

Now Available – A Survivability Self Study Program (SSSP)

An aircraft combat survivability self study program (SSSP) for use on a Windows or Apple personal computer has been developed by Dist. Prof. Emeritus Robert E. Ball for the JASP. The program provides a relatively quick, easy, and effective way to learn about the fundamentals of the aircraft combat survivability discipline. Nearly all of the material in the program has been taken from the Prologue and Chapter 1 of the Textbook "*The Fundamentals of Aircraft Combat Survivability Analysis and Design, Second Edition*," written by Robert E. Ball and published by the American Institute of Aeronautics and Astronautics (AIAA) in late 2003.

The program consists of a series of 800 x 600 pixel cards, and each card contains one subsection of the Textbook. When the program is first launched, an opening video plays. When the video is finished playing, the opening splash card shown below in Fig. 1 appears.



Figure 1 – The splash card

The user proceeds through the program by first clicking on the **Instructions** button. The Instructions card immediately appears with the information on how to use the program. After reading the information on this card and returning to the splash card, the user clicks on the **Credits** button to learn who is responsible for the program. Returning to the splash card and clicking on the **Begin** button starts the study. The user enters his/her name, and the card showing the Table of Contents, shown in Figure 2, appears.

Table of Contents

Table of Contents (ToC)

Click on a Section to go to that Section's card, or press the "return" or "Enter" key to go to the highlighted Section

Prologue -- A Sense of Perspective
MNS, MOPs, MOEs, and aircraft attributes
Survivability as a design requirement
The survivability discipline
Some survivability issues
1.1 Overview of the Fundamentals
1.1.1 What is aircraft combat survivability?
1.1.2 How do we measure survivability?
1.1.3 Why do we need survivability?
1.1.4 One-on-One or engagement level survivability assessment
1.1.5 Many-on-Many or mission level survivability assessment
1.1.6 Campaign-Level survivability
1.1.7 Summary of the survivability equations
1.1.8 How is survivability enhanced?
1.1.9 What are the goals of the ACS discipline?
1.1.10 What is the relationship between survivability and effectiveness?
1.1.11 What are managed attrition and virtual attrition?
1.1.12 When and how do we assess survivability?
1.1.13 What is system survivability?
1.1.14 What is the relationship between the ACS discipline and DE survivability, NBC contamination, and system survivability?
1.1.15 What is the relationship between the ACS discipline and the survivability and system survivability of NBC contamination?
1.1.16 What is battle damage repair?
1.2 Historical Perspective of Survivability
1.2.1 Historical losses and loss rates
1.2.2 World Wars I and II
1.2.3 Post-World War II and the Korean conflict
1.2.4 Southeast Asia conflict, 1964-1973
1.2.5 Conflicts after 1972

Figure 2 – The Table of Contents

This card contains links to each of the subsections in the Prologue and Chapter 1. The user clicks on a subsection, such as “MNS, MOPs, MOEs, and aircraft attributes,” the first subsection in the Prologue, and the first card for that subsection appears, as shown in Fig. 3.

The screenshot shows a software window titled "Section Cards". At the top, there are three circular icons. Below them, the title "Section Cards" is displayed. Underneath the title, the text "Prologue -- a sense of perspective" is shown in a smaller font. Below this, the subtitle "MNS, MOPs, MOEs, and aircraft attributes" is centered. A blue rectangular box contains the text: "There are no formal learning objectives for the Prologue; this material sets the stage for your study of survivability." To the right of this box is a button labeled "My Notes". Below the text box, the instruction "The topics in this Section are:" is followed by a bulleted list: "• The Mission Need Statement (MNS)", "• The Measures of Performance (MOPs)", "• The Operational Requirements Document (ORD)", and "• The Measures of Effectiveness (MOEs)". At the bottom left is a button labeled "I'm ready to read the text now". At the bottom center is a button labeled "ToC".

Figure 3 – The first subsection of the Prologue

The user reads the “Learning Objectives” and the topics list. (There are no Learning Objectives for this subsection.) When ready, the user clicks on the **I’m ready to read the text now** button, and the card containing the text for this subsection appears, as shown in Fig. 4.

