

AIRCRAFT DESIGN AND SYSTEMS GROUP (AERO)

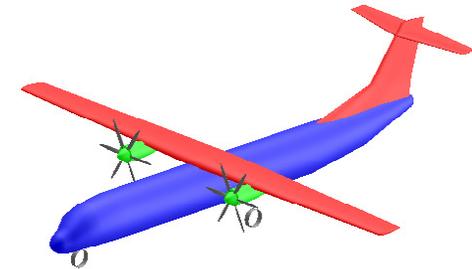
OpenVSP-Connect –  
Visualize **Your** Aircraft Sizing Results with  
NASA's Vehicle Sketch Pad

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Hamburg University of Applied Sciences

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Hamburg University of Applied Sciences



CEAS European Air & Space Conference 2013

Linköping, Sweden

16 to 19 September 2013

## OpenVSP-Connect – Visualize Your Aircraft Sizing Results with NASA’s Vehicle Sketch Pad

### Abstract

A 3D visualization is missing for many aircraft preliminary sizing tools. NASA’s Open Vehicle Sketch Pad (OpenVSP) is easy to use, but lacks an interface to input consistent aircraft data. Such an interface has been programmed and is called OpenVSP-Connect. Aircraft are sketched from about 50 parameters. If these are not known to the user, the interface calculates them as good as possible based on simple equations from aircraft design or statistics. Taken this to the extreme, a decent looking aircraft is drawn from as few as two or three input parameters.

## OpenVSP-Connect – Visualize Your Aircraft Sizing Results with NASA's Vehicle Sketch Pad

### Contents

- OpenVSP
- Three Approaches to Visualization with OpenVSP
- OpenVSP-Connect
- Summary

## OpenVSP-Connect – Visualize Your Aircraft Sizing Results with NASA's Vehicle Sketch Pad

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## OpenVSP

[OpenVSP](#)

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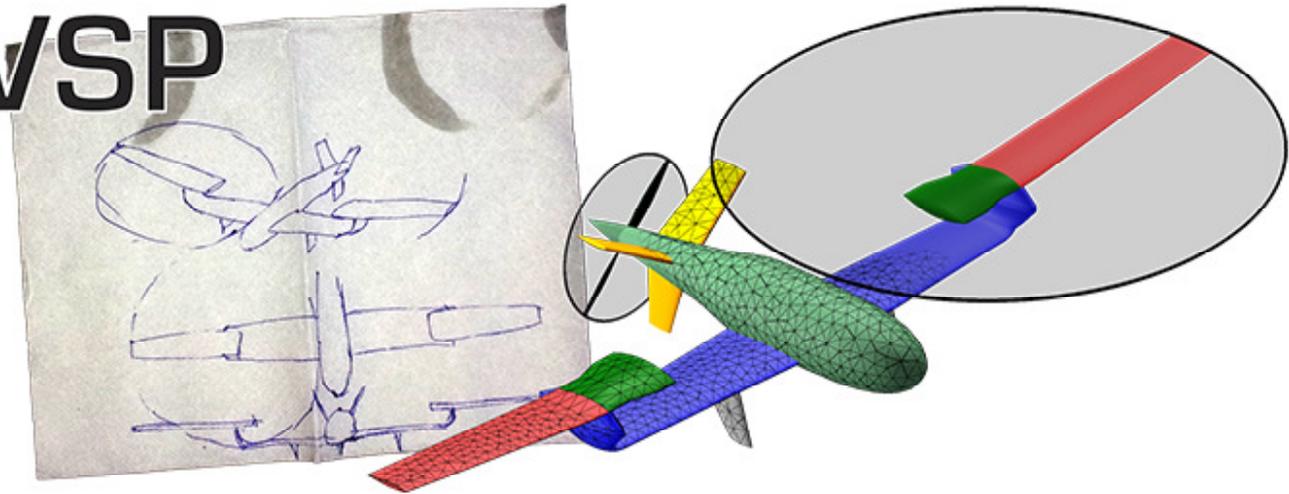
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# OpenVSP



vehicle sketch pad

join us

innovate

analyze

get it

**NASA open source parametric geometry**

[www.openVSP.org](http://www.openVSP.org)

## OpenVSP

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## Download and Install

Getting started with VSP is easy. If you're on Windows or MacOS, visit the [download](#) page and pull down the latest version ready-to-go. If you're on Ubuntu, there are some [installation instructions](#) on the Wiki; installation on most other Linux distributions should be similar.

## Tutorials

VSP is very easy to use. Most users get the hang of it after just a few minutes. If you're looking for more help, there are some [tutorial videos](#) and a downloadable [manual](#) which help you get started in VSP.

## VSP Hangar

The [VSP Hangar](#) is a database of community contributed example models. Check it out for a starting point or just for inspiration. Once you've completed your first model, show it off by contributing it to the hangar.

