



FPGAs and the Quest for New Relevance of America's Space Program

FPGA Mission Assurance Center

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The FPGA Mission Assurance Center

- **A consortium of:**
 - Air Force Research Lab
 - University of New Mexico
 - Sandia National Lab
 - Los Alamos National Lab
 - Xilinx, Inc.
 - SES
- **Funded by a combination of Air Force Research Lab, Congress and Sandia National Lab**
- **Intended to provide assistance to the military/aerospace community for successful use of FPGAs**
- **We are at your service**



To Quote Tim Gallagher

“We shouldn’t just **BILL GATES!**”



Why Should We Care?

- Because FPGAs offer one of our best hopes to revitalize the space industry



Our Entire Society and Economy are Linked to Success in Space



Weather



Broadcasting



Precision Navigation



Precision Farming



Finance



Aviation



Science



Remote Sensing



Package Tracking



Communications

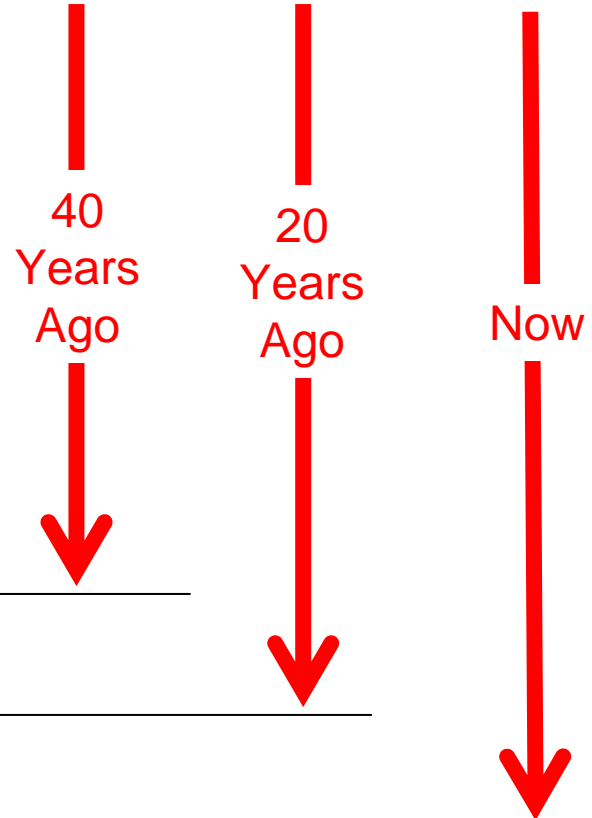


What we do in Space?

- Weather
- Communications
- Intelligence
- Science about space
- Science about earth

- Navigation

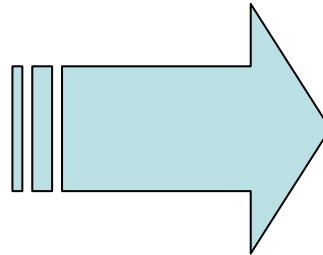
- Limited missile defense



Key Government Findings

Many Studies

- 1999 Rumsfeld Commission
- 2003 Young Panel
- 2004 Young Panel
- 2006 NSPD 49
- 2006 China Space NIE
- 2007 Allard Panel
- 2007 POTUS Memo
- 2008 Congressional Direction on MFP
- 2008 PDM II Study
- 2008 Space NIE



Similar Results

- Space is vulnerable and insecure
- Ambiguous leadership
- Limited advocacy
- Insufficient space communications
- Too much duplication

Some Well Known Opinions/Factoids “Better, Faster, Cheaper” (?)

1992

And industry must also deliver what they promise: Industry scans the federal budget

al
6l
ht
BETTER, FASTER, CHEAPER



2001

O
ct
it
NOT ALWAYS SUCCESSFUL...

<http://spaceflightnow.com/news/n0104/05goldin/>



Recent

N
htt
Sl
htt
**AND KEEPS GETTING
SLOWER & COSTLIER!**

atching in 2013!



<http://en.wikipedia.org/wiki/NPOESS>

<http://www.avtec.com/layout/set/print/content/view/full/306>



Where do we stand?

- Relevant? Certainly
- Improving? Certainly
- Costly? Certainly

But are we:

- “New” enough to excite high interest?
- Cost effective enough relative to our rate of improvement?
- Finding new things to do that are also relevant?



One Way to be More Relevant

Talk like those slick guys from Marketing!