Section Cards

Prologue -- a sense of perspective

MNS, MOPs, MOEs, and aircraft attributes

There are no formal learning objectives for the Prologue; this material sets the stage for your study of survivability.

• **The Mission Need Statement (MNS)**

U. S. military aircraft are designed, developed, and operated to fill a need initially expressed in a DoD Mission Need Statement (MNS). ([Note a \[S+a\]](#)) They are special purpose aircraft that must operate efficiently in peacetime and effectively in wartime. As a result of this dual peacetime-wartime environment, they have more requirements imposed upon them during the acquisition process than those imposed upon civilian aircraft. Here is a list of some of the characteristics, capabilities, or attributes that must be considered when developing or acquiring a military aircraft:

- Affordable,
- Safe to operate and maintain,
- Fast and high (enough) flight,
- Carries a large/heavy payload over a long distance,
- Multimission capability,
- Long lived,
- Stealthy,
- Nighttime capability,
- Low crew workload,
- Easy to modernize,
- Easily maintained,
- Easy to produce and repair,
- Secure communications,

My Notes

This program is fantastic! You really must try it out.

Hiliting Finished ToC

Figure 4 – The first subsection of the Prologue – continued

Note in Fig. 4 that the user can enter notes in a special “My Notes” field on the right side of each card and that important subsection text can be highlighted with a yellow pen, just like a printed textbook. Furthermore, the program provides links for easy access to subsection end notes, figures, and tables without leaving the current card. For example, clicking on the blue underlined “Note a” in the third line of the text in Fig. 4 (or entering cap S and lowercase a on the keyboard) reveals “Note a” on the right hand side of the card, as shown in Fig. 5.



Section Cards

Prologue -- a sense of perspective
MNS, MOPs, MOEs, and aircraft attributes

There are no formal learning objectives for the Prologue;
this material sets the stage for your study of survivability.

My Notes

• **The Mission Need Statement (MNS)**

U. S. military aircraft are designed, developed, and operated to fill a need initially expressed in a DoD Mission Need Statement (MNS). ([Note a \[S+a\]](#)) They are special purpose aircraft that must operate efficiently in peacetime and effectively in wartime. As a result of this dual peacetime-wartime environment, they have more requirements imposed upon them during the acquisition process than those imposed upon civilian aircraft. **Here is a list of some of the characteristics, capabilities, or attributes that must be considered when developing or acquiring a military aircraft:**

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- Multimission capability,
- Long lived,
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- Nighttime capability,
- Low crew workload,
- Easy to modernize,
- Easily maintained,
- Easy to produce and repair,
- Secure communications,

Note a [S+a]

The MNS is a brief, nonsystem specific statement that succinctly defines a mission deficiency or technological opportunity in broad operational terms. It identifies potential materiel alternatives and describes the required operational capabilities and constraints to be studied. Information on the MNS and other aspects of the U.S. Department of Defense acquisition program is provided by the AT&L Knowledge Sharing System and the Defense Acquisition Guidebook available online at <https://akss.dau.mil/default.aspx> and <http://akss.dau.mil/dag/>, respectively.

No Hiliting

Finished

ToC

Figure 5 – Note a

Thus, the user can simultaneously see both the subsection text and the associated end note – no searching through the Textbook to find an end note, figure, or table is required. The program also links the user to the survivability internet sites referenced in the Textbook through the user's internet browser. For example, clicking on the first blue underlined URL at the bottom of "Note a" opens the Defense Acquisition University's "AT&L Knowledge Sharing System web site in the user's browser.

Finally, a few subsections contain links to video showing several aspects of survivability, such as a one-on-one encounter between a helicopter and an IR SAM and several fuel system kill modes in action. Figure 6 shows the video screen for the Fire/explosion – In-tank/ullage kill mode from Table 1.4.

The screenshot displays a software application window with the following components:

- Section Cards:** A sidebar on the left containing a tree view of content sections, with "1.1.8 How is survivability enhanced?" currently selected.
- Videos:** A central video player window titled "FIRE IGNITION SOURCES" showing a video frame with a bright light source and the text "Contact Spark Incendiary Materials".
- Tables:** A large table titled "Table 1.4 List of component and system kill modes" listing various kill modes categorized by component/system.
- Navigation:** Buttons at the bottom include "No Hillitting", "Finished" (unchecked), "ToC", "Close", and "DVD".

