University-Class Spacecraft in 2023: More Missions, More Problems?

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ABSTRACT

A "university-class" mission is one where the training of the students is as least as important as the in-orbit results from the spacecraft. Since the University of Melbourne's Australis OSCAR 5 launched in 1970, nearly 300 universities around the world have built & launched 720 university-class spacecraft. But, most of these events are recent: more than half of these schools had their first launch in the last five years. Coincidentally, 5 years ago is the last time that a paper like this was presented at the conference. And thus it's worth updating the previous work with all these new data points!

Therefore, this paper will review the history of university-class missions with an emphasis on the last five years. These missions will be cataloged and collated to look for trends in spacecraft size, mission type, and on-orbit performance. As usual, three sets of questions will guide the discussion:

1) What kinds of missions have been flown, are being flown and should be flown?
2) What are historical and present-day mission success rates for university-class missions?
3) Why are the mission success rates so poor?

INTRODUCTION

This author has been documenting the history of university-class space missions for 20 years.[1-12] The result of those studies can be broadly summarized as follows:

1) There sure are a lot of student-built satellites, and there will be even more next year.
2) University-class missions have had three watershed years:
   - **1981** The second university-class mission flew (UoSAT-1), starting a steady stream of university-class missions;
   - **2000** A string of on-orbit failures nearly ended student satellite missions in the United States (and directly led to the introduction of the CubeSat standard);
   - **2012** The CubeSat standard was fully embraced by industry professionals, greatly reducing barriers to entry for universities and broadening the numbers and types of participants.
3) While almost all modern university-class missions are CubeSats, not all CubeSats are university-class missions.
4) The student launchspace is dominated by three groups:
   a. ***Flagship universities***, whose satellites are the most reliable and have the most significant missions. These flagships fly a new spacecraft every few years;
   b. ***Prolific independent universities***, who have developed their own string of successful missions, often using a sequence of missions to study specific science phenomena;
   c. ***Hobbyists***, who are still learning how to build successful missions, and have low flight rates and high rates of on-orbit failure.

Why do we need another paper? Well, beyond the obvious excuse to attend this conference, the short answer is: new data and new questions. As many more missions fly, it is possible to collect statistically-relevant data sets regarding university-class missions.

For this year, three questions are being addressed.

1. <u>What kinds of missions have been flown, are being flown and should be flown</u>?
2. <u>What are the historical and present-day mission success rates for university-class missions</u>?
3. <u>Why are the mission success rates so poor</u>?

Before we do all that, we must first define our terms. Following the definitions, we will issue our standard disclaimers about how this data was collected and how much it can be trusted.

Taxonomy

As discussed in previous papers, we narrowly define a ***university-class*** satellite as having three distinct features:

1. It is a functional spacecraft, rather than a payload instrument or component. To fit the definition, the device must operate in space with its own independent means of communications and command.
2. Untrained personnel (i.e. students) performed a significant fraction of key design decisions, integration & testing, and flight operations.
3. The training of these people was as important as (if not more important) the nominal "mission" of the spacecraft itself.

Exclusion from the "university class" category does **not** imply a lack of educational value on a project's part; it simply indicates that other factors were more important than student education (e.g., schedule or on-orbit performance). In many cases, schools that began with university-class missions have "graduated" from university-class to professional programs – such as the Technical University of Berlin, and the University of Toronto's Space Flight Laboratory (SFL).

Note also that, despite the name ***university-class***, this category includes pre-college institutions (high schools and even middle schools).

For the first 15 years of this study, we paid a lot of attention to the distinction between: ***flagship*** and ***independent*** schools. However, as explained in the 2018 paper[13], the explosive growth of CubeSats has eliminated the value of this distinction.

It is generally understood that a ***CubeSat-class*** spacecraft is that fits inside one of the standardized box dispensers. That definition will be used for this paper.

Disclaimers

This study is based on spacecraft data provided by the Seradata SpaceTrak database[14], augmented by the author. The augmented data is compiled from online sources, past conference proceedings and author interviews with students and faculty at many universities, as noted in the references. The opinions expressed in this paper are just that, opinions, reflecting the author's experience as both student project manager and faculty advisor to university-class projects. The author accepts sole responsibility for any factual (or interpretative) errors found in this paper and welcome any corrections. *[The author has been cutting-and-pasting this disclaimer into every one of these papers for nineteen years and has received only a handful of corrections, so he is left to conclude that either (a) he is the greatest fact-checker ever or (b) nobody reads these papers and/or cares enough to send him updates. Thanks are offered to M. Halvorson who admitted to reading at least one of these disclaimers.]*

UNIVERSITY-CLASS MANIFEST, UPDATED

A list of university-class spacecraft launched from 1970 until the end of May 2023 is provided in the Appendix. Because the inclusion or omission of a spacecraft from this list may prove to be a contentious issue – not to mention the designation of whether a vehicle failed prematurely, it is worth repeating an explanation of the process for creating these tables.