<http://www.squidoo.com/valdes>

- Lean
- Value-added
- Outside-the-box
- Focused
- Accelerated
- Empowered
- Customer-oriented

- Machine-to-machine
- Six-sigma
- ISO 9000 certified
- Networked
- B-to-B
- Leveraged
- Web-based

- Value stream
- Core competency
- Architecture
- Portal
- Workflow
- Motion
- Center of Excellence



How Do We “Break the Mold” and Foster Growth?

- Find something ideally relevant
- Cut cost and improve the cost/benefit ratio
- Keep trying new things



<http://karenrippleffect.blogspot.com/2007/10/mold-as-art.html>

All are aided by reducing barriers

- Cost / Resource Access
- Decision inertia
- Regulation

Google's Approach To Fostering Innovation

- Teams not larger than 4-5
- Employees encouraged (required) to “steal” 20% of their time
 - Work on ideas of their own
 - Free from management decision-making
- Acceptance of high failure rates on new ideas

Source: Charles Beames NWC Thesis, 2008



Productivity, Individual Contribution and Living Outside the Box

- Soviet Days:

Approved Solution:

Collective Farms

95% of arable land

< 50% of gross agricultural output



http://dailylife.greenwood.com/teacherr/lesson.asp?id=DLO_E_TE_L03

<http://filebox.vt.edu/users/efalwell/sovietprop/stalin3.html>



Out-of-the-Box Solution:

Private Garden Plots

5% of arable land

> 50% of gross agricultural output



Out-of-the-box at Home

Approved Solution:

Newest/cheapest type-certified jet

Seats: 6

Cost: ~1.3 - 2.1M

Speed: ~400 mph

Efficiency: ~8 mpg



<http://gulfstreamresale.com/p2index.php?id=77>

Out-of-the-Box Solution:

Homebuilt (amateur) 4-place

Seats: 4

Cost: ~200-400K

Speed: ~380 mph

Efficiency: ~25 mpg



http://www.lancair.com/Main/secondary_page_images/ivp_lrg.jpg



Big contributions can come from seemingly laughable beginnings

Cheap airplanes
Built in garages
Led to ...



http://en.wikipedia.org/wiki/Pietenpol_Air_Camper



- Ballistic recovery systems
- Winglets
- Affordable aircraft composite manufacture
- Much lighter weight aircraft engines
- Aviation-safe electronic ignition
- Even private “spacecraft”!

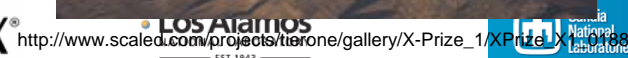
http://www.eaa.org/news/2008/2008-08-29_ab3.asp



<http://www.young eagles.org/photos/gallery.asp?action=viewimage&categoryid=17&text=&imageid=1124&box=&shownew=>



<http://www.aero-news.net/news/genav.cfm?ContentBlockID=815714f-6c12-4057-adbd-12e8e1ad4168&Dynamic=1>



Improving Space Value



“Accelerated,
B-to-B
value stream!”

Cut Launch Cost



http://www.space-travel.com/reports/Air_Force_Approves_SpaceX_To_Operate_On_Cape_Canaveral_Launch_Site_999.html

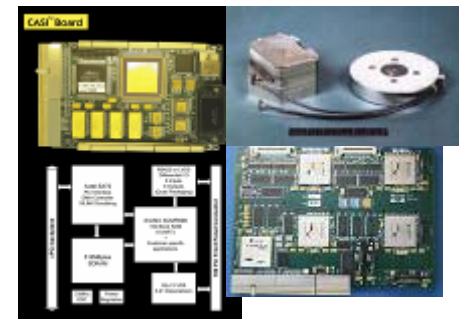
Make Better Use of Launch Capacity

Standardize
& Optimize



<http://www.respondspace.com/Papers/RS3%5CSESSION%20PAPERS%5CSESSION%205%5C5001-LYKE%20%20FRONTERHOUSE%5C5001P.pdf>

Miniaturize



<http://www.broadreachengineering.com/casi.html>

<http://www.dodsbir.net/SuccessStories/SEAKR.htm>

www.l-com/products-es/productservicex?id=296&ty



Why FPGAs Are Highly Appealing

- Hardware easier (quicker, cheaper) to design/test for space qualification
- They are reconfigurable
 - Reuse
- They are reconfigurable
 - Don't require repeated hardware qualification



We Are Not Alone In Recognizing This

2008 FPGA Survey



EETIMES

- EE Times
- and -
- FPGA Mission Assurance Center
- Survey conducted by Wilson Research



