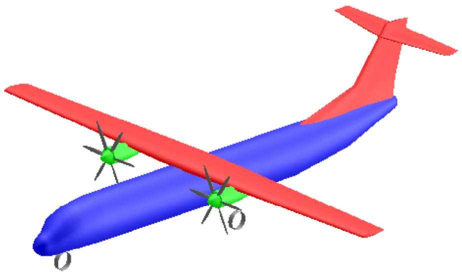
Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences

AIRCRAFT DESIGN AND SYSTEMS GROUP (AERO)

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



Dieter Scholz — Hamburg University of Applied Sciences

Tahir Sousa — Hamburg University of Applied Sciences

CEAS European Air & Space Conference 2013

Linköping, Sweden

16 to 19 September 2013

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 input parameters.

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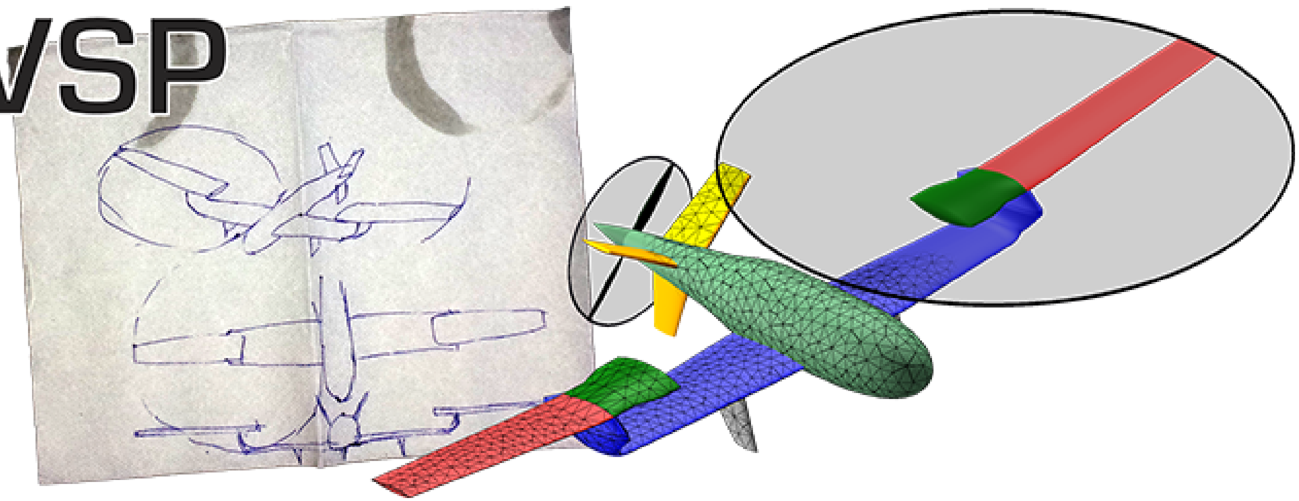
OpenVSP



vehicle sketch pad

innovate

analyze

get it

join us

NASA open source parametric geometry

www.openVSP.org

OpenVSP

OpenVSP | VSP Hangar | Workshop 2013 | Blogs | Get Started | Learn More | Participate | Sign in

