Dr. Bozoki is a Lockheed senior staff engineer specializing in software engineering. He also serves as a consultant to the aerospace industry through his own company, Target Software. Before joining Lockheed, Dr. Bozoki worked in operations research at Ford Motor Co. and Ford Aerospace and has held academic appointments at Stanford, California State University, Sacramento, Sir George Williams University Montreal, and the University of Nevada – Reno.
Dr. George J. Bozoki
Lockheed Missiles and Space Co.
Sunnyvale, California
Software Development cost estimates are often highly inaccurate – even when sophisticated models are used. This is largely due to erroneous software sizing.

It is universally recognized that the software sizing problem remains the most significant roadblock to accurate software cost estimation.

Dependable software cost estimating procedures are key to project planning, proposal preparations and project implementation decisions.

The ability to size software would greatly enhance the accuracy of software cost estimates. With better estimates, cost and schedule performance on current and future DoD software programs would increase significantly.
DATABASE STRUCTURE

PHASE I
- SUBSYS - 1
  - CMS
- SUBSYS - 2
  - MPS
- SUBSYS - M
  - SPS
- CSCI - 1
  - MEX
- CSCI - 2
  - FRM
- CSCI - N
  - FWD

PHASE II
- AREA - 1
  - COMM
- AREA - 2
  - MMI
- AREA - I
  - DATABASE
- FUNCT - 1
  - OPERATOR INPUT
- FUNCT - 2
  - DISPLAY MGMT
- FUNCT - J
  - OPERATOR OUTPUT
- SIZE DRV-1
  - FORMATS
- SIZE DRV-2
  - TERMINAL TYPES
- SIZE DRV-K
  - INPUT DEVICES
SSE OPERATIONS CONCEPTS

FUNCTIONAL
AREA

Man Machine Interface
Report Generation
Network

PROJECT
INFORMATION

Project   Size
P1000     XXX
P1010     XXX
P1020     XXX

FUNCTION

Display Management
Operator Input
Operator Output

SIZE
ACCUMULATION
LIST

Function  Size
Display Mgmt  XXX
Operator Input  XXX
Operator Output  XXX
Total  XXX

SIZE DRIVERS

# of Display Formats
# of Function Keys

OUTPUT REPORTS
& STAR Model Input

ANALOGY or SER
• ANALOGY
  ASSESSING SIMILARITIES AND DIFFERENCES

• SIZE ESTIMATING RELATIONSHIPS (SER)
  BASED ON KEY SIZE DRIVER

• ADJUSTED SER (ASER)
  COMBINATION OF ANALOGY AND SER

KD = # DISPLAY FORMATS
BENEFITS OF DATABASE DRIVEN SIZING:

- CAPTURES ACCURATE HISTORICAL PROJECT DATA.

- ALLOWS CROSS-PROJECT COMPARISON OF LIKE UNITS USING FUNCTIONAL DECOMPOSITION.

- MAPS FUNCTIONAL REQUIREMENTS TO LIKE FUNCTIONS IN THE DATABASE.

PROVIDE ACCURATE BASELINE TO SIZE NEW SOFTWARE PROJECTS
SSM... is a computerized simulation model providing rapid, accurate estimates of the expected size of a software project.

SSM... is fully interactive, self documented, menu driven model with extensive help facility.

SSM... is an expert judgment type model based upon three key facts:

1) The qualitative sizing information available at the proposal stage is more accurate than the corresponding quantitative data.

2) Estimators can make estimates of the relative sizes of modules more reliably than they can of their absolute sizes.

3) The estimated and actual relative magnitude of software modules are strongly correlated.
A. Project Information

B. Module Name / Description

C. Four Input Data Sets
   1) Pairwise Data
   2) PERT Sizing Data
   3) Sorting Data
   4) Ranking Data

D. At least two modules of known size
   (Reference Modules)
SSM OUTPUT TO SOFTWARE COST MODELS

- Module Sizes
- System Size
- Standard Deviations

RESULTS IN:

- More Credible Cost Estimates
• Hardware Requirements
  - IBM PC, XT, AT (or compatible)
  - Minimum 512K of memory
  - One Double-Sided, Double Density (DS/DO) 5.25 inch floppy diskette drive

• Software Requirements
  - Disk Operating System MS-DOS/PC-DOS version 2.0 or higher
<table>
<thead>
<tr>
<th><strong>PROJECT NAME:</strong></th>
<th><strong>FILE NAME:</strong></th>
<th><strong>DATE:</strong> 27 JUN 87</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSM WORKING DIRECTORY:</td>
<td></td>
<td>C: \SSM</td>
</tr>
<tr>
<td>COMPANY/ORG:</td>
<td>SSCAG</td>
<td></td>
</tr>
<tr>
<td>PROJECT NAME:</td>
<td>LANI PHASE 1</td>
<td></td>
</tr>
<tr>
<td>FILE NAME:</td>
<td>DEMO</td>
<td></td>
</tr>
</tbody>
</table>

Use ARROW keys or →↓ to ACCEPT entry  |  F10 when DONE  |  F1 for HELP  |  ESC to ABORT

- 10 -
**PROJECT NAME:** LANI PHASE I  |  **FILE NAME:** DEMO  |  **DATE:** 27 JUN 87

**SSM WORKING DIRECTORY:**  
C:\SSM

---

**MODULE INFO (DATA ENTRY)**

**ENTRY No.:**  1

**NAME:** On Board Computer (OBC) Emulation

**REFERENCE MODULE SIZE:**

**DESCRIPTION:**

On-board Computer (OBC) Emulation – The OBC emulation CSCI emulates the spacecraft OBC for use in spacecraft software validation. The validation is performed by executing the instructions and producing output which shows the effects on the OBC interfaces and timing.