First, using launch logs, the author's knowledge and several satellite databases, a list was created of all university-class small satellites that were placed on a rocket.[14-16] These remaining spacecraft were researched regarding mission duration, size, type and status, with information derived from published reports and project websites.

Regarding ***mission class***, we use the following definitions:

- ***C*** (Communications): The primary mission is to relay communications between two points. Amateur radio service and AIS tracking are common examples.
- ***E*** (Educational): The primary mission is the education/professional training of the participants in the spacecraft design lifecycle. To be and E-class mission any science returns or technology demonstrations must be of secondary value to the education. Typically, E-class missions have no science or technology value, except to the mission developers themselves. E-class missions are also called "Beepsats", as they don't do anything but "beep" health & status data back to the ground.
- ***I*** (Earth Imaging): The mission is to return images of the Earth for commercial and/or research purposes. Planet Labs' Dove constellation is the primary example.
- ***M*** (Military): The mission has military relevance that does not properly fit in the other categories. (For example, SIGINT missions.)
- ***S*** (Science): The mission collects data for scientific research, including Earth science, atmospheric science, space weather, etc. To be S-class, there must be a clear connection between the data collected and end-user researchers; a spacecraft that measures the Earth's magnetic field and publishes the data on the web, hoping that some scientist will find the data

useful, is not an S-class mission. (It's probably an E-class mission.)

- ***T*** (Technology Demonstration): The mission involves the first flight of a new technology or capability, such that it is advanced one or more Technology Readiness Levels (or equivalent indicator). As with S-class missions, it is not enough to simply try out some new technology in space; there must be a clear, obvious process by which the behaviors of this new technology in orbit are validated.
- ***P*** (Proximity Operations, including Space Situational Awareness): distinct from T-class, a P-class mission provides a service or a system-level demonstration of a proximity operations or situational awareness capability.
- ***V*** (Space Services): the spacecraft's primary mission is to provide on-orbit services to other spacecraft, typically as a space tug to deploy spacecraft in a specific orbit.
- ***B*** (Other Missions): the spacecraft is a passive target for some other system, or it is a niche/unique mission (e.g., carrying someone's ashes into orbit).

We define levels of ***mission success*** based on what fraction (if any) of the mission objectives have been achieved. Mission status is distinct from spacecraft functional status; mission status is only concerned with how much of the primary mission has been achieved. An otherwise-functional spacecraft with a broken primary payload would be stuck at Level 3. A spacecraft that cannot downlink its mission data, for whatever reasons, would be stuck at whatever Level it achieved at the point of failure. A spacecraft that achieved its mission success and then died is still at Level 5.

0 ***Manifested***: A launch date has been published. We don't keep track of missions until a launch date has been published.
1 ***Launched***: The rocket began liftoff. (Launch and deployment failures leave a spacecraft at Mission Status 1.)
2 ***Deployed***: The spacecraft is confirmed to have released from the launch vehicle.
3 ***Commissioning***: The spacecraft has had at least one uplink and downlink.
4 ***Primary operations***: The spacecraft is taking actions that achieve primary mission success (i.e., receiving commands, downlinking mission data)
5 ***Mission success***: Primary mission objectives have been met. The spacecraft may continue to operate, run secondary missions, etc.

This list of spacecraft is complete to the best of the author's ability. The caveats from previous versions of this work still apply: launch masses should be considered approximate, as should mission durations.

CENSUS DATA AND OBSERVATIONS

As a follow-up to the 2018 paper, the same time periods will be used, with a new period for 2018-present.

- **1994-2001** This period cover's the author's graduate student years, and could be called "BC" (Before CubeSat). It also corresponds to the development lifecycle of the Sapphire mission, the author's first. As will be shown, these years are characterized by a few, large(r) missions coming out of a few schools. During this period, the flagships dominated the university-class category. It is arguable that this period is no longer relevant, for the same reasons that the author omitted the 12 university-class missions flown before 1994: there are too few and they happened too long ago.
- **2002-2009** This middle period marked the start of the CubeSat expansion. Although in 2018, the rise of the CubeSats seems inevitable, it was by no means a sure thing. (Shameless plug: check the bibliography and read my papers from the time.) This period started the growth of the independent university spacecraft developers.
- **2010-2017** CubeSats are firmly entrenched in the smallsat world. This period is also marked by a significant shift from flagships to independents. A lot of independents.
- **2018-2023** While this fourth time period has a lot in common with the prior period, the sheer number of university missions puts it in a new category.