Survey Specifics

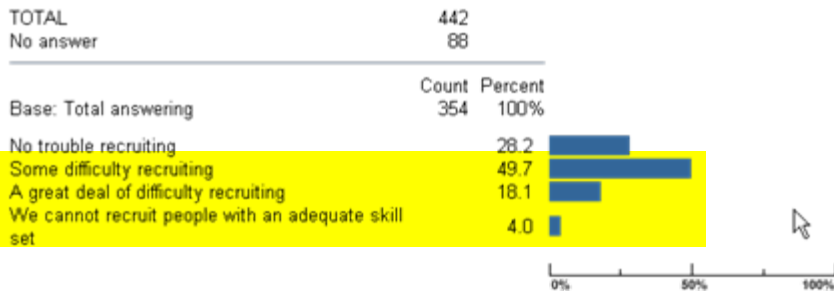
- Follow-on to Prior Survey (2006)
- Sought input from the EDA community across application areas/industries
- Primarily U.S.
- So far, over 400 responses



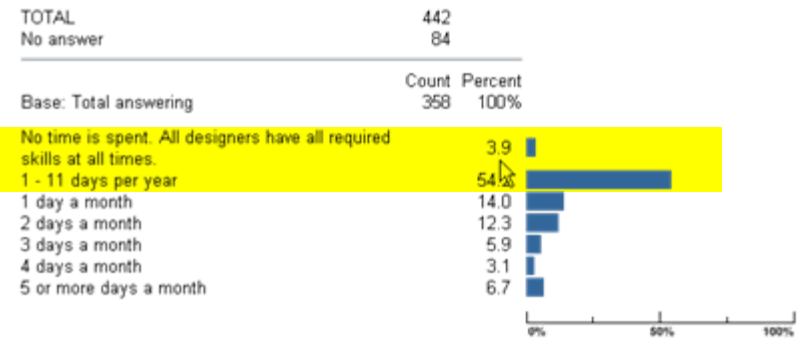
Key Finding: Talent is Available but Not Easy to Find and Prepare

- Over 70% reported some difficulty recruiting
- We're not doing much to prepare new hires

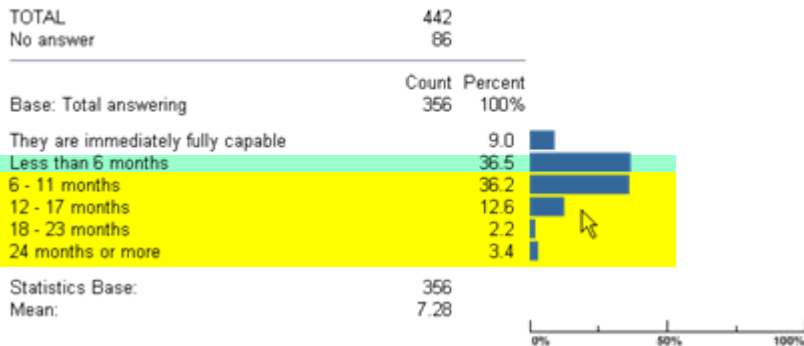
B1. Does your organization have any difficulty recruiting professionals with an adequate skill set to work with FPGAs?



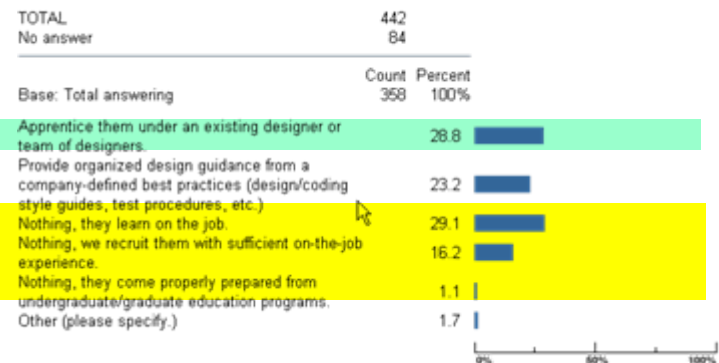
B3. How much of your time (or your designer's time) is spent in continuing education (learning how to use tools, etc.) - including seminars, courses, and self-study?



B5. How long does it typically take for a new designer to be fully productive in your environment?



B4. What do you do the most to prepare your designers to produce in your environment?



Write-in Awards!

- **Wish Upon A Star Award**

How do you get good designers?

“By wishing rilly rilly hard!”



<http://www.esandb.com/images/Write-in%20Awards%20Logos%20-%20Final%20-%202008.pdf>
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- **Preparation H Award**

What do you do to prepare your designers?

