# Extra-Vehicular Activity Systems Sizing Analysis Tool (EVAS_SAT) Development Status

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## Overview

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- EVAS_SAT Structure
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## Overall Objective

- Initiated by NASA/JSC to develop an Extra-Vehicular Activity System Sizing Analysis Tool (EVAS_SAT) for EVA system architecture and studies to support space suit development efforts.

- EVAS_SAT estimates the mass, power and volume characteristics for user-defined EVA System architectures including Suit Systems, Airlock Systems, Tools and Translation Aids, and Vehicle Support equipment.

- Designed for use by members of the EVA community and related areas.

- Assumes subsystem familiarity on the part of the intended user group and in the analysis of results. *Note: Sizing results are not certified at this time.*

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## Functions of EVAS_SAT

- To aid conceptual design of the EVA system for future human exploration missions.

- To estimate the EVA system mass, volume, and power requirements for different EVA configurations and mission scenarios.

- To conduct trade studies of the EVA system based on different combinations of technologies in the subsystem.

- To conduct optimization studies and help determine the best technology candidates for development efforts.

# Development Status

- **Previous work**
  - ✓ FY01 - Evaluated related models to determine a starting point; developed the tool based on the LSOPP model.
  - ✓ FY02 - Developed basic structure of EVAS_SAT.
  - ✓ FY03 – Expanded mass and power categories; developed capability to compare cases; introduced a dual airlock capability; updated and expanded breathing gas supply, vent flow, $CO_2$, $H_2O$, and thermal control technologies; and enhanced the Tools and Translation Aids worksheet.
  - ✓ FY04 – Added user-defined option to all components and vehicle support capability for 2-vehicle mission; enhanced LCVG and non-liquid cooling garment sizing.
- **Currently under development**
  - – FY04 – Mass and heat balance models are under development.
- **Future work**
  - – Research and validate EVAS_SAT data.
  - – Add additional new technology information.
  - – Reduce EVAS_SAT program size and increase performance.

# EVAS_SAT Sizing Philosophy

- Research and determine baseline sizing for existing unit.

- Determine baseline capacity.

- Break down components into categories with similar sizing relationships

- Scale new configuration relative to the baseline capacity.

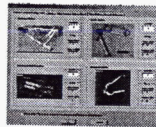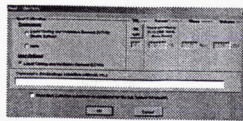- Default values in EVAS_SAT are capacities of existing unit.

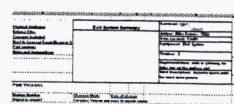# EVAS_SAT Structure

## Input pages

## User Interface

## Sizing Module

## Result pages

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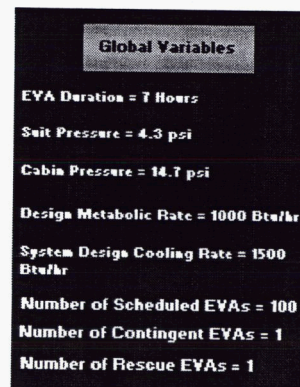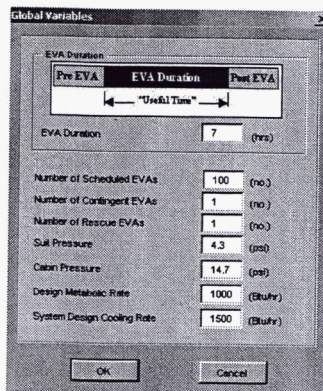
# Global Variables and Data Control

- Display of global variables and data control options is contained within each system.