But don't just take my word for it. As shown in Figure 1, 720 university-class missions have launched since 1970, and 360 of them since the start of 2018.

In terms of simple numbers: from 1 January 1994 until 31 May 2023, there have been 726 university-class spacecraft launched from 295 educational institutions in 61 countries worldwide. Half of those missions have come in the last 5 years.

While, as shown in Figure 1, a significant number of university missions are not CubeSats, CubeSats do comprise a sizeable majority of the missions. The handful of university spacecraft that aren't CubeSats are either PocketQubes or specialty buses by some of the remaining flagship schools.

As we do in each paper, it is worth repeating how much has changed in the since our first publication on this subject. In 2004, the idea of ten manifested missions a year would have been a delightful notion; today, that would be a significant step backward. CubeSats play an outsized role in the availability of spaceflight to universities. This is worth noting and celebrating.

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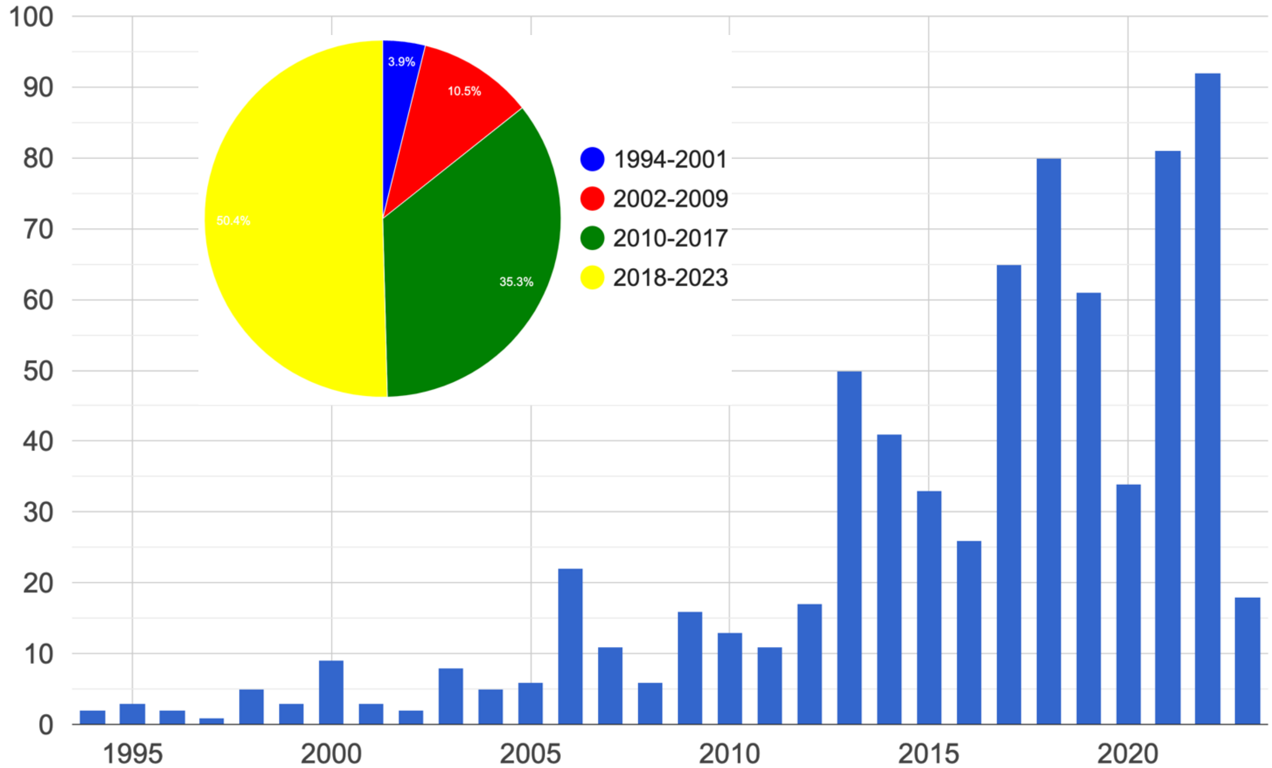

Figure 1: Number of University-Class Missions Launched Each Year, and Grouped by Era