OpenVSP



# User Manual

---

**81 pages**

## OpenVSP

The screenshot shows the Google Groups interface for the 'OpenVSP' group. At the top, there is a search bar with the text 'Nach Themen suchen'. Below the search bar, the word 'Gruppen' is displayed in red. To the right of 'Gruppen' are three buttons: a red button labeled 'NEUES THEMA', a grey button with a refresh icon, and a grey button labeled 'Alle als gelesen markieren'. Below these buttons, the group name 'OpenVSP' is shown in a large font, followed by 'Öffentlich geteilt'. Underneath, it says '30 von 159 Themen (99+ ungelesen)' and includes a star icon and a blue button labeled 'Zum Posten der Gruppe beitreten'. To the right of this button is a '+1' icon. Below the group information, there is a list of four topics, each with a person icon, the topic name, and the number of members in parentheses. The topics are: 'NASA N2 (4)' by Pavan Soni (4 Beiträge - 6 Aufrufe), 'NASCART Tagging/Collars (6)' by Karén Melikov (6 Beiträge - 14 Aufrufe), 'VSP degenerate geometry (4)' by Steve (4 Beiträge - 11 Aufrufe), and 'VSP 3.0 Import File Formats (10)' by Karén Melikov (10 Beiträge - 21 Aufrufe).

## OpenVSP Google Group

## OpenVSP

 OpenVSP

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### OpenVSP wiki

OpenVSP is a parametric aircraft geometry tool. OpenVSP allows the user to create a 3D model of an aircraft defined by common engineering parameters. This model can be processed into formats suitable for engineering analysis.

The predecessors to OpenVSP have been developed by J.R. Gloudemans and others for NASA since the early 1990's. On January 10 2012, OpenVSP was released as an open source project under the NASA Open Source Agreement (NOSA) version 1.3.

[FAQ](#)

[Installation Instructions](#)

[Developer Instructions](#)

[API Use Cases](#)

start

Search, Clock, Link, Up arrow icons

## OpenVSP

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### OpenVSP Frequently Asked Questions and Tips

#### Known Bugs and Workarounds

1. The airfoil picture covers the Wing editor on MacOS.
  - When using OpenVSPmac2.0.3 or earlier, the airfoil cross-section plot persists when you leave the Foil tab of the `MS_Wing` editor. This is a known bug. Until it is fixed, the workaround is pretty easy. Once you leave the Foil tab by selecting another tab in the `MS_Wing` editor, simply click on the component name in the Geom Browser (usually sitting just to the left of the `MS_Wing` editor). This will force a refresh of the `MS_Wing` editor window.

## OpenVSP

### Filter Results

Source Quality
<input type="checkbox"/> 5 - Completely Inaccurate (1)
<input type="checkbox"/> 1 - Definitive (1)
<input type="checkbox"/> 2 - Essentially Exact (3)
<input type="checkbox"/> 3 - Good (11)

Manufacturers
<input type="checkbox"/> (5)
<input type="checkbox"/> Bombardier (3)
<input type="checkbox"/> NASA (3)
<input type="checkbox"/> Boeing (2)
<input type="checkbox"/> MIT (1)
<input type="checkbox"/> McDonnell Douglas (1)
<input type="checkbox"/> Embraer (1)

Units
<input type="checkbox"/> feet (14)
<input type="checkbox"/> dimensionless (2)

Tags
<input checked="" type="checkbox"/> transport (16)
<input type="checkbox"/> airplane (15)
<input type="checkbox"/> airliner (7)
<input type="checkbox"/> turboprop engine (3)
<input type="checkbox"/> twin-engine (3)
<input type="checkbox"/> blended wing body (2)
<input type="checkbox"/> lifting body (2)
<input type="checkbox"/> utility (1)

Filter Results

Name	Source Quality	Manufacturer	Model	Downloads	Comments	Date
IK-02	3			43	0	2013-02-24
IK-01	3			33	0	2013-02-24
LJJ-3X1	5		Jumbo Luxuryliner/ Cargo Transport	42	0	2013-01-31
DC-10	3	McDonnell Douglas	DC-10	99	0	2013-01-23
Bombardier Dash 8 Q400 clean w/o prop	2	Bombardier	Q400	144	0	2012-10-11
Bombardier Dash 8 Q400 clean w/o prop	2	Bombardier	Q400	70	0	2012-10-10
Bombardier Dash 8 Q400 clean	2	Bombardier	Q400	131	0	2012-10-04
ATR 42-600 Hybrid Electric	3		Hybrid ATR-42	119	0	2012-08-15
ATR 42-600	3	Embraer	ATR-42- 600	129	0	2012-08-15

# OpenVSP Hangar

## OpenVSP

[OpenVSP](#)

[VSP Hangar](#)

[Advanced Search](#)

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# Boeing 787-300

## OpenVSP Hangar

<b>File ID#</b>	61
<b>Manufacturer</b>	Boeing
<b>Model</b>	787-300
<b>Units</b>	Feet
<b>Description</b>	A general, non-exact Boeing 787-300 model
<b>Source Quality</b>	3 - The source material used to create this model was Good. This means good 3-view drawings were used to create the model.
<b>Model Suitability</b>	<ul style="list-style-type: none"> <li>2 - Cartoon or Pretty Picture</li> <li>2 - Weight and balance</li> <li>2 - OML for wetted areas/drag buildup</li> <li>2 - Check internal layout/volume</li> <li>2 - Structures</li> <li>2 - Build a display model</li> <li>3 - Accurate OML for detailed aerodynamic analysis or CFD</li> </ul>

**Tags** [airplane](#) , [transport](#)

left-click = rotate, middle-button/CTRL-left-click = pan, scroll/right-click/ALT-left-click = zoom

[Download](#)

[Revisions \(0\)](#)

OpenVSP

## Boeing 787-300



[hangar.openvsp.org](http://hangar.openvsp.org)

**X3DOM**  
LOADING SCENE...

**OpenVSP Hangar**

## OpenVSP



OpenVSP

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papers

These publication lists are very incomplete. Please take no offense to omissions – please help out and add them.