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

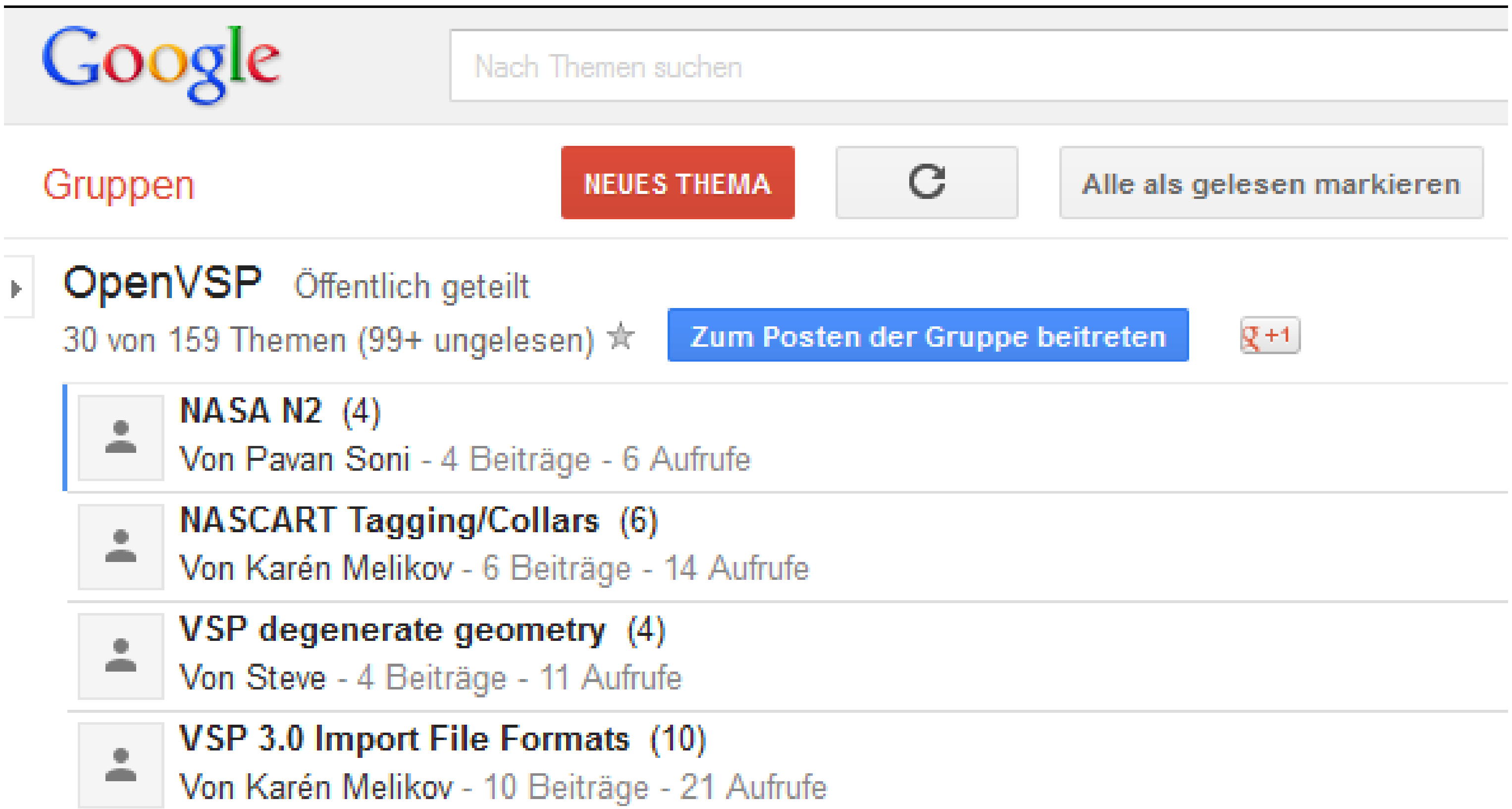
The VSP Hangar is a database of community contributed example models. Check it out for a starting point or just for inspiration. Once you've completed your first model, show it off by contributing it to the hangar.

OpenVSP

User Manual

81 pages

OpenVSP



OpenVSP Google Group

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start

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

OpenVSP

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faq

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
- ☐ 5 - Completely Inaccurate (1)
- ☐ 1 - Definitive (1)
- ☐ 2 - Essentially Exact (3)
- ☐ 3 - Good (11)

Manufacturers
- ☐ (5)
- ☐ Bombardier (3)
- ☐ NASA (3)
- ☐ Boeing (2)
- ☐ MIT (1)
- ☐ McDonnell Douglas (1)
- ☐ Embraer (1)

Units
- ☐ feet (14)
- ☐ dimensionless (2)

Tags
- ☑ transport (16)
- ☐ airplane (15)
- ☐ airliner (7)
- ☐ turboprop engine (3)
- ☐ twin-engine (3)
- ☐ blended wing body (2)
- ☐ lifting body (2)
- ☐ 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

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Boeing 787-300

OpenVSP Hangar

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

Download | Revisions (0)

File ID#	61
Manufacuter	Boeing
Model	787-300
Units	Feet
Description	A general, non-exact Boeing 787-300 model
Source Quality	3 - The source material used to create this model was Good. This means good 3-view drawings were used to create the model.
Model Suitability	2 - Cartoon or Pretty Picture 2 - Weight and balance 2 - OML for wetted areas/drag buildup 2 - Check internal layout/volume 2 - Structures 2 - Build a display model 3 - Accurate OML for detailed aerodynamic analysis or CFD
Tags	airplane , transport