Component/system	Kill mode
Fuel	Fuel supply depletion Fire/explosion <u>In-tank/ullage</u> Void space Hydrodynamic ram Structure/removal Structure overload Structural weakening Lamination/fiber buckling Inertial force Mechanical damage S/overheat S/explosion Inlet flow distortion Tire failure Fuel ingestion Foreign object damage Fan/compressor damage Combustor damage Turbine damage Exhaust duct or after-burner damage Engine fire Engine subsystem or control failure Loss of lubrication Engine controls and accessories failure Mechanical/structural damage Loss of lubrication Disruption of the control signal path Loss of pilot Loss of control lines Computer failure Sensor damage Loss of control power Hydraulic failure Electrical failure Cavitation damage Damage to control surfaces/hinges
Electrical power	Hydraulic fluid fire Severing/grounding Mechanical damage Overheating Injury/death Life support failure
Crew	

Figure 6 – A video card

When the user is finished reading a subsection, the “Finished” box at the bottom of the card is checked (Fig. 5). The user then returns to the Table of Contents (Fig. 2) by clicking on the ToC button at the bottom of the card (Fig. 5). Clicking the link to “Survivability as a design discipline,” the second subsection in the Prologue, takes the user to that subsection. This process is continued until the user has finished all of the subsections – approximately the first 200 pages of the 900 page Textbook.

Another unique aspect of the computer-based program is the automation of the end-of-subsection problem-answering procedure. Clicking the **Problems** button at the bottom of each subsection card takes the user to the list of the end-of-subsection problems. When clicked, each problem appears on a card, such as Problem 1.1.2, “What is another term for the man-made hostile environment?” shown in Fig. 7.

The screenshot shows a software interface titled "Problems and Answers Section 1.1". Under the heading "1.1.1 What is Aircraft Combat Survivability?", there is a "Learning Objective 1.1.1" section with the text: "Describe the aircraft attributes of combat survivability, susceptibility, vulnerability, and killability." Below this is a "Problem 1.1.2" section with the question: "What is another term for the man-made hostile environment?". A text input box contains the answer "The enemy's xxx xxx.". A blue button labeled "And your answer is?" is positioned above two other buttons: "I disagree" and "I give up".

Figure 7 – A problem card

The user types an answer to the problem in the answer textbox by replacing the red xxx's with words. (Clicking the tab button will take the user to the next appearance of xxx.) If the answer is correct, the user is congratulated, and he/she proceeds to the next problem. If incorrect, the user has the opportunity to immediately type in another answer or to return to the subsection, determine the correct answer, and type it in the answer textbox. This process is repeated until the user either answers the problem correctly, or gives up, reads the correct answer on the problem card and proceeds to the next problem. The user can click the **I disagree** button on any problem card and send an e-mail message to Prof. Ball complaining about any unfair problems. A report card keeps a record of the correct and incorrect answers.

The user can save, quit, and return to the program at any time, starting where they previously stopped. All user notes, highlighted text, finished subsections, and the report card are saved when the user saves the program.

The SSSP can be obtained from the DoD Survivability/Vulnerability Information Analysis Center (SURVIAC) at
<http://www.bahdayton.com/surviac/survivabilityeducation.htm>

Versions of the program are available for both Windows and Apple computers, and both versions require QuickTime. You can download any version directly from the web site, and you may also request a CD containing all of the versions.

Although the AIAA/JASP Survivability Textbook is not required when using this program, the user may find it helpful to have a copy available. A copy of the Textbook can be obtained from the AIAA at <http://www.aiaa.org/content.cfm?pageid=360&id=1008> or from any online book seller. If the user is a U. S. Government civilian or military employee, he/she can obtain a copy at no cost from the Survivability/Vulnerability Information Analysis Center (SURIVAC) at (937)255-4840 or DSN 785-4840. The e-mail address is crosthwaite_kevin@bah.com.

Any questions regarding this program can be e-mailed to Prof. Ball at survivability@gmail.com.