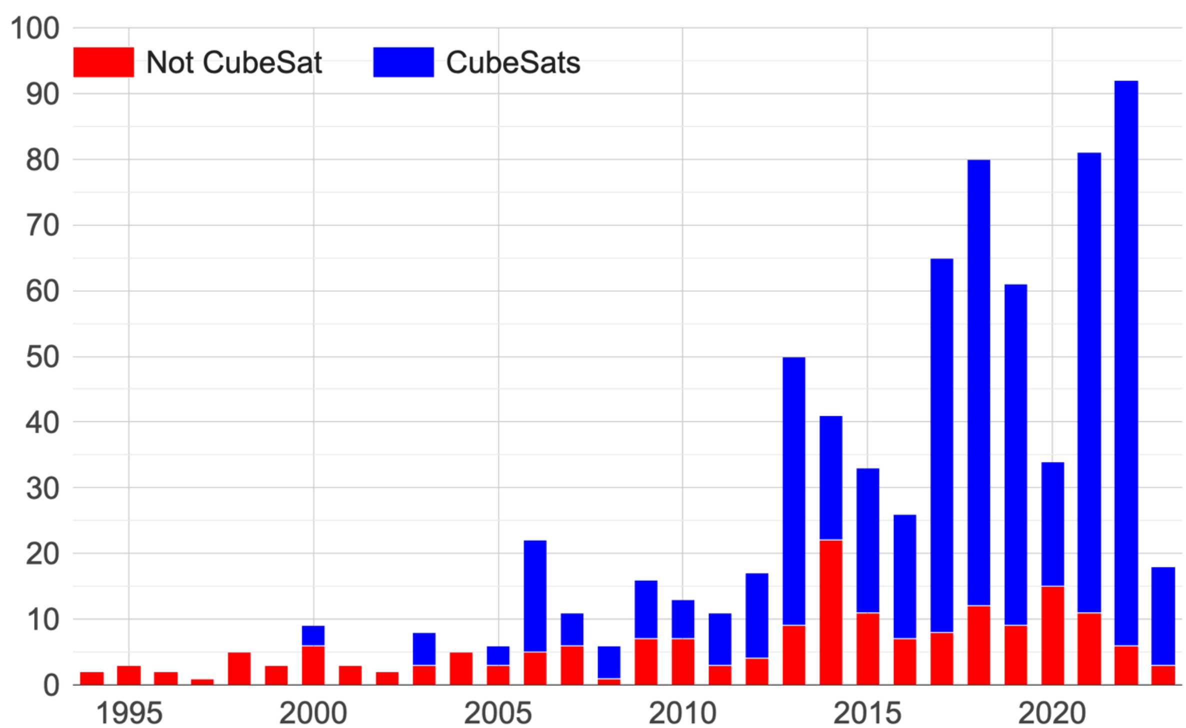

Figure 2: University-Class Missions by Form Factor

Nationality of the Builder

Seven hundred spacecraft is a large group to study, with a lot of variables within. Next, let us consider the places in the world where these missions are flown and how they get into orbit.

As shown in Figure 3 and Figure 3, the United States, Europe and Japan have produced the majority of university-class missions. But in the last 5 years, Russia and the other Asian nations have increased their output.

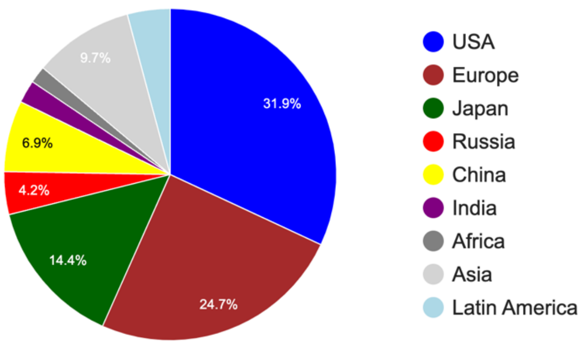

Figure 3: University-Class Missions by Nation of Builder (1994-2017)

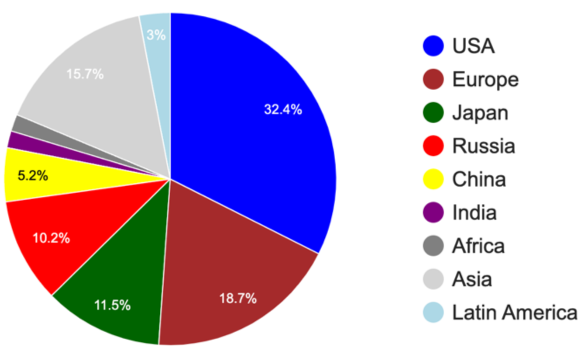

Figure 4: University-Class Missions by Nation of Builder (2018-2023)

When we consider to the nations from which these missions launch (Figure 5 and Figure 6), we observe that university-class missions are a worldwide phenomenon. It is worth noting that since 2018, there is a noted increase in the share of launches coming from the US (primarily SpaceX Transporter mega-launches), the ISS (the NASA ELaNa program) and New Zealand (Rocket Lab). Some of this change is also geopolitical, given the restrictions on using Russian rockets and the new launch vehicle challenges that Japan and Europe are currently experiencing.

