Re: How big would an SSTO be?

Source: http://sci.tech−archive.net/Archive/sci.space.policy/2007−07/msg00161.html

- *From*: Len <len@xxxxxxxxxxxxxx>
- *Date*: Thu, 05 Jul 2007 09:30:26 −0700

On Jul 5, 2:11 am, BradGuth <bradg...@xxxxxxxxx> wrote:

> On Jul 2, 3:22 pm, Len <l...@xxxxxxxxxxxxxx> wrote:
>
> > On Jul 1, 6:23 pm, Sylvia Else <syl...@xxxxxxxxxxxxxxxxxxx> wrote:
> >
> > > Len wrote:
> > >
> > > > On Jun 30, 6:03 am, Alex Terrell
> > > > <alexterr...@xxxxxxxxx> wrote:
> > > >
> > > > > On 30 Jun, 04:38, Sylvia
> > > > > Else
> > > > > <syl...@xxxxxxxxxxxxxxxxxxx>
> > > > > wrote:
> > > >
> > > > > > Len wrote:
> > > >
> > > > > > > On
> > > > > > > Jun
> > > > > > > 29,
> > > > > > > 6:55
> > > > > > > pm,
> > > > > > > Sylvia
> > > > > > > Else
> > > > > > > <syl...@xxxxxxxxxxxxxxxxxxx>
> > > > > > > wrote:
> > > >
> > > > > > > > David
> > > > > > > > Cornell
> > > > > > > > wrote:

If someone were to build an SSTO using realistic assumptions about mass ratios and available power systems, how big a vehicle would be needed to send (say) three people and a modest amount of cargo into LEO? I have seen Apollo capsules in museums, so I am using them as my

baseline. Would such a thing be the size of a regular jetliner? Or the new Airbus super jumbo jet? Or are we talking about a Zeppelin on steroids? Also, how would these things scale? If we wanted to increase the crew from three to four, would the vehicle size go up

by a third? Or more? Thanks David Cornell

You didn't say so, but I'm assuming you mean a reusable craft. Disposable SSTO's seem a waste of effort. The most developed design I've seen for a reusable SSTO is http://www.reactionengines.co.uk/skylon_vehicle.htm It has a payload of 12 tonnes, and a maximum takeoff

weight around 280 tonnes, similar to that of a 777−300. It uses a new engine design with some technological challenges, but they seem to have made some progress with it. They're obviously financially constrained, so if you have a spare $billion, I'm sure they be interested in talking. Skylon is an

automated system, and as such is not designed to have a crew, but could carry people as payload. This document http://www.reactionengines.co.uk/downloads/JBIS_v discusses that application using a module carrying 40 people, though that's obviously in a transport application (to a space hotel, perhaps). If you have space tourism in mind, with passengers

not leaving the craft and floating around the cabin, then presumably they'd need more space per passenger. It's hard to say how this scales for a smaller payload, but at a guess, I'd say you could get a craft to carry four people that was the size of a small airliner

in
the
50
seat
range.
Sylvia.

I
have
probably
looked
at
as
many
launch
vehicle
concepts
−−rocket
powered
and
airbreathers−−as
anybody
in
the
world.
The
devil
is
in
the
details.
I
would
not
consider
Skylon
anywhere
close
to
realistic.
As
for
purely
rocket−powered
approaches,
I
have
never
been
able
to

convince
myself
that
any
SSTO
having
a
gross
mass
of
less
than
about
800
tonnes
was
very
realistic.
And
for
HTOL,
some
type
of
ground
cart
to
support
the
vehicle
at
gross
mass
is
probably
necessary−−thus
making
it
really
an
assisted
SSTO,
rather
than
a
pure
SSTO.
Staging−−even
subsonically
at
altitude

or
at
low
supersonic
speeds
greatly
relieves
the
challenge.
IMO,
staging
can
sometimes
be
beneficial
from
the
operations
point
of
view−−as
wsll
as
the
performance
point
of
view.
SSTOs
are
undoubtedly
appealing
from
the
psychological
point
of
view.
However,
they
may
not
be
a
good
way
to
run
an
airline.
At

some
combination
of
size
and
yet−to−be−discovered
technology,
SSTOs
will
make
technical,
economic
and
marketing
sense;
but
I
don't
see
this
happening
soon.
Len

Would you
care to
expand on
your
concerns.
At the
moment,
you've
basically
said that
you're an
expert and
that we
should
believe your
claim that
Skylon is
not realistic.
Sylvia.