### Papers about VSP

- Chaput, A., Rizo-Patron, S., "Vehicle Sketch Pad Structural Analysis Module Enhancements for Wing Design", 50th AIAA Aerospace Sciences Meeting, Nashville, TN, 2012, AIAA-2012-546
- Hahn, A., "Application of Cart3D to Complex Propulsion-Airframe Integration with Vehicle Sketch Pad", 50th AIAA Aerospace Sciences Meeting, Nashville, TN, 2012, AIAA-2012-547



## OpenVSP-Connect – Visualize Your Aircraft Sizing Results with NASA's Vehicle Sketch Pad

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## Three Approaches to Visualization with OpenVSP

# Open Vehicle Sketch Pad Aircraft Modeling Strategies

Andrew S. Hahn<sup>1</sup>

*NASA Langley Research Center, Hampton, VA, 23681*

Geometric modeling of aircraft during the Conceptual design phase is very different from that needed for the Preliminary or Detailed design phases. The Conceptual design phase is characterized by the rapid, multi-disciplinary analysis of many design variables by a small engineering team. The designer must walk a line between fidelity and productivity,

...

American Institute of Aeronautics and Astronautics

## Three Approaches to Visualization with OpenVSP

*Hahn:* There are **two basic kinds of models created in Open VSP:**

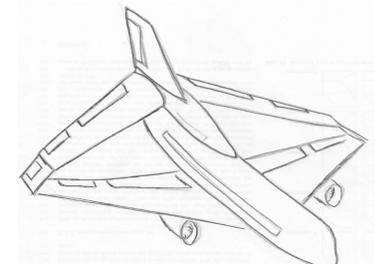
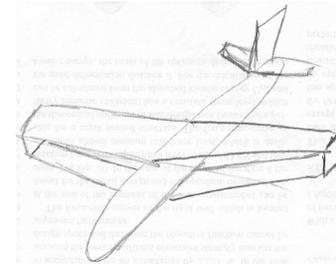
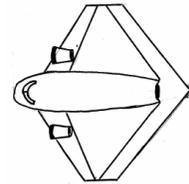
The **first approach** is the **“clean sheet” design** in which the **parameters are all chosen** by the designer using Open VSP. In this case, there is no other geometry and so this model is considered definitive.

The **second approach** basic kind of model is the **“match” design**. ... In this case, there is some other standard of comparison, be it a real aircraft or a geometry from a different modeler such as CAD. It takes significantly more effort to produce a model that is as good of a representation as possible. Usually, the only **geometric information available is limited tabular data and a three - view drawing**. There are different ways of building this kind of model, but the preferred way is to gather the most accurate information and then expend some effort to **derive the parameters that Open VSP needs** to create the model.

## Three Approaches to Visualization with OpenVSP

# The first approach: „clean sheet“ design

- Hand Sketches

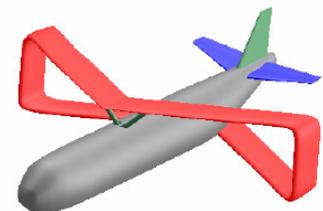
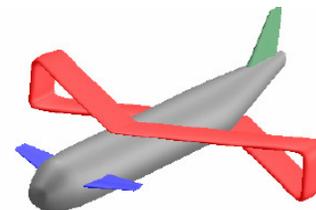
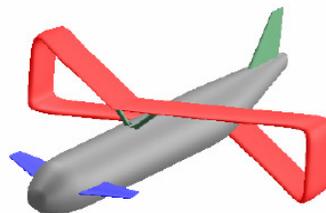
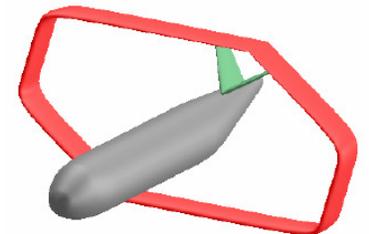
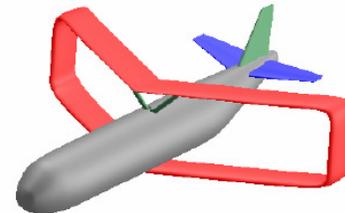
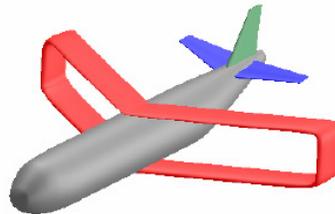