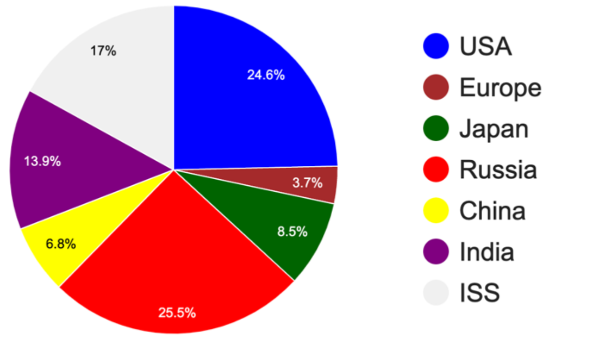

Figure 5: Countries that Provided Launches to University-Class Missions (1994-2017)

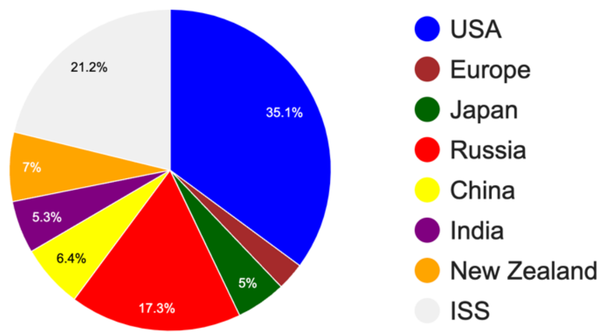

Figure 6: Countries that Provided Launches to University-Class Missions (2018-present)

Mission Types

As shown in Figure 7 and Figure 8, university projects are dominated by E-class and T-class missions (about 1/3rd each), followed by Science missions (1/6th) and Communications. The broad distribution of mission types does not change appreciably over time (Figure 9). It is worth noting that there has been a slight shift back towards E-class missions in the past 5 years. In prior papers, we mused that E-class missions would be replaced by science and technology demonstrations, but that has not happened.

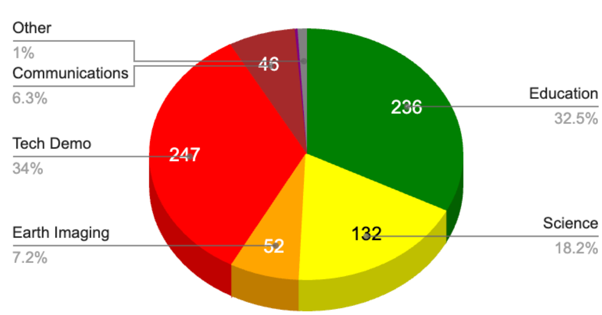

Figure 7: Types of Missions Flown by Universities (1994-2023)

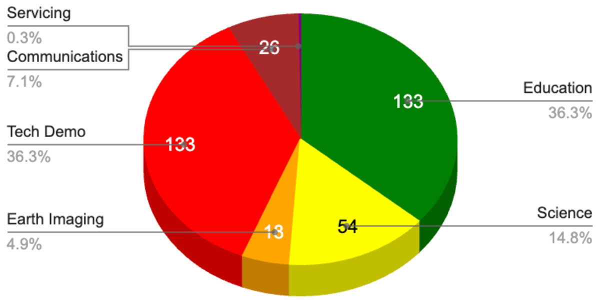

Figure 8: Types of Missions Flown by Universities (2018-present)

MISSIONS AND SUCCESS RATES

And that brings us back to our enduring question.

Do these missions matter?

Do university-class missions have useful outcomes? Do these spacecraft produce science, engineering and/or educational results that justify their launch slots, or are they expensive educational vanity projects?

As shown in Figure 9, university-class missions have pursued a wide assortment of industry-relevant activities. E-class missions have been seen as a "starter mission", a way to quickly gain flight experience before taking on more advanced missions.[10] As will be shown in the next section, with a large number of schools flying their first-ever spacecraft from 2018-2023, one would naturally expect to find a large number of E-class missions. About half of the schools with a first flight since 2018 flew E-class missions, which is only slightly greater rate than the first 180 schools to fly a spacecraft.

Still, having a mission is "relevant" to industry is not the same as a mission that actually contributes. It is beyond the scope of this paper to discuss and verify the science or technology relevance of individual missions – although we would very much like to see such a paper! Instead, we will point out that we only assign S-class status to missions with a publishing science PI with an instrument on the spacecraft and/or an external peer-reviewed science sponsor (e.g. NSF or NASA EPSCOR). Similarly, the C-class missions carry capable Amateur radio transponders or participate in Automatic Identification System (AIS) tracking and communi-cations. And the T-class missions must be operating and collecting data on a device or subsystem that advances the state of the art for small satellites. It is not enough to fly a camera that no one has flown before; that camera must have capabilities that have not flown before.