**Global Variables**

EVA Duration

| Pre EVA | EVA Duration | Post EVA |
|---------|--------------|----------|

"Useful Time"

| | | |
|---|---|---|
| EVA Duration | 7 | (hrs) |
| Number of Scheduled EVAs | 100 | (no.) |
| Number of Contingent EVAs | 1 | (no.) |
| Number of Rescue EVAs | 1 | (no.) |
| Suit Pressure | 4.3 | (psi) |
| Cabin Pressure | 14.7 | (psi) |
| Design Metabolic Rate | 1000 | (Btu/hr) |
| System Design Cooling Rate | 1500 | (Btu/hr) |

OK     Cancel

**Global Variables**

EVA Duration = 7 Hours

Suit Pressure = 4.3 psi

Cabin Pressure = 14.7 psi

Design Metabolic Rate = 1000 Btu/hr

System Design Cooling Rate = 1500 Btu/hr

Number of Scheduled EVAs = 100

Number of Contingent EVAs = 1

Number of Rescue EVAs = 1
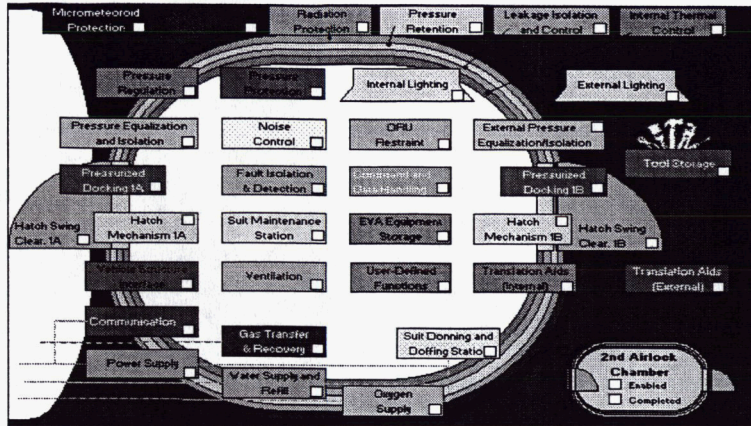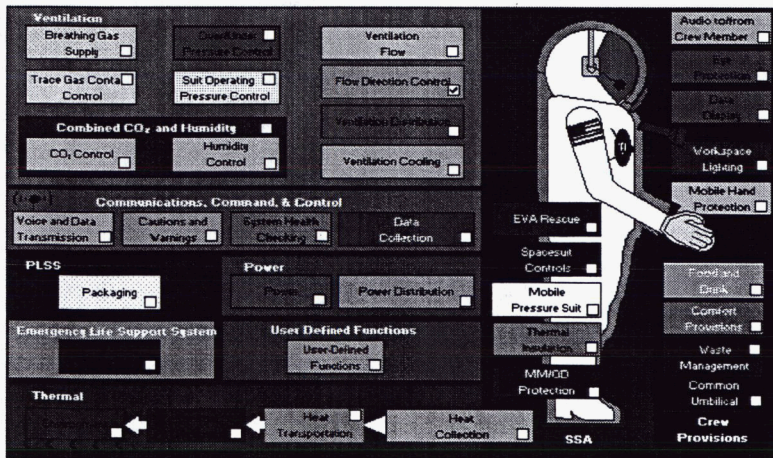
# Airlock

- Spreadsheet page which includes sizing calculations for related subsystems.
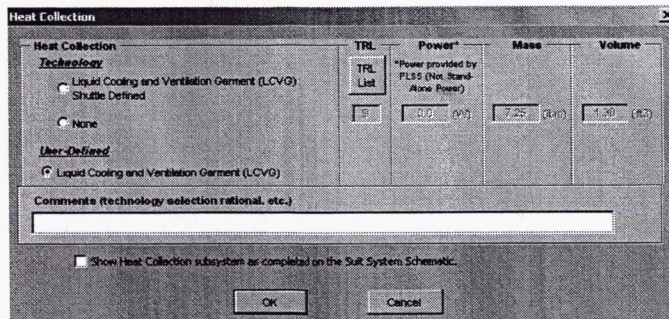
# Suit System