- Creative Methods

- Brainstorming
- Gallery Method

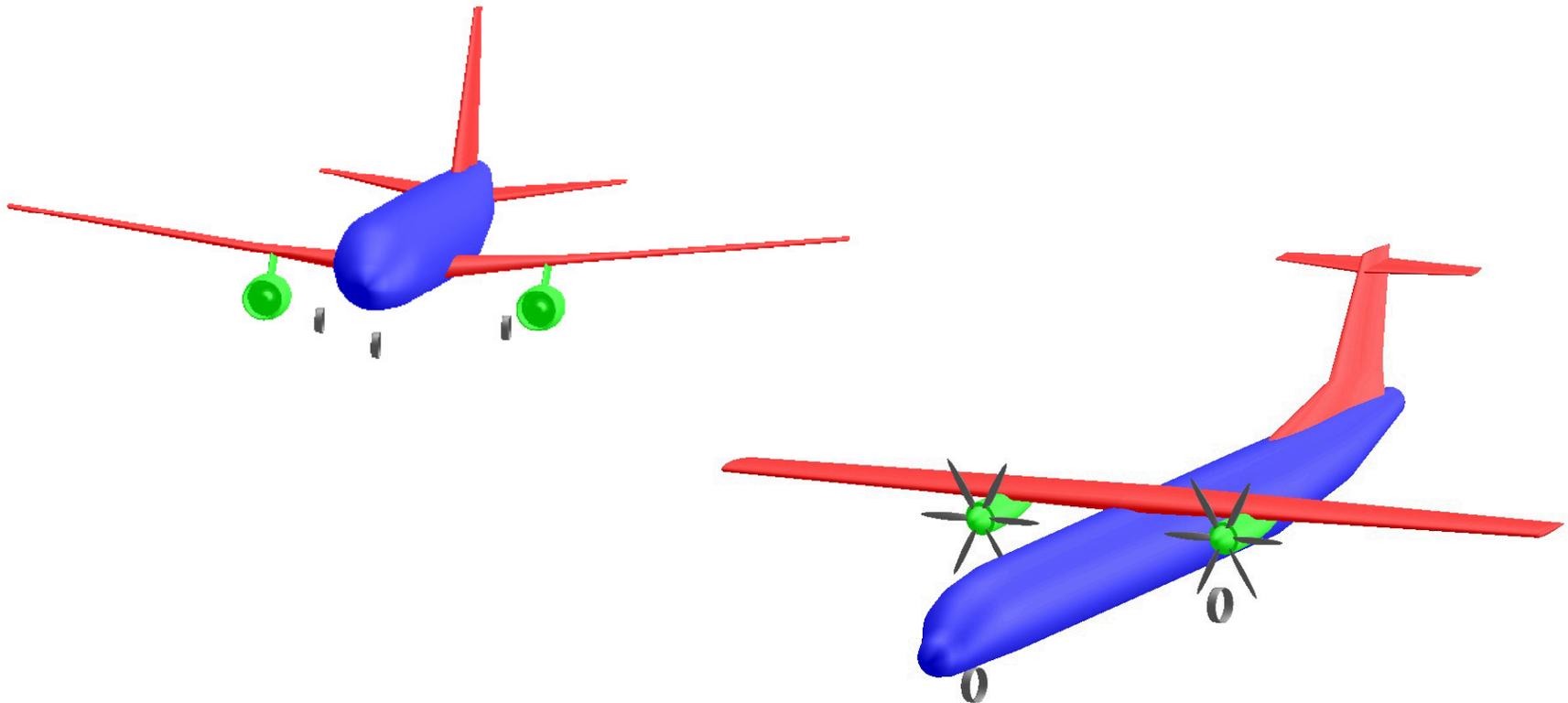


- Visualization with OpenVSP



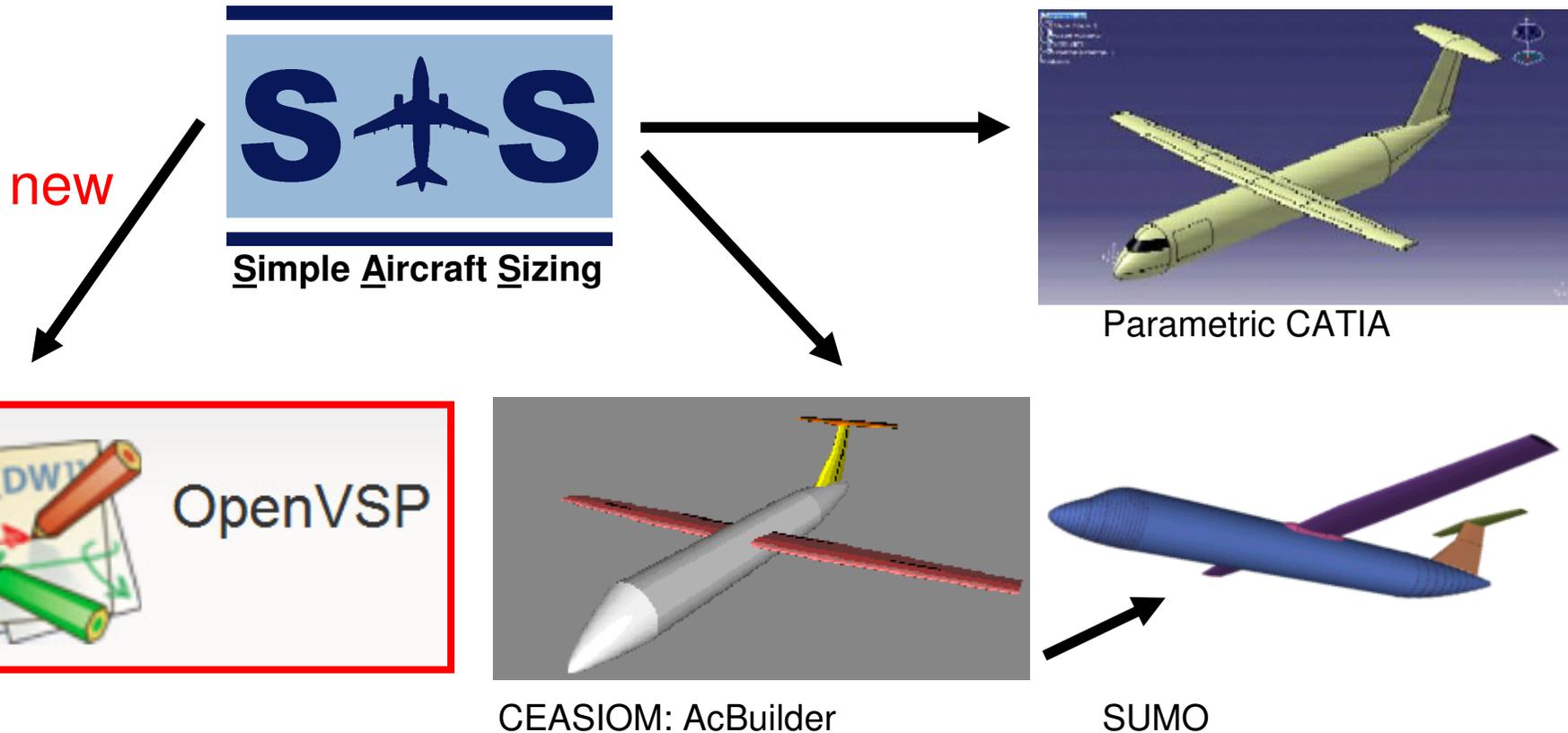
## Three Approaches to Visualization with OpenVSP

### The second approach: „match“ design



## Three Approaches to Visualization with OpenVSP

### The third approach: „calculated“ design



## Three Approaches to Visualization with OpenVSP



OpenVSP

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# RASCE

**Rapid Air System Concept Exploration**

RASCE is developed by Armand J. Chaput, and is distributed with the following license statement.

## Three Approaches to Visualization with OpenVSP

DRAFT



**AEROSPACE ENGINEERING  
& ENGINEERING MECHANICS**

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# Rapid Air System Concept Exploration (RASCE)

***Overview***  
*July 2009*

**University of Texas at Austin Air System Laboratory**  
Armand J. Chaput, Director