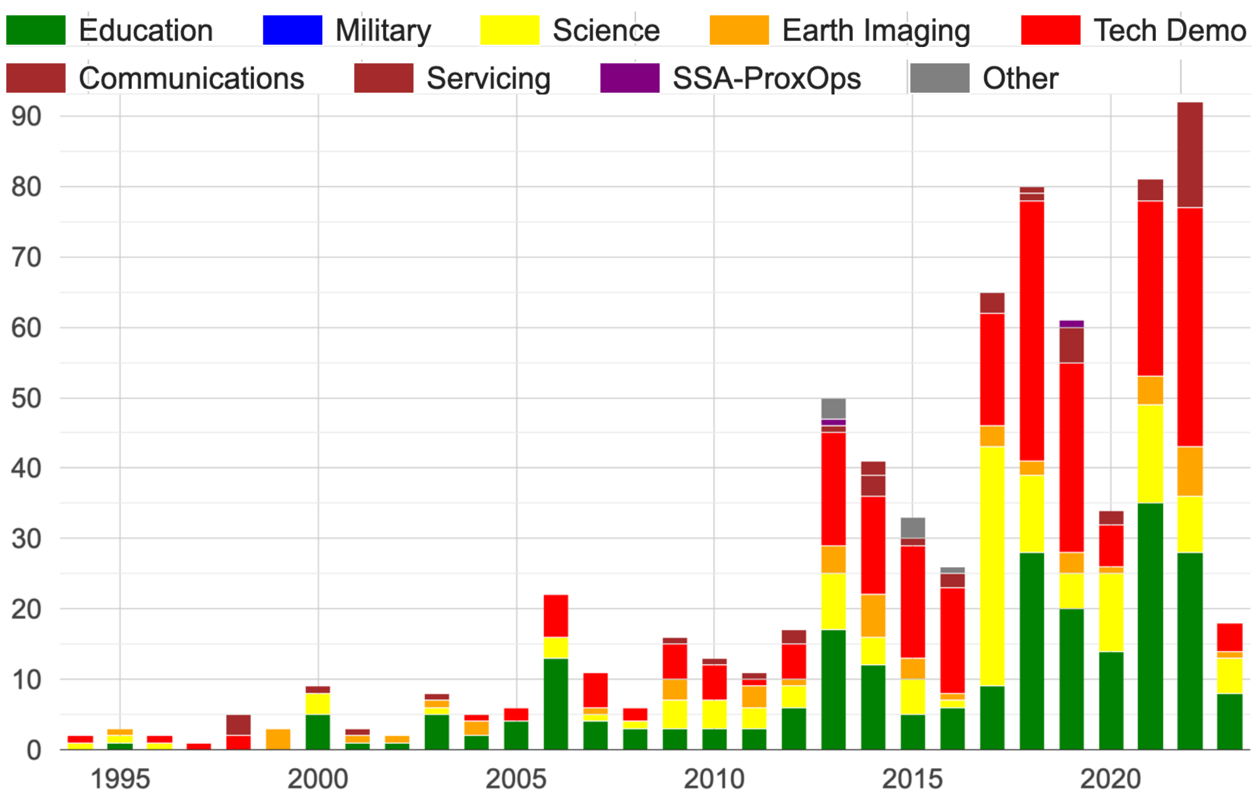

Figure 9: Mission Type by Launch Year

The last, admittedly anecdotal, evidence for the relevance of university-class missions has two parts: first, the ubiquitous acceptance of the CubeSat standard and the ubiquitous presence of university-class mission alumni in every part of the space industry. The latter claim is easy to justify to the target audience for this paper, as the Smallsat conference is overrun with alumni of student-built spacecraft missions. As for the former, References 4, 6 and 8 detail the fact that the overwhelming fraction of the first hundred CubeSats were university-class missions, and now the overwhelming fraction of CubeSat launches since 2018 were not. As early adopters, the universities retired risk associated with CubeSat component development and served as the launch customers for qualifying dispensers and multi-mission opportunities.

Whose Risk Is It, Anyway?

Next, let us consider the issue of mission success and failure. Using the mission status scale discussed, above, we first examine the results for all university-class missions (Figure 10). What is striking about this plot is first that just shy of one-tenth of all university missions are lost to launch failure. This is a number out of proportion with the number of launch failures each year. The reason for this high rate is twofold: university missions are often placed on rocket platforms making their first-ever launch attempt (e.g, ORS-4). First-flights have a significantly higher failure rate than later flights. Secondly, university-class missions tend to be launched in groups of 6 to 20 (or more, thanks to the Transporter series). When a rocket fails, a lot of university missions are lost.