- Spreadsheet page which includes sizing calculations for related subsystems.
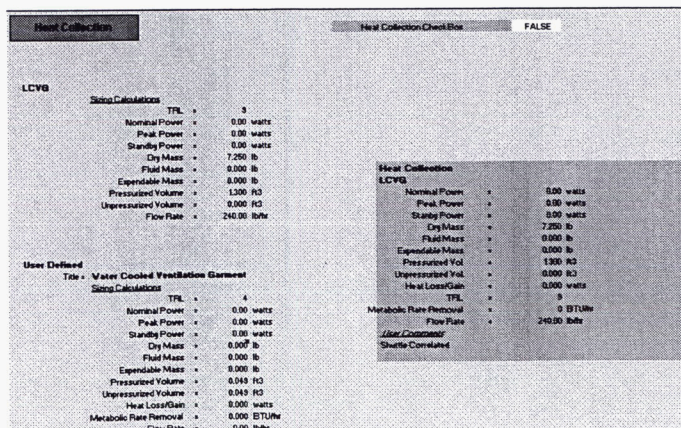
# Heat Collection Interface Form

- Visual Basic form which displays default values and allows user input.
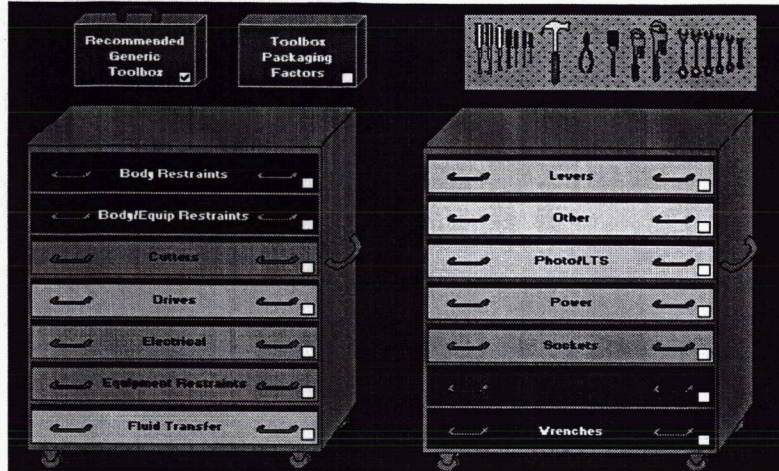
# Sizing Module

- One set of sizing calculations for each technology.
- Current values summarized for transfer to Main Module.

## Tools and Aids

- Spreadsheet page which includes sizing calculations for related subsystems.

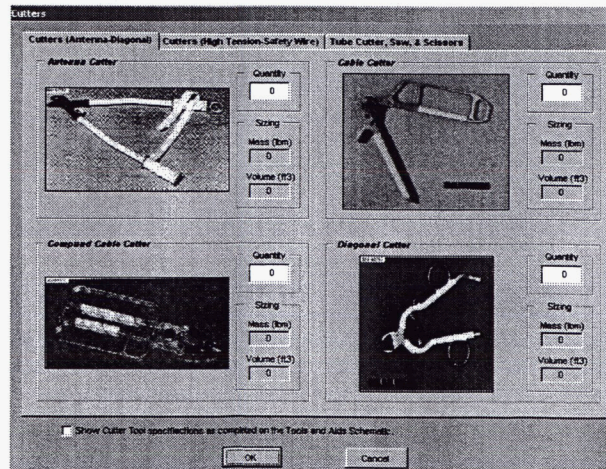## Cutter Tools Interface Form

- Visual Basic form which displays default values and allows user input.

## Vehicle Support

- Spreadsheet page which includes sizing calculations for related subsystems.

| Vehicle Selection | Vehicle #1 Support Technologies | Quantities | EVA System Needs |
|---|---|---|---|
| O₂ Characteristics | O₂ | | O₂ Characteristics |
| H₂O Characteristics | H₂O | | H₂O Characteristics |
| Cooling Characteristics | Cooling | | Cooling Characteristics |
| Voice Characteristics | Voice | | Voice Characteristics |
| Data Characteristics | Data | | Data Characteristics |
| Vent Characteristics | Vent | | Vent Characteristics |
| Power Characteristics | Power | | Power Characteristics |
| Regen Characteristics | Regen | | Regen Characteristics |
| Other Characteristics | Other | | Other Characteristics |

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## Main Module

- Summary page for mass, power, and volume sizing results.