OpenVSP

hangar.openvsp.org

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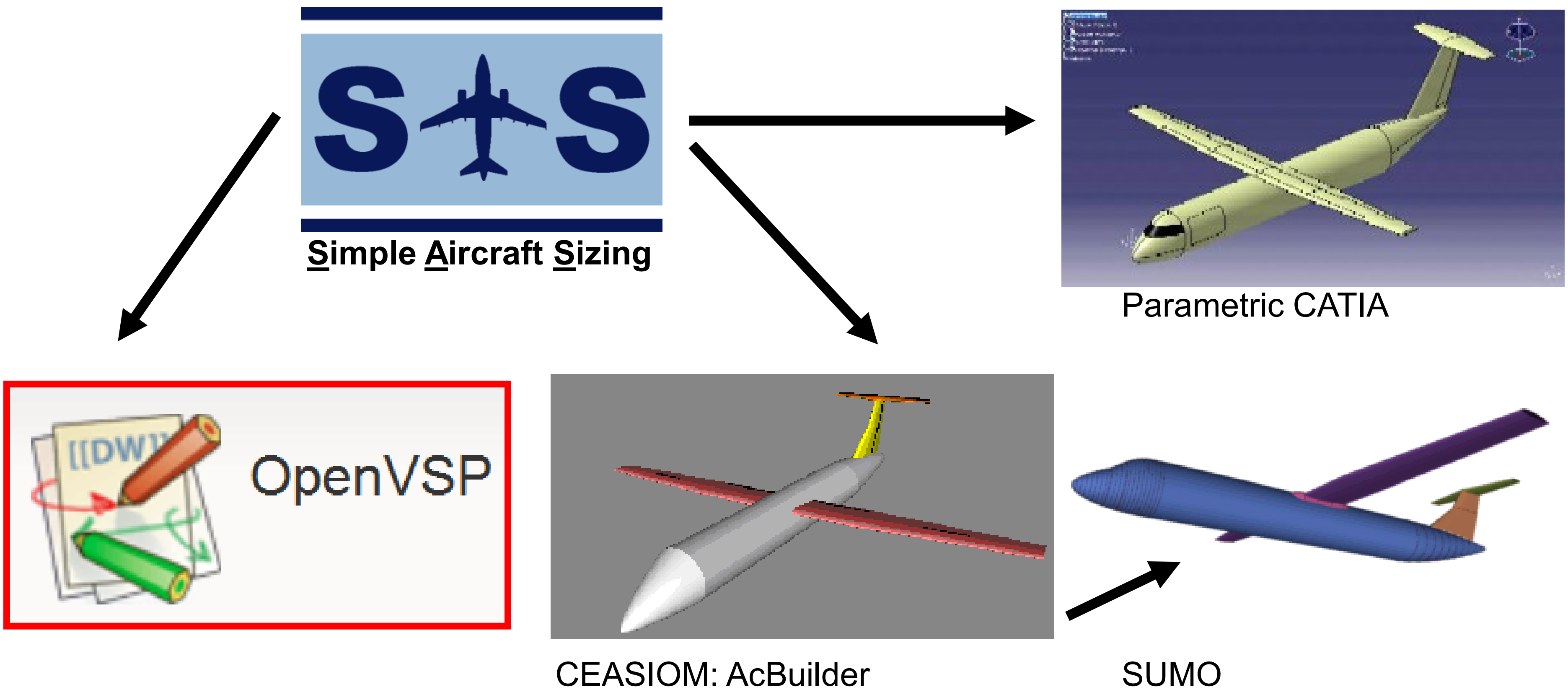
papers

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 Aeorspace Sciences Meeting, Nashville, TN, 2012, AIAA-2012-546
- Hahn, A., "Application of Cart3D to Complex Propulsion-Airframe Integration with Vehicle Sketch Pad", 50th AIAA Aeorspace Sciences Meeting, Nashville, TN, 2012, AIAA-2012-547

OpenVSP and Other Options for 3D Aircraft Visualization



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

Three Approaches to Visualization with OpenVSP

Open Vehicle Sketch Pad Aircraft Modeling Strategies

Andrew S. Hahn [1]
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

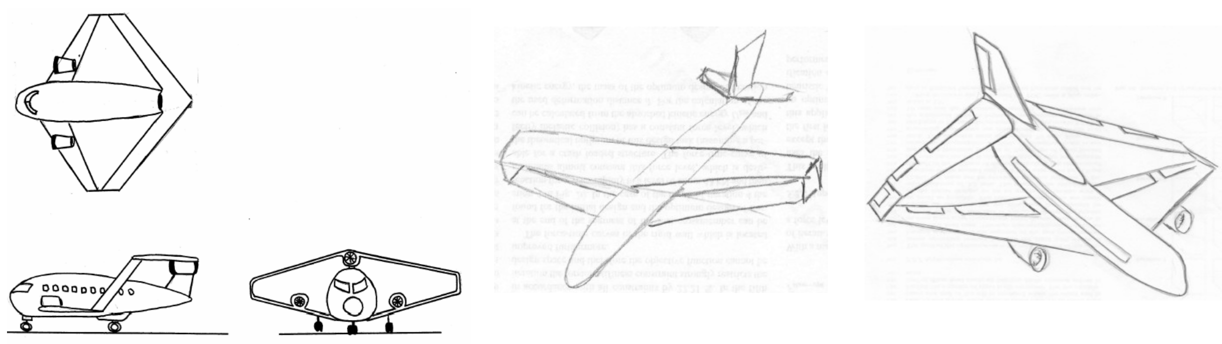
Hahn: There are **two basic kinds of models created in Open VSP**:

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.