DRAFT

© 2009 Armand J. Chaput

See also:  
OpenVSP-  
Workshop  
2012

## Three Approaches to Visualization with OpenVSP

### Summary



**RASCE - a physics-based, conceptual level, air system design and analysis M&S environment developed to provide students with hands-on experience in air system design including real world design drivers not typically taught**

- *In continuous use since 2003 on student design projects*
- *Also applied to government and industry concept studies*

**RASCE is particularly well suited for concept screening and quantitative design and technology trade studies**

- *Configuration features and trade offs can be carefully and systematically controlled over a broad trade space*

**RASCE runs in real time on a standard laptop**

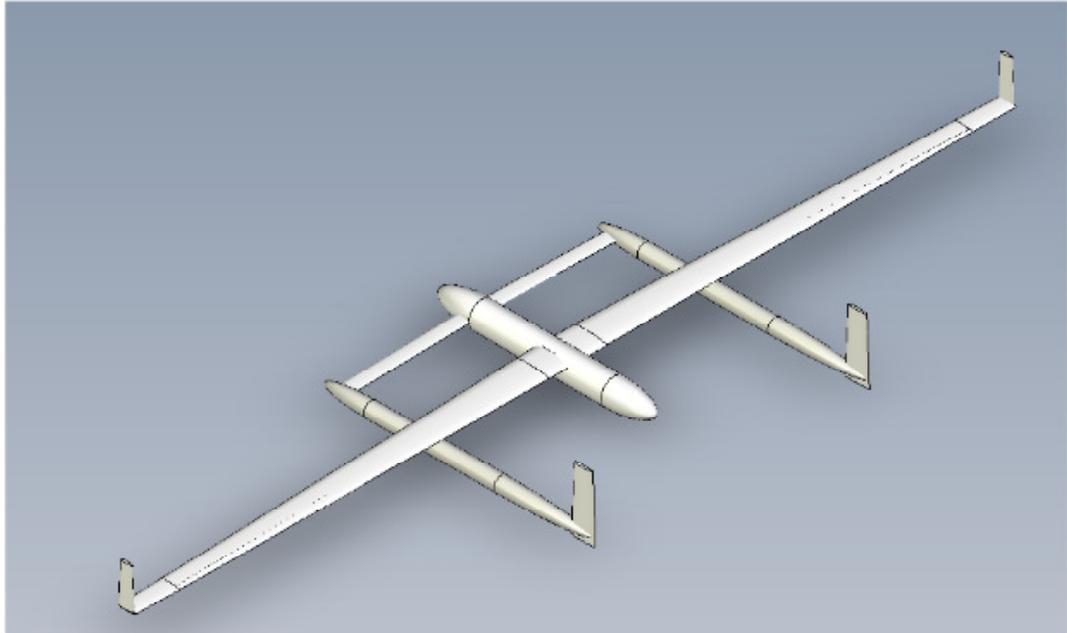
- *No laborious input data preparation and/or hand calculations*