**EVA System Sizing Analysis Tool (EVAS_SAT)**

Main Module | Airlock | Suit System | Tools and Aids | Vehicle Support | Case Data | EVAS Summary

**INPUT PARAMETERS**

**Design Parameters**

| | | | |
|---|---|---|---|
| Suit Type | | | Suit Selection |
| Environment | | | Environment |

**Global Variables**

| | | | |
|---|---|---|---|
| EVA_Time | 7 | hrs | Total EVA Time (Hr) |
| Suit_Pres | 4.3 | psi | Suit Pressure (psi) |
| Cab_Pres | 14.7 | psi | Cabin Pressure (psi) |
| Met_Rate_Cap | 1000 | Btu/hr | Metabolic Rate Design Capacity (Btu/Hr) |
| Cool_Sys_Cap | 1500 | Btu/hr | Cooling System Design Capacity (Btu/Hr) |
| EVA_scheduled | 100 | no. | Number of Scheduled EVAs |
| EVA_contingent | 1 | no. | Number of Contingent EVAs |
| EVA_rescue | 1 | no. | Number of Rescue EVAs |
| EVA_crew | 2 | no. | Number of crewmembers on EVA |

**SYSTEM SIZING RESULTS**

| System | Sub-System Name | Mass (lb) | | | Vol (ft3) | | Power (W) | TRL | System Technology |
|---|---|---|---|---|---|---|---|---|---|
| | | Dry | Fluid | Expendables | Press. | Unpress. | Nominal | | |
| Airlock | | | | | | | | | |
| Suit System | | | | | | | | | |
| Tools & Translation Aids | | | | | | | | | |
| Vehicle Support | | | | | | | | | |
| EVA System Totals | | | | | | | | | |

**EMERGENCY**

## EVA Systems Summaries

- One output worksheet for each of the four EVA systems.
- Consistent with Advanced Development Office's (EX) format.

| | | EVA System Summary | | Hardware Type: Concept |
|---|---|---|---|---|
| Physical Attributes | | | | Author: Mike Rouen / 39242 |
| Related Files | | | | Date Created: 9Jul01 |
| Concepts Included | | | | Equipment: EVA System |
| Used in Concept/Event/Element S | | | | |
| Past Versions | | | | Version: 2 |
| Notes and Assumptions | | | | |
| | | | | Implementation: suits to gateway for later use on the surface and |
| | | | | Brief Description: Includes space suits for each crew person |

**Past Versions**

| Version Number | Changes Made | Date of change |
|---|---|---|
| Original to version1 | Corrected Volume and mass to include spares | |

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## Conclusions

- EVAS_SAT contains a fully functional menu interface system that is easily navigated between systems and subsystems. Users can access subsystem components in any order desired. Independent parameters can be changed without having to redo the entire subsystem entry.

- Easy to determine if the subsystem has been completed.

- Detailed sizing is performed quickly using either default values or user input.

- New technologies can be readily added.

- Trade studies and system optimization of the EVA system can be accomplished with ease and efficiency.

# Acknowledgment

The developers wish to thank Mike Rouen/NASA JSC for his advice and direction during the project development and the JSC Crew and Thermal Systems Division management for funding this project.

Special thanks also go to Scott Ross/NASA JSC, Raul Blanco/NASA JSC, J. Pantermuehl/Hernandez Engineering, W. Vonau/GB Tech, B. Conger and G. Lucas/LMSO, and various college interns for their valuable contributions to the development of this analysis tool.

Information was extracted from existing studies and includes contributions by individuals in the following areas:

- Gretchen Thomas/NASA JSC ($CO_2$ removal)
- Grant Bue/NASA JSC & Gregg Weaver/LMSO (LCVG)
- Dr. Siraj Jalali/Oceaneering Space Systems (ejector)

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# References

References are available and will be provided upon request.