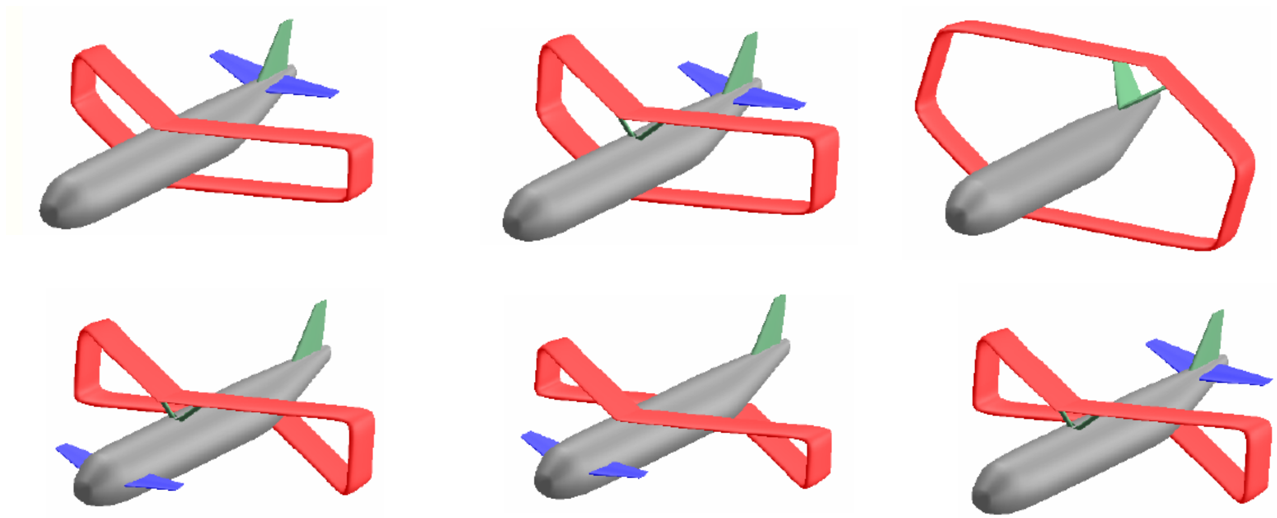
The first approach: clean sheet design

- Hand Sketches

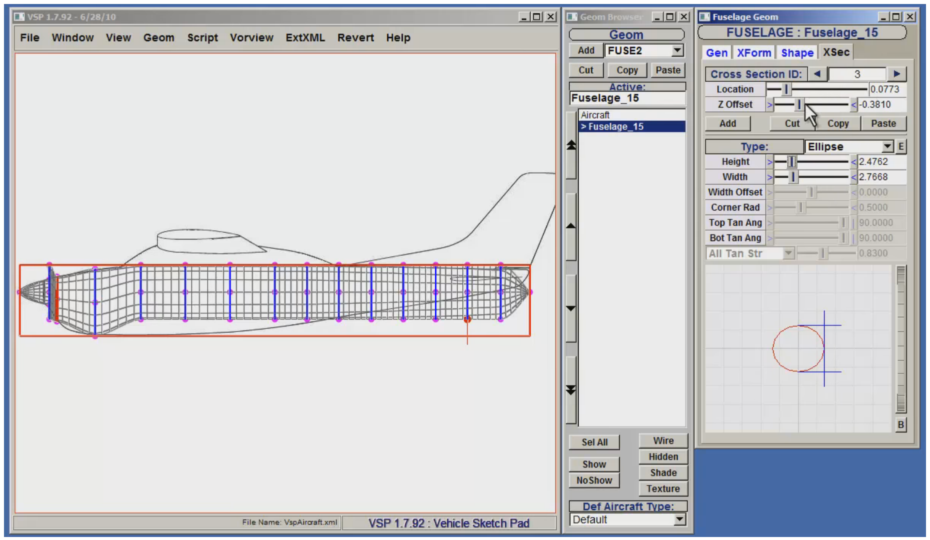


- Creative Methods
  - Brainstorming
  - Gallery Method

- Visualization with OpenVSP

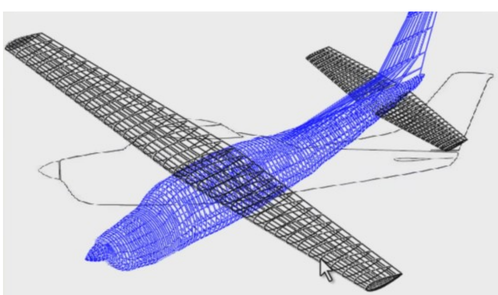


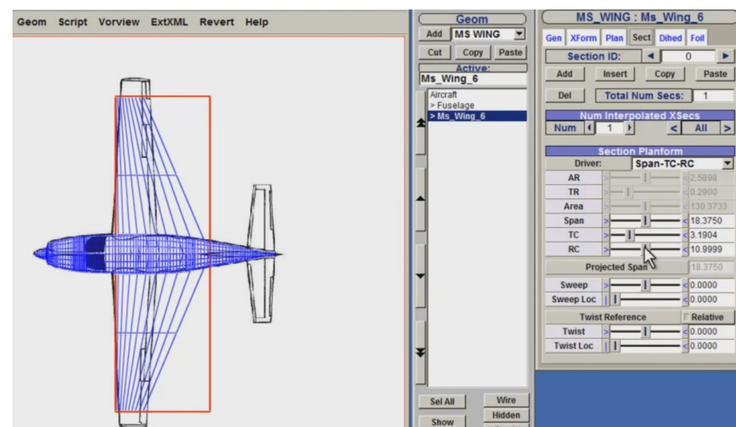
The second approach: matched design



Edit the cross sections of the fuselage in order to line them up over the background image.