**Experienced users can go from initial concept to complete air system sized to standard mission rules in < 1 hour**

© 2009 Armand J. Chaput

## Three Approaches to Visualization with OpenVSP

**3D model output  
rendered by SolidWorks**



**3D Rendering of Aircraft Configuration Designs**

James R. Carlson<sup>1</sup>  
*University of Texas, Austin, Texas, 78712*

© 2009 Armand J. Chaput

  THE UNIVERSITY OF TEXAS AT AUSTIN  
Cockrell School of Engineering  
AEROSPACE ENGINEERING  
& ENGINEERING MECHANICS

## OpenVSP-Connect – Visualize Your Aircraft Sizing Results with NASA’s Vehicle Sketch Pad

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## OpenVSP-Connect

# OpenVSP-Connect

**Connect** YOUR Aircraft Design Tool with Vehicle Sketch Pad from NASA

OpenVSP-Connect is primarily intended as an interface tool between ANY aircraft design tool and Open Vehicle Sketch Pad (openVSP) from NASA. OpenVSP-Connect needs OpenVSP for the display of the aircraft. You can download OpenVSP for free:

<http://www.openVSP.org>

In the order of 50 core parameters of the aircraft are used to calculate the input parameters required by OpenVSP to sketch a passenger aircraft. For each parameter a proposed value is given and automatically applied as long as the user does not specify his/her own value.

By using all default values, the program works in "automatic mode": Based on just two input values "Cruise Mach number" and "Number of passengers" an aircraft can be sketched automatically based on passenger aircraft statistics.

For further information, documentation please refer to:

<http://OpenVSP-Connect.ProfScholz.de>

OpenVSP-Connect is a project by Aircraft Design and Systems Group (AERO) at Hamburg University of Applied Sciences (HAW Hamburg).



## OpenVSP-Connect

OpenVSP-Connect is primarily intended as an **interface tool between ANY aircraft design tool and** Open Vehicle Sketch Pad (**openVSP**) from NASA.

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**For each parameter a proposed value is given and automatically applied as long as the user does not specify his/her own value.**

By using all **default values**, the program works in **"automatic mode"**: Ultimately, based on just three input values **"Number of passengers"**, **"Range"** and **"Cruise Mach number"** an aircraft can be sketched automatically based on passenger aircraft statistics.