“Nothing, they come ill prepared and stay that way”



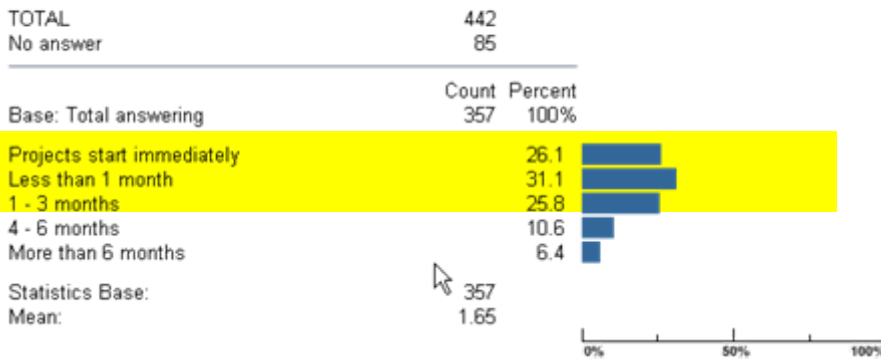
<http://www.flickr.com/photos/8341340@N05/2385545676/>



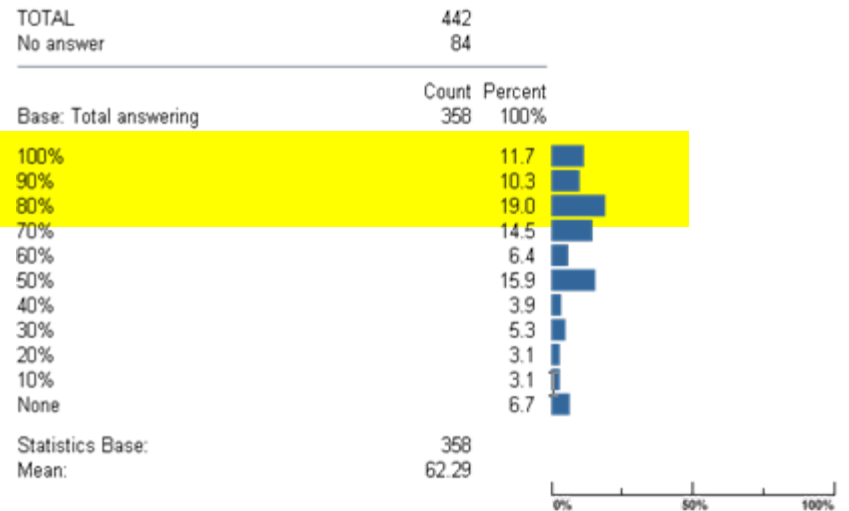
Schedules

- Quick starts
- “Fair” schedule adherence ... but ...
- Serious impacts when schedules fail

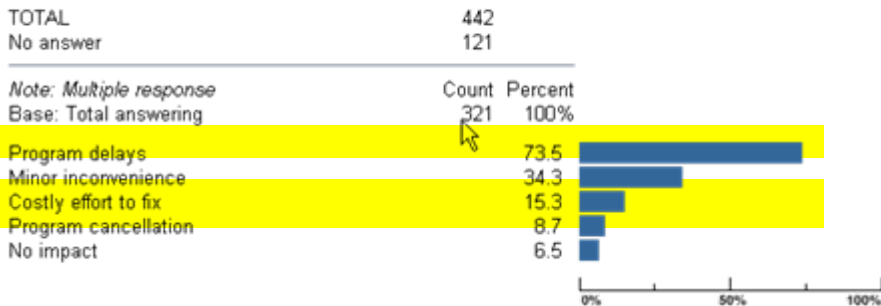
B6. How long does it take your company to assemble a competent design team for a new project?



B10. Over the past year, approximately what percent of your designs been completed on time?



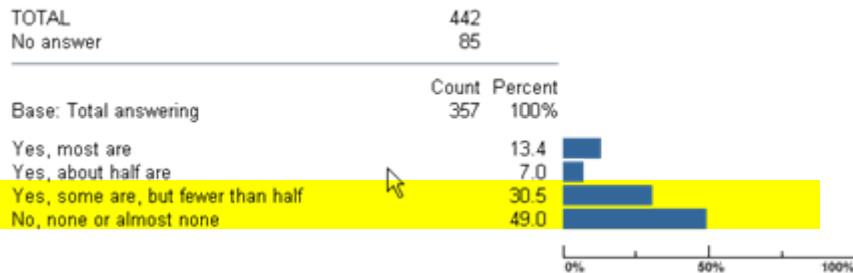
B10a. If less than 100%, what was the impact?