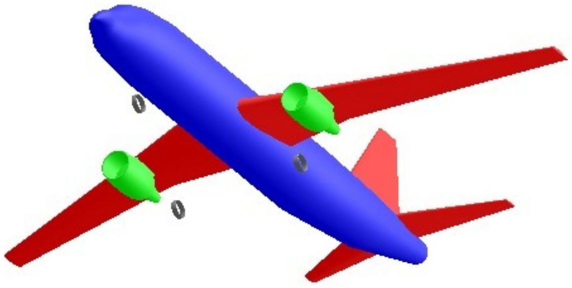
Edit wing parameters to match the wing and the tail in the background image.

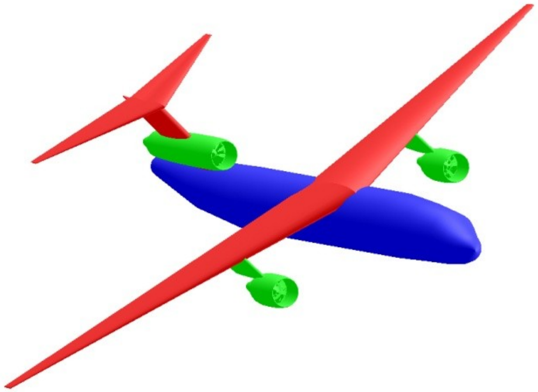


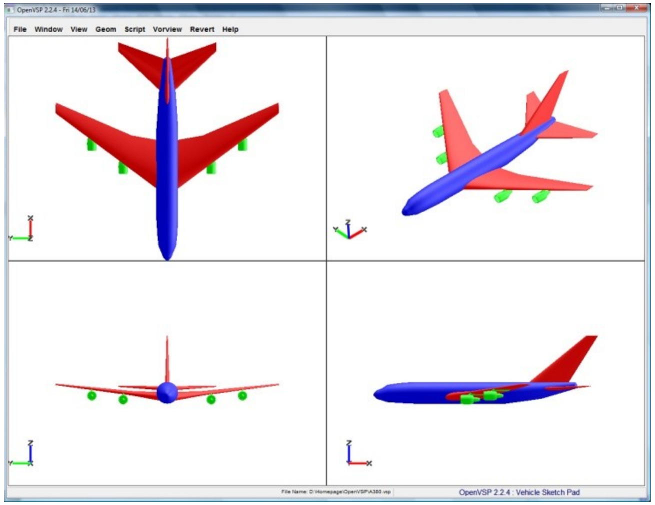


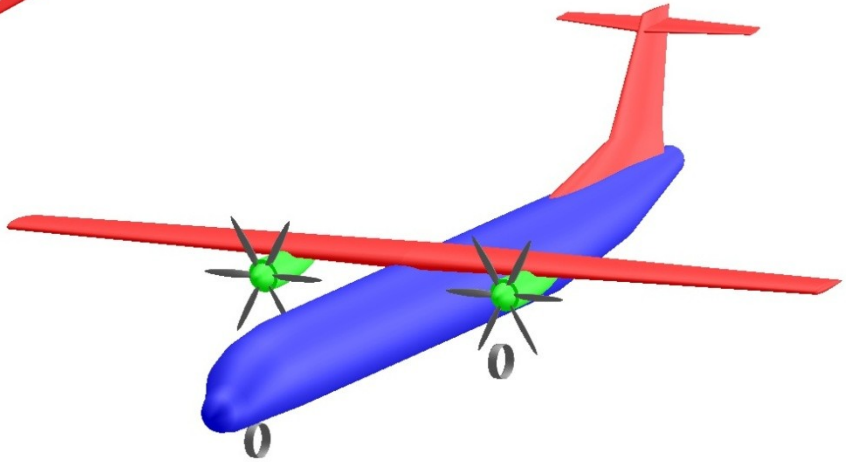
Three Approaches to Visualization with OpenVSP

The third approach: calculated design: OpenVSP-Connect









An approach to "calculated design" under 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

Cockrell School of Engineering
AEROSPACE ENGINEERING & ENGINEERING MECHANICS

Rapid Air System Concept Exploration (RASCE)

Overview
July 2009

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

DRAFT

See also: OpenVSP-Workshop 2012

Three Approaches to Visualization with OpenVSP

Summary

Cockrell School of Engineering
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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

