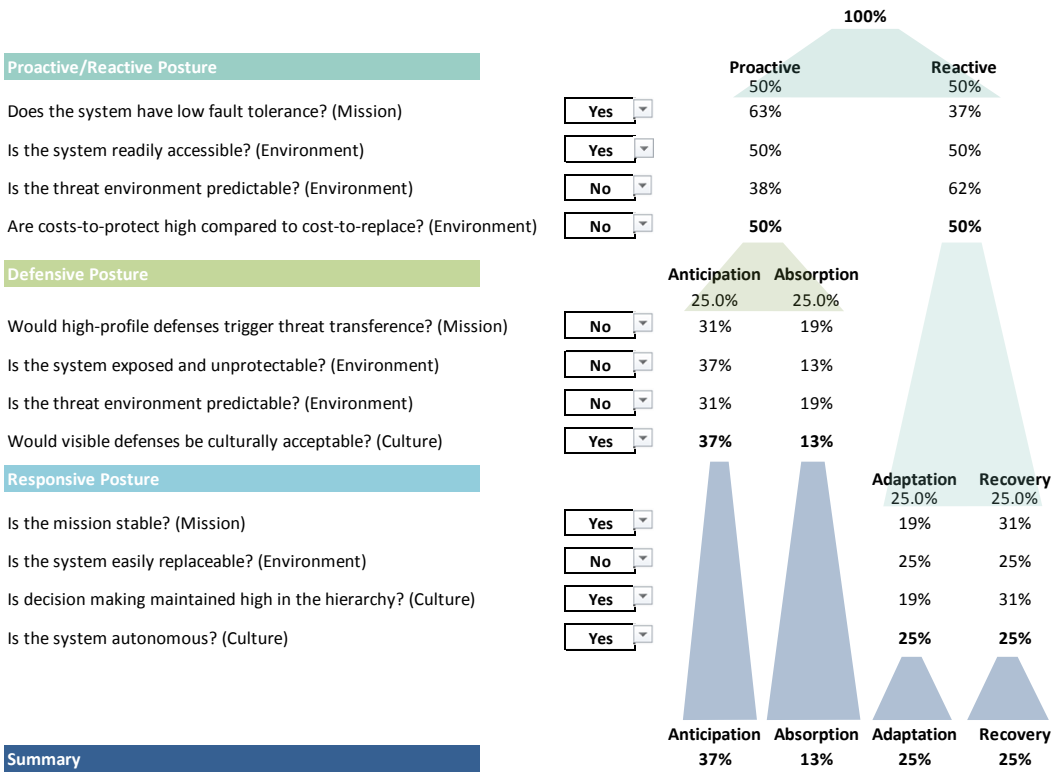
Hydroelectric Dam	**37.5%**	**37.5%**	**6%**	**19%**
Low fault tolerance (any failure likely means total failure) combined with high costs-to-replace and lengthy time-to-replace encourage proactive posture. Acceptability of fortification measures, which points to anticipation, balanced by exposure of the structure, which points to absorption.				
Electric Power Distribution System	**6%**	**19%**	**19%**	**56%**
Drivers pushing reactive posture: exposed and vulnerable, threat environment unpredictable, costs-to-repair relatively low. Mission stability and relative ease of repair favor recovery over adaptation.				
First Responder Services	**12.5%**	**12.5%**	**75%**	**0%**
Exposed, relatively high fault tolerance, and unpredictable threat environment encourage reactive posture. Adaptation encouraged over reliance on recovery based on multi-faceted mission which is subject to change, decision making localized, and operations relatively autonomous.				
Nuclear Power Plant	**37.5%**	**37.5%**	**6%**	**19%**
Emphasis on proactive posture resulting from low fault tolerance (associated with potential cascading effects), difficult to access for repairs, threats unpredictable, high cost-to-replace and long time-to-replace.				

Topics for Future Research

- Necessary and sufficient question set?
- Are “Mission, Environment, Culture” adequate?
- What is appropriate weighting within questions?
- Binary “yes-no” responses or “1-10”?
- Output in % or High/Med/Low?

Objective of the Methodology

- **Promote reflection on organizational nature and objectives**
- **Provide a concept/tool to support decisions about future resilience investments**



Paper available through conference site

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Air Traffic Control System Example

		Proactive 50%	Reactive 50%
Proactive/Reactive			
Does the system have low fault tolerance? (Mission)	Yes	63%	37%
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		Anticipation 12.5%	Absorption 12.5%
Defense Approach			
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		Adaptation 37.5%	Recovery 37.5%
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