When we take a closer look at each of the eras (Figure 11, Figure 12, Figure 13, Figure 14) it looks as though university-class missions went through a string of bad luck in the second era (2002-2009) and have been unusually lucky in the recent era, given the number of new launch vehicles going through their growing pains.

The second observation from Figure 10 is that about a third of all manifested university-class missions fail to achieve any of their primary mission objectives (i.e. the DOA and Early Loss categories on the chart). When the launch failures are factored out, the failure rate approaches 40%. Furthermore, mission success rates appear to be decreasing over time, from roughly two-thirds in the first era to on the order of 40% in over the last eight years.

It is at this point that the author must pause and plead for universities to be more forthright about the status of their projects. At the time of this writing (1 June 2023) nearly 25% of the missions flown since 2018 have no known mission status; the author does his best internet sleuthing and social-media-post following, but even then there's a lot of guesswork in these numbers. A charitable reading of the numbers would assign the unknowns into the other categories by rough proportions. However, one cannot rule out the possibility that most (if not all) of the "unknowns" are DOAs or Early Failures.

What is happening? As outlined in previous papers, we believe that flagship programs, by nature of their national government sponsorship, have access to resources, facilities and mentoring that lead to greater mission success. By their very nature, independent schools do not have such access. And, since prolific schools manage to produce multiple missions, they have an opportunity to implement lessons learned and best practices into their development process. The prolific schools managed to persist through failure. Regardless of whether their persistence is due to visionary leadership, persuasive project managers or just sheer stubbornness, it would be worthwhile to study those twelve prolific schools to identify common characteristics. In fact, the twelve prolific programs appear to be overtaking the flagship schools in terms of mission performance. Again, this is likely evidence that the prolific programs have developed good mission assurance practices; it also indicates that our "flagship" definition may not be as useful as it was 10 years ago.

But we are sidestepping the question. Is the failure rate among regular independent schools too high? Yes!

Why do we continue to sponsor regular independent schools in the face of those dismal numbers? We don't know. But we think it is a combination of (a) the lack of knowledge of the actual failure rates and (b) the high turnover among regular independent schools. As will be shown, in the next section, more than half of the schools that launched their first mission 5 or more years ago have not flown again. In that way the loss of each mission is viewed in isolation, and not as a trend.

What can be done? In the author's thirty years of experience with university-class missions, he has noted that student-led projects often fail because of a lack of time/resources given to systems-level testing. This lack of testing is driven by a lack of time; university missions fly as secondaries, and they cannot force a slip in the launch schedule when typical integration problems arise. The only available option to these programs is to reduce or eliminate system-level testing.

Since it is unlikely that launch vehicles will slip their schedules to accommodate secondary payloads (and we are not recommending that they do!), the only option is to better prepare independent programs for the likelihood of schedule constraints, and help them prepare their design/complexity accordingly.

[Full, sad disclosure: the previous two paragraphs are direct cut-and-pastes from the author's 2018 Smallsat conference paper. Nothing has changed.]

Therefore, to finally address the original question: the fact that university missions fail at a greater rate than professional missions is not a reason to dismiss university missions. The failure rate is too high for certain groups, and more could be done to introduce and enforce best practices for those groups.

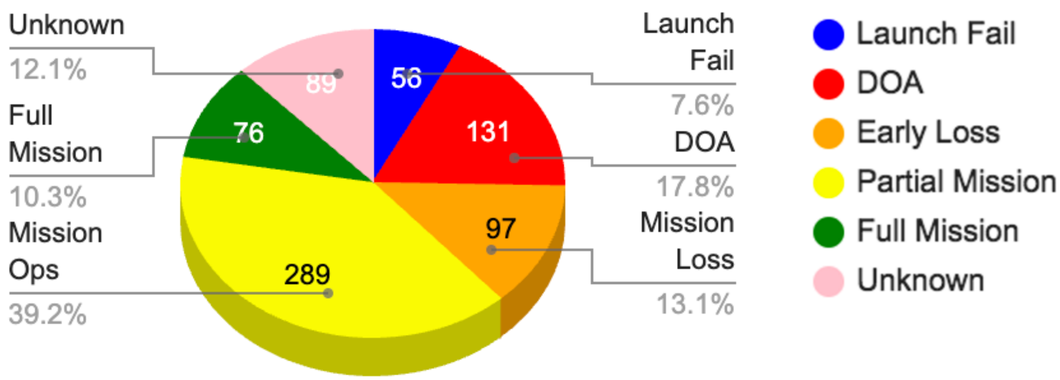

Figure 10. Mission Status for all University-Class Missions (1970-2018)