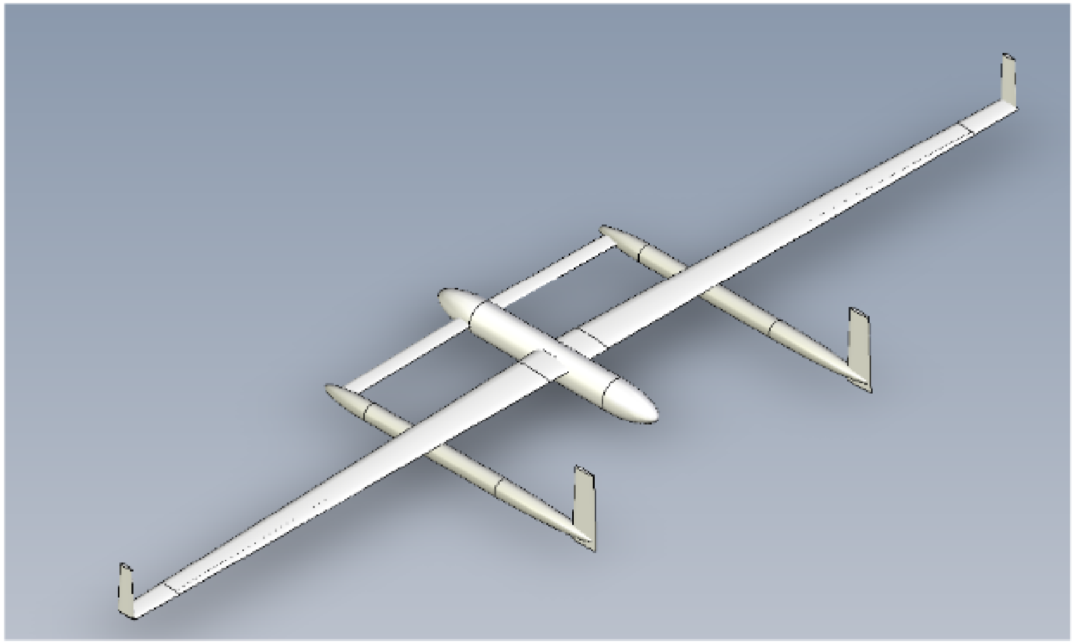
- *No laborious input data preparation and/or hand calculations*

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

Three Approaches to Visualization with OpenVSP

3D model output rendered by SolidWorks

Cockrell School of Engineering
AEROSPACE ENGINEERING & ENGINEERING MECHANICS



3D Rendering of Aircraft Configuration Designs

James R. Carlson[1]
University of Texas, Austin, Texas, 78712

… but not with OpenVSP ???

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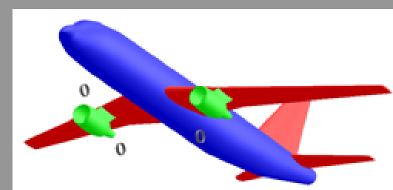
OpenVSP-Connect

OpenVSP-Connect

Connect YOUR Aircraft Design Tool with Vehicle Sketch Pad from NASA



OpenVSP-Connect started as an interface tool between ANY aircraft design tool and Open Vehicle Sketch Pad (openVSP) from NASA.
OpenVSP renders a 3D visualization of an aircraft. Follow this link for more information on OpenVSP:
http://www.openVSP.org

OpenVSP-Connect still runs on OpenVSP 2.2.4 for Win 32.
This version of OpenVSP is provided together with the OpenVSP-Connect download.

In the order of 47 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.

GPLv3

For further information, documentation, and software download please refer to:
http://OpenVSP.ProfScholz.de

OpenVSP-Connect

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":** Ultimately, based on just two input values **"Number of passengers" and "Cruise Mach number"** an aircraft can be sketched automatically based on passenger aircraft statistics.

OpenVSP-Connect

1	**Convert to OpenVSP XML**			
2	Convert data from Input-Tab to an OpenVSP XML file.			
3			**Visualization**	
4	**Parameter names**	**Parameter values**	**needed?**	**XML generated from OpenVSP Connect**
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_Sp
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_Ca
572	**/Mswing_Parms**			</Mswing_Parms>
573	**Airfoil_List**			<Airfoil_List>