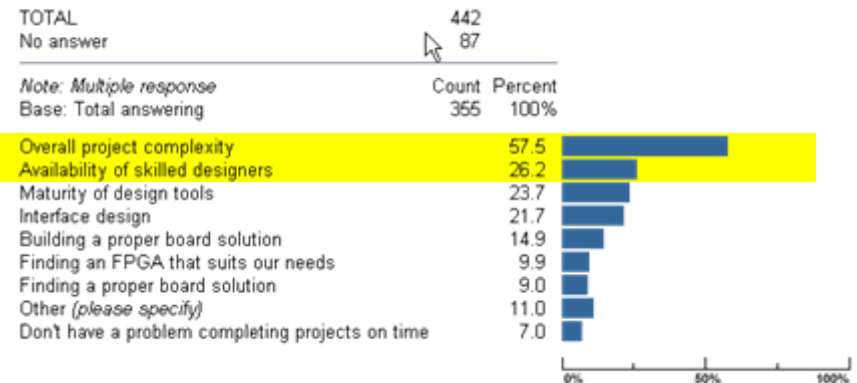
Management Issues

- Very few managers with relevant background
- Challenges with complexity, skilled designers

B8. Are the managers in your organization also skilled FPGA designers?



B11. What have been your greatest impediments to creating designs on time?



Write-in Awards!

- **Wannabe Author Award**

Why do your projects not finish on time?

“I could write a book, but I’d get in trouble for doing that.”

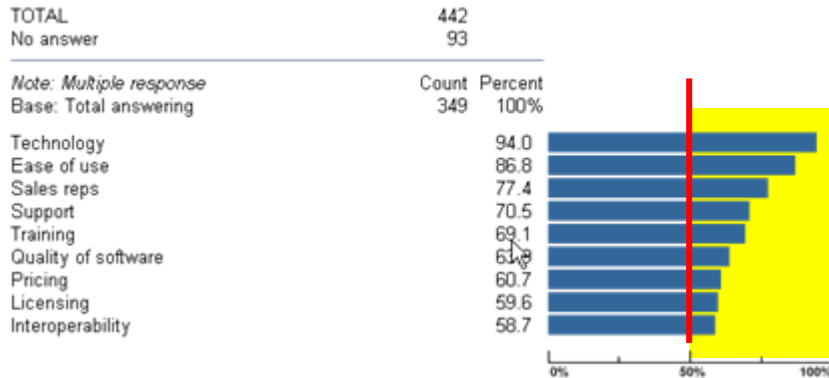


<http://www.flickr.com/photos/dnhosor/129815468/>

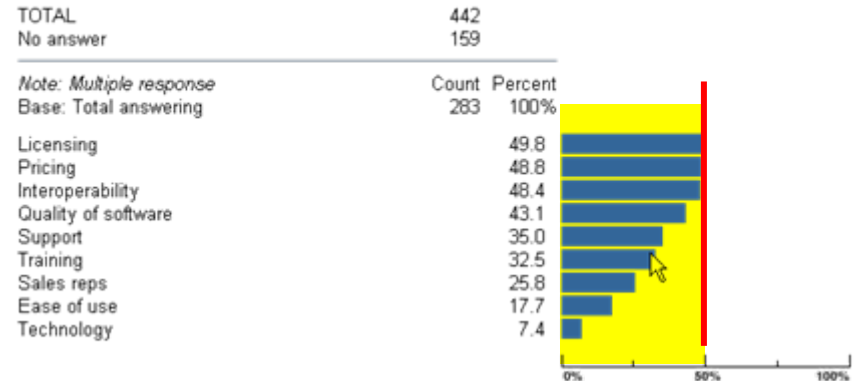


Impression of Industry is Generally Favorable

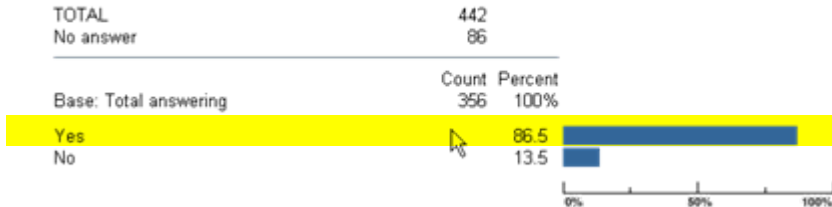
B22a. As you reflect on your total experience with FPGA vendors, what is your opinion or impression of the following? - Favorable