---

**ARROW keys/ left = ACCEPT entry | F9 = ACCEPT module | F10 = ACCEPT & DONE | F1 = HELP | ESC = ABORT**
PROJECT NAME: LANI PHASE I
FILE NAME: DEMO
DATE: 27 JUN 87

SSM WORKING DIRECTORIES:
C:\SSM

PAIRWISE DATA (DATA ENTRY)

CURRENT PAIR: 1
REMAINING PAIRS: 14

Spacecraft and System Simulation
System Status and Schedule

LARGER MODULE

Use ←→ to SELECT module ←↑ = ACCEPT F2/F3 = L/R DES F9 = FAST mode F1 = HELP ESC = ABORT
**Project Name:** LANI Phase I

**File Name:** DEMO

**Date:** 27 Jun 87

**SSM Working Directory:** C:\SSM

**Module Name:** Spacecraft Monitor and Control

**Current Number:** 4

**Remaining Modules:** 1

**Size Estimates:**
- Lowest: 23,000
- Most Likely: 30,000
- Highest: 40,000

**Change Rate:** 1000

- **GENERATE** number
- **PgUp/PgDn** = CHANGE rate
- **F2** = DESCR
- **F1** = HELP
- **ESC** = ABORT
PROJECT NAME: LANI PHASE I  FILE NAME: DEMO  DATE: 27 JUN 87
SSM WORKING DIRECTORY:  C:\SSM

SORTING DATA (DATA ENTRY)

MODULE NAME: On Board Computer (OBC) Emulation
CURRENT NUMBER: 1  REMAINING MODULES: 1

SIZE INTERVALS

7601 - 10000
10001 - 14000
14001 - 19000
19001 - 25000
25001 - 34000
34001 - 46000

Use ARROW keys to SELECT size interval  = to ACCEPT  F2=DESCR  F1=HELP  ESC to ABORT
PROJECT NAME: LANI PHASE I  FILE NAME: DEMO  DATE: 27 JUN 87

SSM WORKING DIRECTORY:
C:\SSM

RANKING DATA (DATA ENTRY)

REMAINING MODULES TO RANK: 0

Trend Analyzer  System Status and Schedule

LARGER MODULE

Use ←→ to select module ←→ = accept F2/F3 = L/R descr F9 = fast mode F1 = help ESC = abort
**SSM OUTPUT SCREEN**

**PROJECT NAME:** LANI PHASE I  
**FILE NAME:** DEMO  
**DATE:** 27 JUN 87

**SSM WORKING DIRECTORY:**  
C:\SSM

---

**SSM SIZE ESTIMATES**

<table>
<thead>
<tr>
<th>MODULE NAME</th>
<th>-STD DEV</th>
<th>EXPECTED MODULE SIZE</th>
<th>+STD DEV</th>
<th>MODULE DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>O/B Computer Emulation</td>
<td>10300</td>
<td>12900</td>
<td>15500</td>
<td>2600</td>
</tr>
<tr>
<td>Operations Planning</td>
<td>86400</td>
<td>103700</td>
<td>121000</td>
<td>17300</td>
</tr>
<tr>
<td>S/C &amp; System Simulation</td>
<td>85000</td>
<td>85000</td>
<td>85000</td>
<td>0</td>
</tr>
<tr>
<td>S/C Monitor &amp; Control</td>
<td>23800</td>
<td>29900</td>
<td>36000</td>
<td>6100</td>
</tr>
<tr>
<td>System Status &amp; Schedule</td>
<td>11400</td>
<td>13400</td>
<td>15400</td>
<td>2000</td>
</tr>
<tr>
<td>Trend Analyzer</td>
<td>12000</td>
<td>12000</td>
<td>12000</td>
<td>0</td>
</tr>
</tbody>
</table>

Use ARROW keys to SCROLL display | F10/←→=DISPLAY system size | F1=HELP | ESC=ABORT
SSM OUTPUT SCREEN

PROJECT NAME: LANI PHASE I
FILE NAME: DEMO
DATE: 27 JUN 87

SSM WORKING DIRECTORY: C:\SSM

SYSTEM SIZE SUMMARY (*)

EXPECTED SYSTEM SIZE: 257000
STANDARD DEVIATION: 18600

( *) All REFERENCE modules are INCLUDED.
( STD DEV = 0 for reference modules).

CONFIDENCE LIMITS

<table>
<thead>
<tr>
<th>PROBABILITY (%)</th>
<th>LOW</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>244400</td>
<td>269500</td>
</tr>
<tr>
<td>68</td>
<td>238300</td>
<td>275600</td>
</tr>
<tr>
<td>95</td>
<td>219800</td>
<td>294200</td>
</tr>
<tr>
<td>99</td>
<td>201200</td>
<td>312800</td>
</tr>
</tbody>
</table>

Press F9 for PREVIOUS output display  Press F10 or ← to RETURN to MAIN menu