OpenVSP-Connect

4. Wing

Wing Type	$Type_W$	Double-trapezoida	[-]									
Total Area	S_W	122.600	[m²]	<<<<<<	Toral Area Suggestion	S_W	142.830	[m²]				
Total Aspect ratio	A_W	9.396	[-]									
					Total Span	b_W	33.940	[m]				
Outboard 25% Sweep	$\varphi_{25,W,o}$	25.000	[°]	<<<<<<	25% Wing sweep suggestion	$\varphi_{25,W,o}$	21.881	[°]				
Taper Ratio	λ_W	0.246	[-]	<<<<<<	Taper Ratio Suggestion	λ_W	0.176	[-]				
					Root Chord	$c_{r,W}$	6.741	[m]				
					Tip Chord	$c_{t,W}$	1.658	[m]				
					Outboard Leading edge Sweep	$\varphi_{0,W,o}$	27.282	[°]				
					Outboard Trailing edge sweep	$\varphi_{100,W,o}$	17.641	[m]				
Airfoil thickness ratio	(t\c)	0.130	[-]	<<<<<<	Thickness ratio	(t\c)	0.116	[-]				
X position of wing	$RelPos_{W,x}$	31.500	% of fuselage	<<<<<<	X position of wing		31.500	% of fuselage length				
Z position of wing	$RelPos_{W,z}$	25.000	% of fuselage diameter									
Outboard dihedral angle	$\Gamma_{W,o}$	5.100	[°]	<<<<<<	Outboard dihedral angle	$\Gamma_{W,o}$	2.166	[°]				
Edit this section												
Relative kink position	$\eta_{k,W}$	0.320	[-]	<<<<<<	Relative kink position	$\eta_{k,W}$	0.320	[-]	Relative kink constant	$k_{\eta,k,W}$	0.320	[-]
Inboard Leading edge Sweep	$\varphi_{0,W,i}$	27.282	[°]	<<<<<<	Inboard Leading edge Sweep	$\varphi_{0,W,i}$	27.282	[°]				
Inboard Trailing edge Sweep	$\varphi_{100,W,i}$	0.000	[°]	<<<<<<	Inboard Trailing edge Sweep	$\varphi_{100,W,i}$	0.000	[°]				
Inboard dihedral angle	$\Gamma_{W,i}$	5.100	[°]	<<<<<<	Inboard dihedral angle	$\Gamma_{W,i}$	5.100	[°]				

5. Fuselage

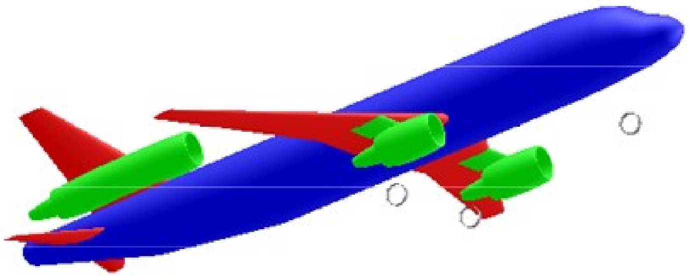
Fuselage diameter	d_F	3.960	[m]	<<<<<<	Fuselage diameter	d_F	3.744	[m]	Number of seats per row	n_{SA}	6	
Fuselage length	L_F	35.800	[m]	<<<<<<	Fuselage length	L_F	43.560	[m]	Slenderness ratio	$k_{l,F/d,F}$	11.000	[-]
Nose length	$L_{nose,F}$	6.203	[m]	<<<<<<	Nose length	$L_{nose,F}$	6.203	[m]				
Cockpit length	$L_{cock,F}$	2.574	[m]	<<<<<<	Cockpit length	$L_{cock,F}$	2.574	[m]	Cockpit length constant	$k_{l,cock,F}$	0.650	[-]
Fuselage aft length	$L_{aft,F}$	13.068	[m]	<<<<<<	Fuselage tail length	$L_{tail,F}$	13.068	[m]	Fuselage tailcone constant	$k_{l,tail,F}$	3.300	[-]
					Cylinder length	$L_{c,F}$	16.529	[m]				

6. Horizontal Tail

Total aspect ratio	A_H	5.000	[-]	<<<<<<	Aspect Ratio	A_H	5.201	[-]	HT Aspect ratio constant	$k_{A,H}$	0.554	[-]
Taper ratio	λ_H	0.295	[-]	<<<<<<	Taper Ratio	λ_H	0.295	[-]	HT taper ratio constant	$k_{\lambda,H}$	1.200	[-]
Total area	S_H	31.000	[m²]	<<<<<<	Area	S_H	25.306	[m²]	Tail volume coefficient of HT	C_H	0.991	[-]
Sweep	$\varphi_{25,H}$	28.000	[°]	<<<<<<	Sweep	$\varphi_{25,H}$	30.000	[°]	HT 25% sweep constant	$\Delta\varphi_{25,H}$	5.000	[-]
Dihedral angle	Γ_H	6.000	[°]	<<<<<<	Dihedral angle	Γ_H	0.000	[°]				
X position of HT	$RelPos_{H,x}$	84.000	% of fuselage	<<<<<<	X position of HT	$RelPos_{H,x}$	84.000	% of fuselage length				
Z position of HT	$RelPos_{H,z}$	-15.000	% of VT spar	<<<<<<	Z position of HT	$RelPos_{H,z}$	-15.000	% of VT span				