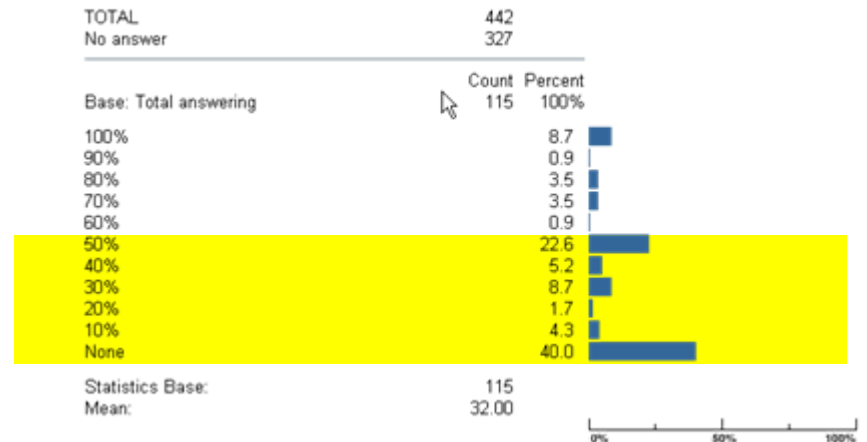
B22b. As you reflect on your total experience with FPGA vendors, what is your opinion or impression of the following? - Unfavorable



B12. Do FPGAs meet your performance needs in terms of speed?



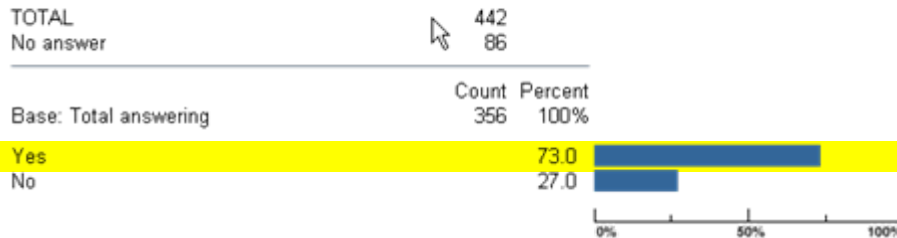
B12a. If not, what percentage increase in performance is needed?



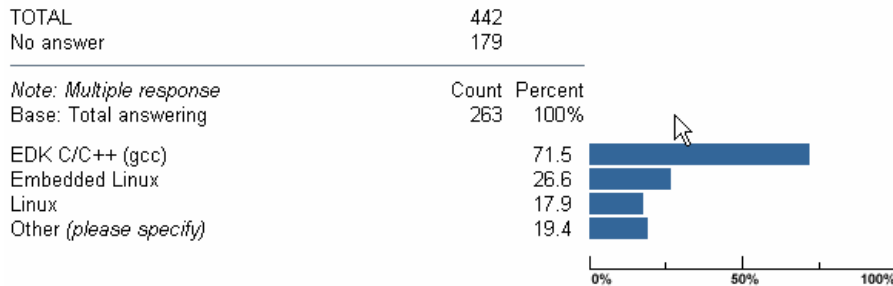
Key Finding: Complex System-on-a-Chip Design is Now Very Common

- “Most” use soft cores

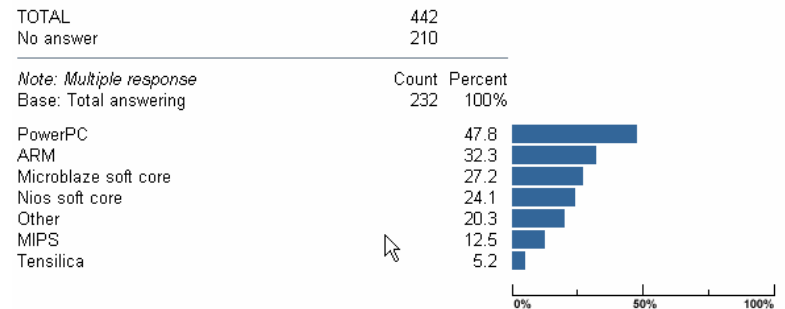
B16. Do your projects require software written for embedded processors?



B16a. If yes, what languages and tools do you use?



C10a. Which of the following embedded processor cores do you currently use and do you plan to use in your designs in the next 12 months? - Currently use



Write-in Awards!