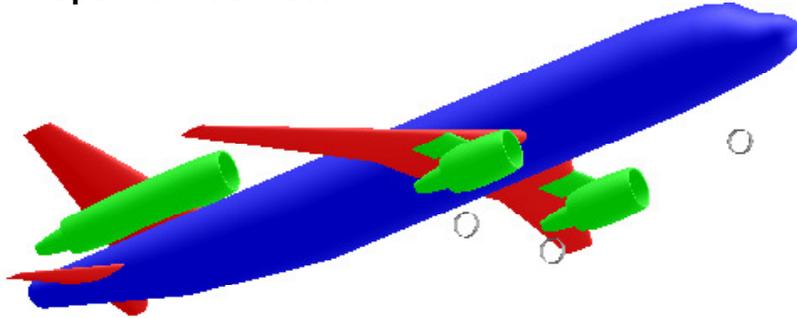
## OpenVSP-Connect

1 <b>Convert to OpenVSP XML</b>				
2 Convert data from Input-Tab to an OpenVSP XML file.				
3				
4				
	<b>Parameter names</b>	<b>Parameter values</b>	<b>Visualization needed?</b>	<b>XML generated from OpenVSP Connect</b>
5				
6	xml version	"1.0"		<?xml version="1.0"?>
7	Vsp_Geometry			<Vsp_Geometry>
8	Version	3		<Version>3</Version>
9	Name	AeroAircraft		<Name>AeroAircraft</Name>
26	VirtWindow_List			<VirtWindow_List>
208	Component_List			<Component_List>
209	Component	HORIZONTAL TAIL	Yes	<Component>
339	Component	VERTICAL TAIL	Yes	<Component>
511	Component	WING	Yes	<Component>
512	Type	Mswing		<Type>Mswing</Type>
513	General_Parms			<General_Parms>
561	Mswing_Parms			<Mswing_Parms>
562	Total_Area	104,544832		<Total_Area>0.000.105</Total_Area>
563	Total_Span	33,728326		<Total_Span>0.000.034</Total_Span>
564	Total_Proj_Span	33,695906		<Total_Proj_Span>0.000.034</Total_Proj_Span>
565	Avg_Chord	3,528260		<Avg_Chord>0.000.004</Avg_Chord>
566	Sweep_Off	0,000000		<Sweep_Off>0.000.000</Sweep_Off>
567	Deg_Per_Seg	9		<Deg_Per_Seg>9</Deg_Per_Seg>
568	Max_Num_Seg	9		<Max_Num_Seg>9</Max_Num_Seg>
569	Rel_Dihedral_Flag	0		<Rel_Dihedral_Flag>0</Rel_Dihedral_Flag>
570	Rel_Twist_Flag	0		<Rel_Twist_Flag>0</Rel_Twist_Flag>
571	Round_End_Cap_Flag	Yes		<Round_End_Cap_Flag>1</Round_End_Cap_Flag>
572	/Mswing_Parms			</Mswing_Parms>
573	Airfoil_List			<Airfoil_List>

## OpenVSP-Connect

1	2	A	B	C	D	E	F	G	H	I	J	K
	42	<b>4. Wing</b>										
	43											
	44	<b>Wing Type</b>	Type <sub>w</sub>		Double-trapezoidal	[-]						
	45	Total Area	S <sub>w</sub>		120,000	[m <sup>2</sup> ]						
	46	Total Aspect ratio	A <sub>w</sub>		9,480	[-]						
	47							Total Span	b <sub>w</sub>	33,728	[m]	
	48	Outboard 25% Sweep	φ <sub>25%,w</sub>		21,881	[°]	<<<<<<	25% Wing sweep suggestion	φ <sub>25%,w</sub>	21,881	[°]	
	49	Taper Ratio	λ <sub>w</sub>		0,198	[-]	<<<<<<	Taper Ratio Suggestion	λ <sub>w</sub>	0,198	[-]	
	50							Root Chord	c <sub>r,w</sub>	5,939	[m]	
	51							Tip Chord	c <sub>t,w</sub>	1,176	[m]	
	52							Outboard Leading edge Sweep	φ <sub>l,w</sub>	24,334	[°]	
	53							Outboard Trailing edge sweep	φ <sub>tr,w</sub>	14,022	[m]	
	54	Airfoil thickness ratio	(t/c)		0,116	[-]	<<<<<<	Thickness ratio	(t/c)	0,116	[-]	
	55	X position of wing	RelPos <sub>w,x</sub>		31,500	% of fuselage l	<<<<<<	X position of wing		31,500	% of fuselage length	
	56	Z position of wing	RelPos <sub>w,z</sub>		25,180	% of fuselage diameter						
	57	Outboard dihedral angle	Γ <sub>w,o</sub>		2,512	[°]	<<<<<<	Outboard dihedral angle	Γ <sub>w,o</sub>	2,512	[°]	
	58											
	59	<b>Edit this section</b>										
	60	Relative kink position	η <sub>k,w</sub>		0,320	[-]	<<<<<<	Relative kink position	η <sub>k,w</sub>	0,320	[-]	Relative kink constant
	61	Inboard Leading edge Sweep	φ <sub>l,w,i</sub>		24,334	[°]	<<<<<<	Inboard Leading edge Sweep	φ <sub>l,w,i</sub>	24,334	[°]	
	62	Inboard Trailing edge Sweep	φ <sub>tr,w,i</sub>		0,000	[°]	<<<<<<	Inboard Trailing edge Sweep	φ <sub>tr,w,i</sub>	0,000	[°]	
	63	Inboard dihedral angle	Γ <sub>w,i</sub>		2,512	[°]	<<<<<<	Inboard dihedral angle	Γ <sub>w,i</sub>	2,512	[°]	
	64											
	65	<b>5. Fuselage</b>										
	66											
	67	Fuselage diameter	d <sub>f</sub>		3,950	[m]						
	68	Fuselage length	L <sub>f</sub>		35,827	[m]	<<<<<<	Fuselage length	L <sub>f</sub>	35,827	[m]	Slenderness ratio
	69	Nose length	L <sub>nose,f</sub>		6,187	[m]	<<<<<<	Nose length	L <sub>nose,f</sub>	6,187	[m]	
	70	Cockpit length	L <sub>cockpit,f</sub>		2,568	[m]	<<<<<<	Cockpit length	L <sub>cockpit,f</sub>	2,568	[m]	Cockpit length constant
	71	Fuselage aft length	L <sub>aft,f</sub>		13,035	[m]	<<<<<<	Fuselage tail length	L <sub>tail,f</sub>	13,035	[m]	Fuselage tailcone constant
	72							Cylinder length	L <sub>cyl,f</sub>	16,604	[m]	
	73											
	74	<b>6. Horizontal Tail</b>										

## OpenVSP-Connect



### Input of Aircraft Design Parameters

Enter the results from any aircraft sizing or aircraft conceptual design tool. If data is unknown, use values as proposed here.