7. Vertical Tail

OpenVSP-Connect



Input of Aircraft Design Parameters

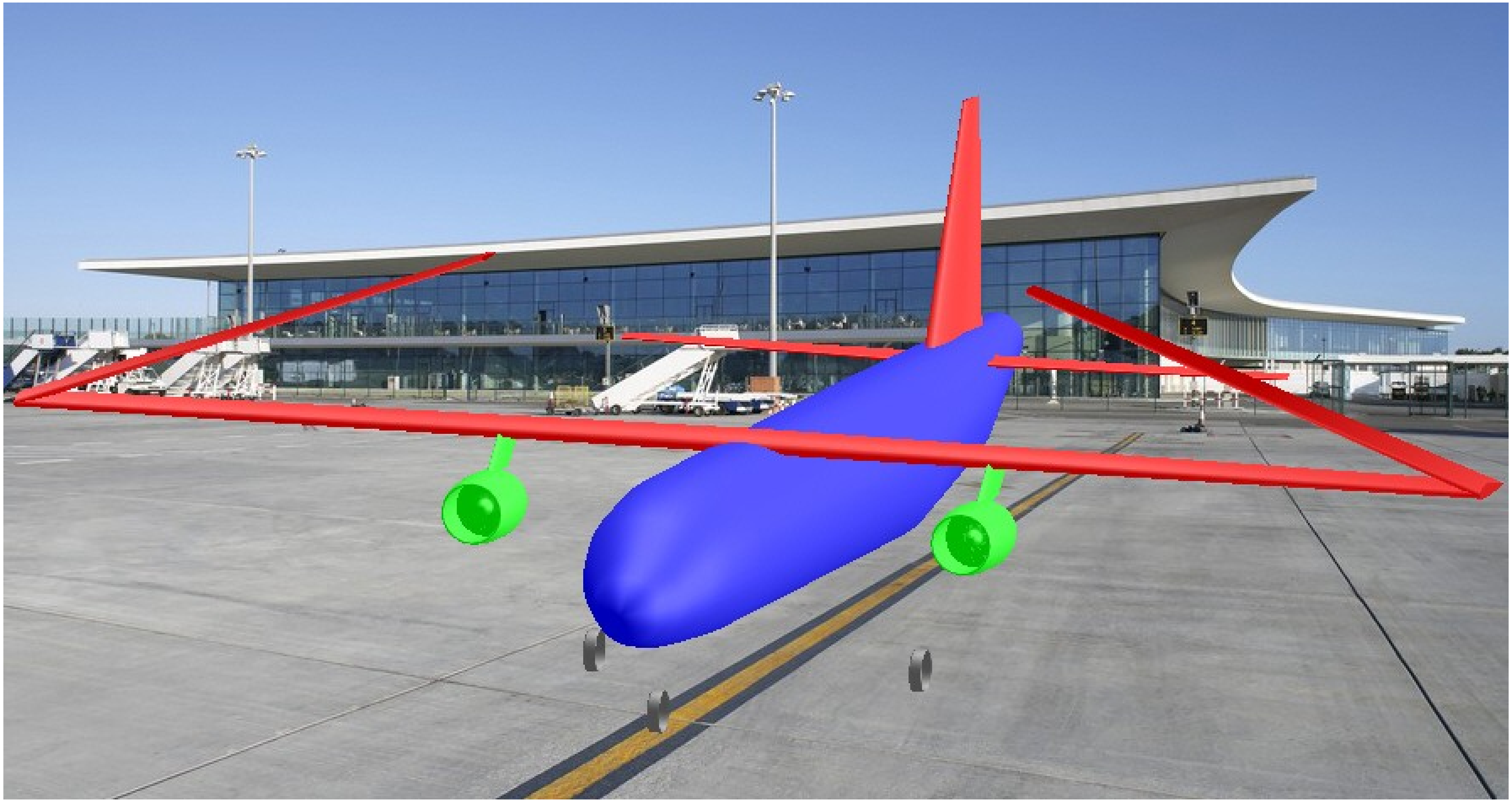
Enter the results from any aircraft sizing or aircraft conceptual design tool. If data is unknown, use default values as proposed here.

Aircraft Name	AirbusA320
Description	**Press "3D-Visualization" to draw the A320.** Data was taken from https://de.wikipedia.org/wiki/Airbus-A320-Familie For data unavailable at Wikipedia, default data was used. For other aircraft, "Positions of Aircraft Components" (Part 8) may need to be adapted manually.

1. Action buttons

Automatic Mode	3D Visualization	Tool Chain
Reset all initial links in the input cells, so that all the necessary parameters can be calculated from Aircraft Design expert knowledge based just on **the Number of Passanger**, **Cruise Mach Number**, and the **other values boxed in**.	**Convert your data to an OpenVSP file** (*.vsp) and open it in OpenVSP for 3D visualization. --- Ensure that cell marked as **OpenVSP_Dir** (H10) on the side of this box is filled correctly.	**Load aircraft parameters:** 1.) retrieved from literature or 2.) calculated from any Excel-based aircraft sizing tool. --- Ensure that cells marked as **MyToolPath** (H12) and **MyToolName** (H13) on the side of

Path to OpenVSP Executable	D:\Homepage\OpenVSP\vsp.exe
Path to OpenVSP File	D:\Homepage\OpenVSP\AirbusA320.vsp
Path to your Aircraft Design tool/data	D:\Homepage\OpenVSP
Name of your Aircraft Design tool/data	MyTool.xlsx



Investigation of folding wings at airports

Contents

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 two input values **"Number of passengers" and "Cruise Mach number"** an aircraft can be sketched automatically based on passenger aircraft statistics and "expert" knowledge.

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

http://OpenVSP.ProfScholz.de