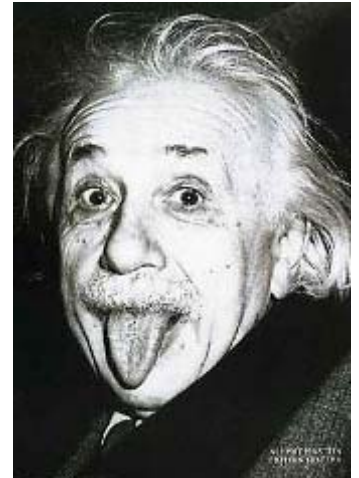
- **Einstein Award**

What best describes your organization's use of FPGAs?

“Have no clue”

Or as Einstein said:

“If we knew what it was we were doing, it wouldn't be research.”



Key Finding: Mil/Aero is a Large Portion of FPGA Community

- General Trend: ~25% or more of Reconfigurable EDA engineers surveyed seek:
 - Aerospace applications
 - High-rel or rad-hard/tolerant components
 - SEU or other radiation effect mitigation

A1. What is your organization's primary business activity?

TOTAL 424
No answer 7

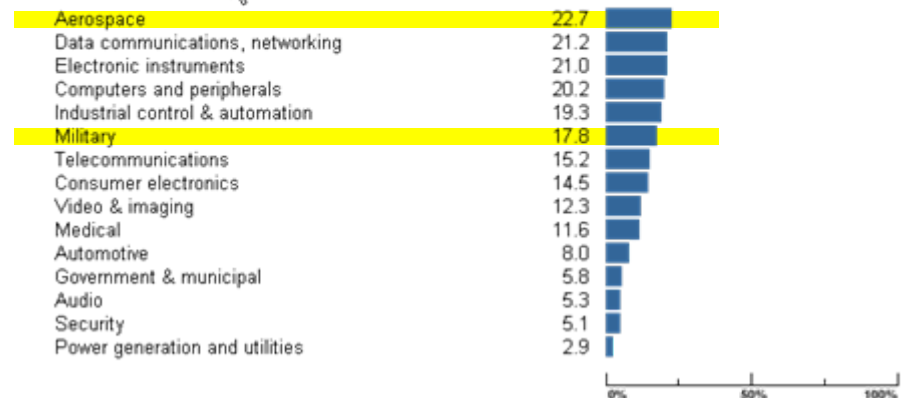
Base: Total answering 417 100%

Business Activity	Count	Percent
Applications software development	2.2	
Communications carrier (telecomm, datacomm, cable, internet/online service provider)	5.8	
Computer manufacturer (hardware, software, peripherals)	11.3	
Computer-related retailer, distributor, wholesaler	0.2	
Solutions provider/VAR/ e-business integrator	0.0	
Other computer-related/communications business (specify)	5.3	
Aerospace	15.1	
Agriculture/mining/oil/gas	0.5	
Banking	0.2	
Business services	0.0	
Construction/architecture	0.0	
Consulting (non communications/computer)	1.7	
Education/training	0.7	
Engineering/science/research	26.4	
Financial services/VC/accounting	0.2	
Government: federal (including military)	3.4	
Government: local	0.2	
Government: state	0.5	
Healthcare/pharmaceuticals/biotech/biomedical	5.0	
Insurance	0.0	
Manufacturing and process (other than computer related)	10.1	
Media/marketing/advertising	0.0	
Non-profit/charity/trade association	0.0	
Real estate/legal	0.0	
Transportation/logistics	0.7	
Travel/hospitality/recreation/entertainment	0.2	
Utilities	0.7	
Wholesale/trade/distribution/retail	1.0	
Other general business (please specify)	8.6	

A4. What types of applications best describe your primary development projects?

TOTAL 424
No answer 9

Note: Multiple response
Base: Total answering 415 100%



E1. Which of the following best describes your organization's use of FPGAs?

