

## 1 PURPOSE

The purpose of the Resilient Systems Working Group (RSWG) is to further the understanding of resilience of human-made systems and to provide a clear description of the principles of resilience within the canon of systems engineering knowledge areas (KAs). The working definition of resilience, as agreed by the RSWG, is that “Resilience is the capability of a system with specific characteristics before, during and after a disruption to absorb the disruption, recover to an acceptable level of performance, and sustain that level for an acceptable period of time.” The following words were clarified:

- The term *system* is limited to human-made systems containing software, hardware, humans, concepts, and processes. Infrastructures are also systems.
- The term *sustain* allows determination of long-term performance to be stated.
- *Characteristics* can be static features, such as redundancy, or dynamic features, such as corrective action to be specified.
- The terms *before*, *during* and *after* – Allow the three phases of disruption to be considered.
  - *Before* – Allows anticipation and corrective action to be considered
  - *During* – How the system survives the impact of the disruption
  - *After* – How the system recovers from the disruption
- *Disruption* is the initiating event of a reduction in performance. A disruption may be either a sudden or sustained event. A disruption may either be internal (human or software error) or external (earthquake, tsunami, hurricane, or terrorist attack).

## 2 GOAL

The goal of the RSWG is to make a measurable impact on resilience at the national and international level. The primary mechanism for this impact is The Infrastructure Security Partnership (TISP). TISP is a consortium of government agencies, universities, private businesses, and professional societies (such as INCOSE). TISP seeks to find ways to make the national infrastructure resilient to terrorist attacks and natural disasters. TISP has direct links to the Department of Homeland Security (DHS) Office of Resilience and the White House Office of Resilience. Two TISP products are in development, and RSWG members have contributed to their development. One is the Regional Resilience Guide, and the other is the Creating Resilient Infrastructure handbook. Publication in 2011 is anticipated.

Another product of the RSWG is the Resilience Knowledge Area (KA) in the Systems Engineering Body of Knowledge (SEBoK). Version 0.25 has already been published.

## 3 SCOPE

Resilience is an emergent property of complex systems. The attributes of resilience are capacity, flexibility, tolerance, and cohesion. Resilience is implemented through a set of identified heuristics. About 40 of these heuristics have been identified. Hence, the scope of resilience is beyond traditional reductionist systems engineering. Resilience is not a specialty topic. Reliability and system safety can be considered part of the capacity attribute. Resilience is an over-arching set of design principles intended to enable a system to recover from a disruption.

Hence, both analytic and holistic considerations are required for resilience. Analytic capabilities are required to define the capacity attribute. Flexibility, tolerance, and cohesion are more dependent on holistic methods.

The term resilience has been used in other fields for many years. These include materials science, psychology, and ecology. However, these fields study *intrinsic* resilience as opposed to designed-in resilience, which is the focus of this WG. Hence, intrinsic resilience is out of scope. However, the resilience found in natural systems may be used as examples for human-made systems.

#### 4 SKILLS AND EXPERTISE REQUIRED

Although resilience is in a seminal stage of study, members should be thoroughly familiar with its principles. Two primary references are (Jackson, 2010) and (Hollnagel et al., 2006).

A second skill is the ability is the interpersonal skills needed to work with groups, such as TISP.

#### 5 MEMBERS, ROLES AND RESPONSIBILITIES

List the names of members and briefly describe their responsibilities.

- Lead: Scott Jackson
  - o Primary contact with external organizations, such as TISP
  - o Maintaining member list and email distribution
  - o Chairing meetings at symposia and workshops
  - o Reporting status
  - o Publishing newsletter
- Board Sponsor(s)/Champion(s): Bill Miller
  - o Resource advocacy and status reporting to the INCOSE BOD and external stakeholders.
- Members
  - o The member list has about 90 names. However, the following members have participated in various activities
    - Azad Madni (workshop meeting)
    - Dick Emerson (guidebook planning and fire protection meeting)
    - KC King (TISP meetings)
    - Katri Hakoli (TISP meetings)
    - Jennifer Maxwell (Insight article preparation)
    - Daryl McDaniel (TISP meetings)
    - David Boyd (fire protection meeting)

#### 6 OUTCOMES (PRODUCTS/SERVICES)

The primary project is known as the TISP project. A TPP has been submitted for this project. Two products are expected to be produced for this project. One is called the Regional Resilience Guide. The other is called the Creating Resilience Infrastructure handbook. The RSWG has already made inputs to these products. Publication is expected in 2011.

In 2009 members of the RSWG met with representatives of the San Francisco Fire Department in San Francisco. Also present were representatives of the Anti-Terrorism International Working



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Group (ATIWG) and the Infrastructure Working Group (IWG). The result was an Insight article by (Maxwell and Emerson, 2009) which documented resilience aspects of the fire protection domain.

Another product also delivered in an Annotated Resilience Bibliography. This product can be found on INCOSE Connect. The information in this product will be used in other products.

## 7 APPROACH

Define the general approach that will guide this WG/Initiative including:

- Meetings are normally held at the International Workshop (IW) meetings.
- Members are encouraged to attend the TISP teleconferences
- The final products are the responsibility of TISP.
- Occasional participation with other WGs when expertise in resilience principles is needed by them. The two WGs where collaboration has been needed are the Anti-Terrorism International WG (ATIWG) and the Infrastructure WG (IWG).

## 8 MEASURES OF SUCCESS

The ultimate measure of success is the publication of guidebooks and standards that instruct local and regional entities on how to achieve resilience in their infrastructure.

## 9 RESOURCE REQUIREMENTS

Membership of INCOSE in TISP requires an allocation of \$1750. This membership in TISP entitles all INCOSE members to participate in TISP.

## 10 DURATION

This Charter will remain in effect until rescinded by the signatory.

## 11 SIGNATURES

Scott Jackson

Date 11/13/10

### 1<sup>st</sup> Level of Approval

Date August 23, 2011

Technical Director, INCOSE

### 2<sup>nd</sup> Level of Approval (Note this will be added by the INCOSE Technical Director when deemed appropriate.)

Chairman, INCOSE Board of Directors

Date

## References



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HOLLNAGEL, E., WOODS, D. D. & LEVESON, N. (eds.) 2006. *Resilience Engineering: Concepts and Precepts*, Aldershot, UK: Ashgate Publishing Limited.

JACKSON, S. 2010. *Architecting Resilient Systems: Accident Avoidance and Survival and Recovery from Disruptions*, Hoboken, NJ, John Wiley & Sons.

MAXWELL, J. & EMERSON, R. 2009. Observations of the resilience architecture of the firefighting and emergency response infrastructure. *Insight*. International Council on Systems Engineering.

### Revision History

<u>Date</u>	<u>Revision</u>	<u>Description</u>	<u>Author</u>
11/13/10	1.0	Initial Draft.	Scott Jackson