I believe Len is an expert
and would take his word for
it.
Nevertheless, an expansion
on the concerns would be of
interest.

> However, I don't see the benefit in SSTO when concepts like Quickreach 2 (http://www.astronautix.com/lvs/quieach2.htm) could reach orbit for relatively low cost.
>
> Len − how does Quickreach 2 compare to the latest space van proposals?

I have been out of town. I'll respond in more detail tomorrow.

As a quick answer, Quickreach should be able to launch a nearly twice as large payload a couple of years earlier than the Space Van 2011.

We expect to carry 2000−kg−−or eight passengers −−to an ISS−type orbit (not our main mission) for a price (including ROI) of $2,000,000 per flight in 2007 dollars. This compares to a Quickreach cost (price?) of $20,000,000 in 2005 dollars. The Space Van should be able to achieve much more frequent flights, since there are no expendable parts or reusable parts that require extensive refurbishment between flights.

The Space Van should have good abort options
throughtout its flight regime−−starting with engine−out abort capablility just after liftoff with derated engines. The engines are derated for much improved time between overhaul.

As for Sylvia's request, I am not sure exactly what cycle Skylon plans to use, but I suspect that it is some type of combined−cycle engine. The poor−man's approach to analyzing combined cycle performance (except for potential benefits from saving installation space through integration) is to imagine separate rocket and airbreathing engines. The resulting thrust and specific impulse usually equals the goals for the combined cycle engine. This anaylis trick allows a quick assessment of how much airbtreathing and how much rocket the designer would like to have. If one then goes through some tradeoffs of different ratios and allows for real−trajectory estimates of drag losses and real−structure mass estimates allowing for realistic inlets and the impact of flying the whole vehicle at relatively high dynamic pressures and velocities, I have always found that the best ratio is 100 percent rocket. Many others−−including highly knowledgeable people like Henry Spencer −−have noted that the airbreathing appeal is rather superficial and vanishes under realistic analyses.

Len

Yet Reaction Engines have gone through the same process, and reached the
conclusion that for their craft and engine the numbers do add up. The
people involved in the project are not amateurs. If you want to claim
that Skylon won't work, you need to point specifically to

> where Reaction
> Engines have gone wrong, not make vague claims about
> analyses of other
> craft.
>
> Sylvia.

Actually, I do not feel any need to justify not wasting any more of my life on airbreathers for acceleration. The 1960's aerospace plane, the more recent NASP and many other fiascoes spent far more money failing to meet their promises than has been spent on rocket−powered space planes−−before finally admitting failure. And then another group come along with the same claims. They are welcome to try; I−−and many others−−prefer to put our resources into more productve efforts.

The summary reasons that I gave earlier for doubting that airbreathing designed to operate over a significant mach−number range can outperform pure−rocket approaches for acceleration missions are not vague. These are very real, specific and damning.

Reaction Motors may have "reached the conclusion that for their craft and engine the numbers do add up." This claim has been made many times before−−only to have such claims quietly fade away when the admittedly complex. somewhat counter−intuitive analyses are made in sufficient detail and honesty.

Normally I am a "live and let live" type of guy. However, NASP type claims have several times derailed much more promising, rocket−powered approaches. Of course, that is in a government−sponsored world. In a commercial world, I am only concerned about being able to attract investment for the approach that I think is most

> workable in the near future. If investors choose
> to fund something like Skylon as well, I wish them
> luck. However, I shall not be particularly
> concerned about real competition.
>
> Len− Hide quoted text −
>
> − Show quoted text −

> Your honest input is well taken by way of how I've thought about this SSTO Skylon, as simply being too much fly−by−rocket pie in the sky, especially at their impressive ratio of 23.3:1 for accommodating 12 tonnes worth of most anything LEO, is just way more than a little outside of the regular laws of physics.
>
> Unless Skylon is assisted with a pair of reusable LRBs, there's no way such a SSTO monocraft is ever going to deliver those 12 tonnes into LEO, especially if limited to LOx/LH2. Possibly 6 tonnes.
>
> Therefore, I still like your 800 tonne SSTO alternative, seems capable of perhaps getting as much as 24 tonnes into LEO.
> −
> Brad Guth

While we seem to be in general agreement on this particular part of this thread, I think that a 24−tonne payload is probably optimistic for an 800−tonne gross mass SSTO.

In the 1960's, I used to pose the question: "To stage or not two−stage?" At the present time, I feel that two−stage is the right answer. An established high traffic level and/or better in−hand technology and/or a willingness to develop really large vehicles could make an SSTO economically and technically viable.

Len

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