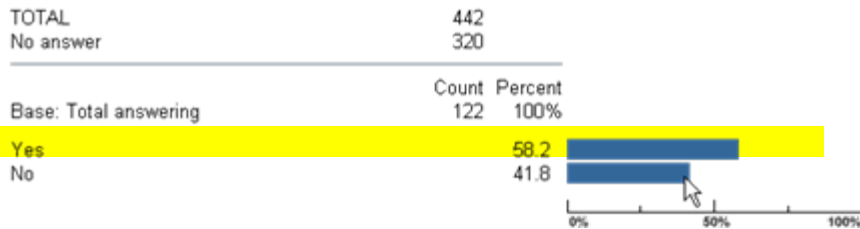
TOTAL 424
No answer 303

Base: Total answering 121 100%

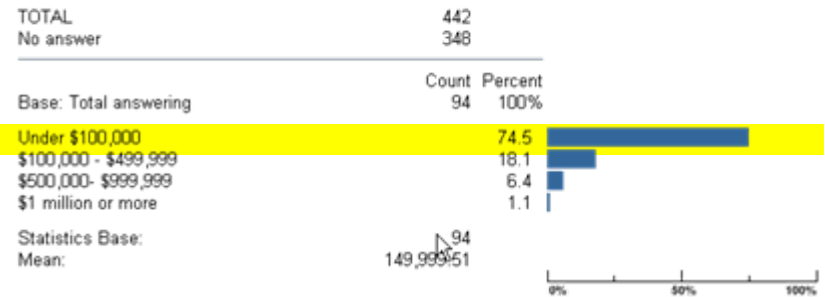


SEU Immunity / Scrubbing are Important to a Considerable Industry Segment

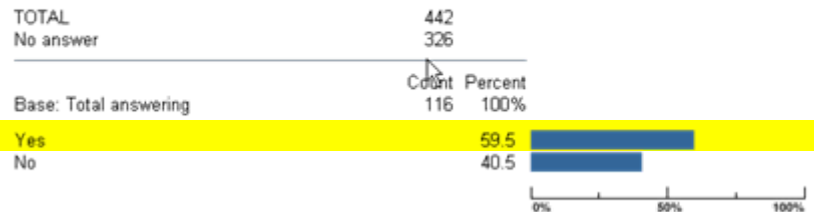
E2. Does your organization attempt to mitigate the effects of Single Event environments?



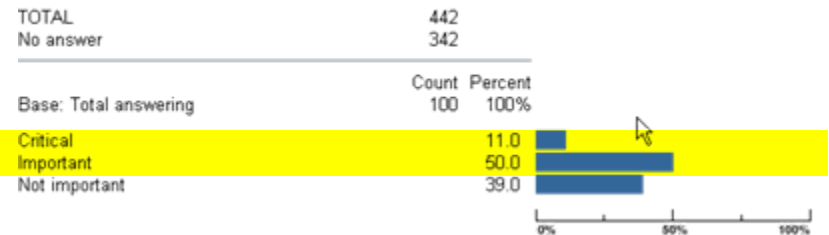
E10. If a scrubber were provided to your organization, how much NRE would this save?



E8. If a rad-hard universal scrubber (method for correcting configuration faults) could be bought off-the-shelf, would your organization be interested in using this?



E11. What would be the time savings impact if available?



Write-in Awards!

- “Customer-Oriented Six-Sigma Center of Excellence” Award

What Could FMAC do to best help you?

“Quit sending out 12-minute surveys that take 1-1/2 hours”



<http://www.flickr.com/photos/pixxiestails/266397380/>



FMAC's Highest Priority – Education To Ensure Qualified Designers!



- University-Level Programs



- Community College Outreach

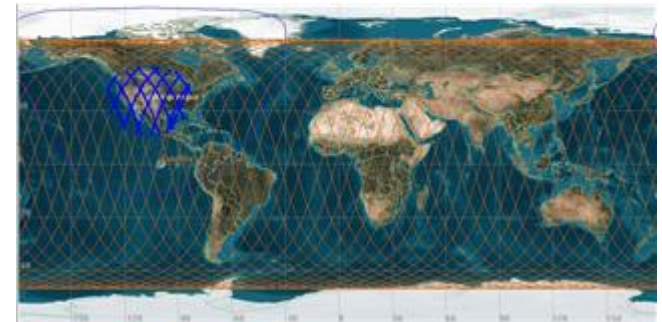
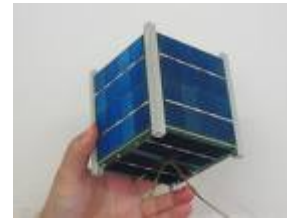


- Industrial Outreach
- Professor Workshops
- High School Outreach



Efforts to Merge FPGAs on Small Satellites

- Working to develop CubeSat constellation for space weather research utilizing Virtex-5 SIRF FPGA
- Collaboration between UNM, NM Tech, AFRL, Los Alamos



Test & Validation Processes for Aerospace and Defense Applications of FPGAs

- Los Alamos efforts in characterization of single event sensitivity, MBU, SEFI analyses.
- Sandia/UNM collaboration on the Materials on the International Space Station Experiment (MISSE) Project.



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Or join us at:

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