Aircraft Name

Description

#### 1. Action buttons

Open File in OpenVSP

Convert your data into an OpenVSP readable format and open it in OpenVSP. Ensure that cell marked as **OpenVSP\_Dir** on the side of this box is filled correctly.

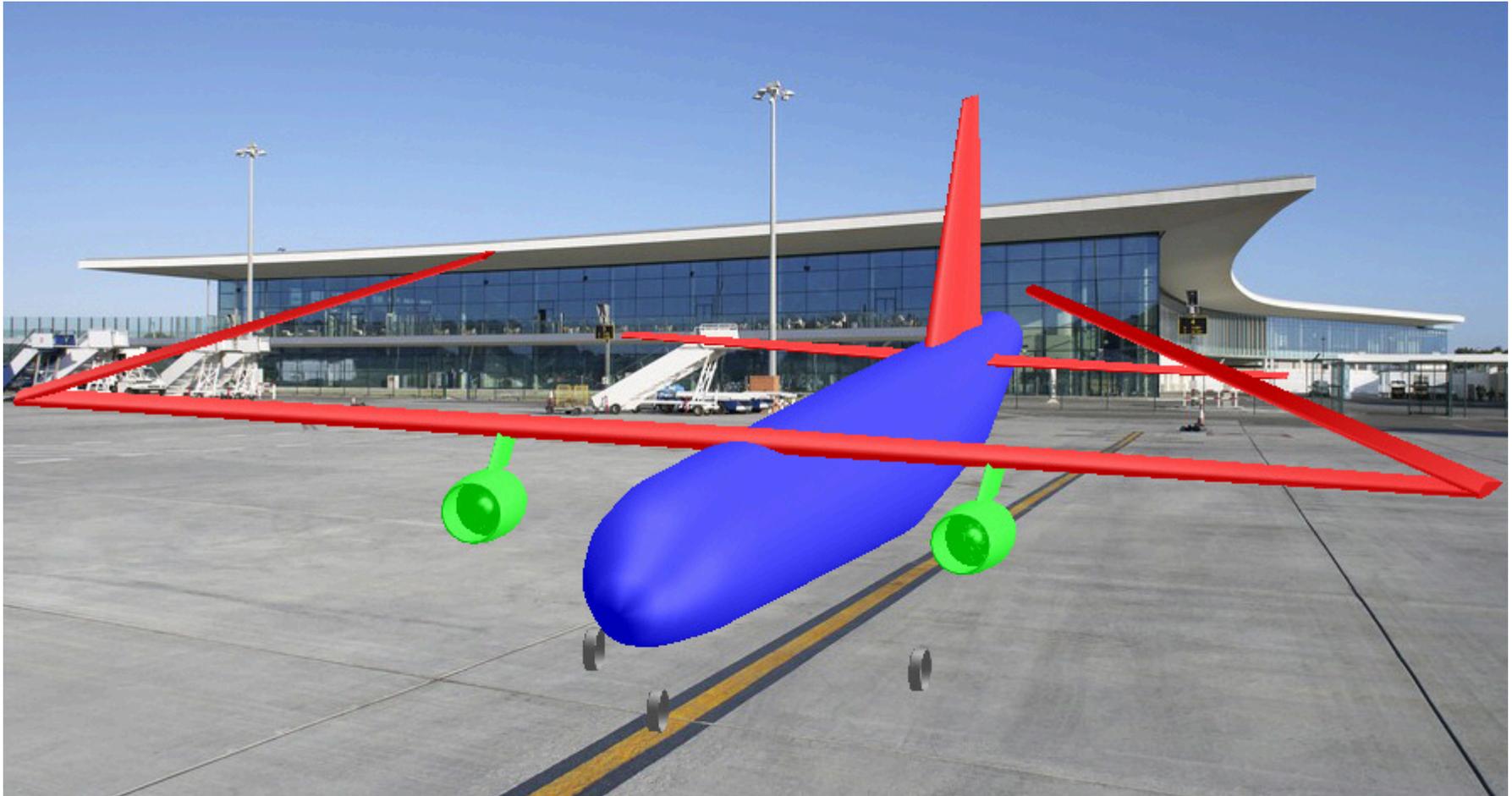
See changes made in OpenVSP

After saving changes of your file in OpenVSP, click this button to see your changes in Excel. The path of this file is taken from **OpenVSP File** on the right of this box.

Path to OpenVSP EXE

OpenVSP File

Number of changes:



## Summary

- OpenVSP-Connect is primarily intended as an **interface tool between ANY aircraft design tool and** Open Vehicle Sketch Pad (**openVSP**) from NASA.
- **For each parameter a proposed value is given and automatically applied as long as the user does not specify his/her own value.**
- By using all **default values**, the program works in "**automatic mode**": Ultimately, based on just three input values "**Number of passengers**", "**Range**" and "**Cruise Mach number**" an aircraft can be sketched automatically based on passenger aircraft statistics.



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