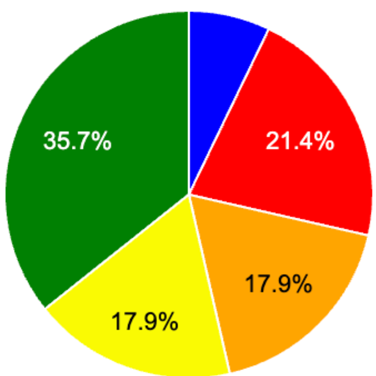

Figure 11. Mission Status for University-Class Missions (1994-2001, 28 Missions)

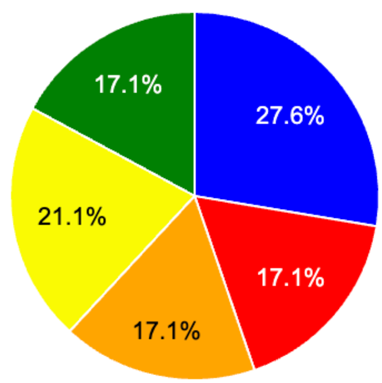

Figure 12. Mission Status for University-Class Missions (2002-2009, 76 Missions)

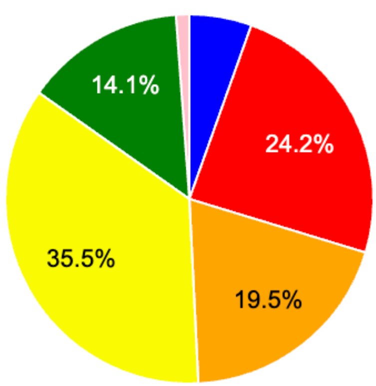

Figure 13. Mission Status for University-Class Missions (2010-2017, 256 Missions)

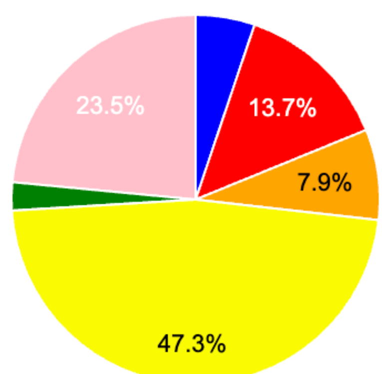

Figure 14. Mission Status for University-Class Missions (2018-2023, 266 Missions)

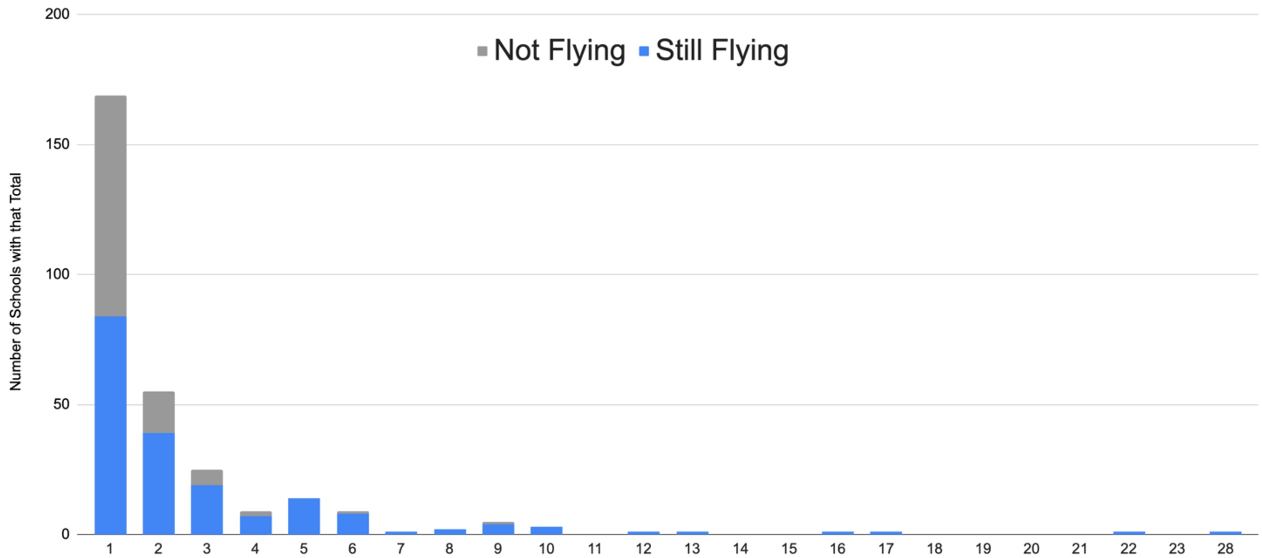

Figure 15. Count of Schools by Total Number of Missions Flown

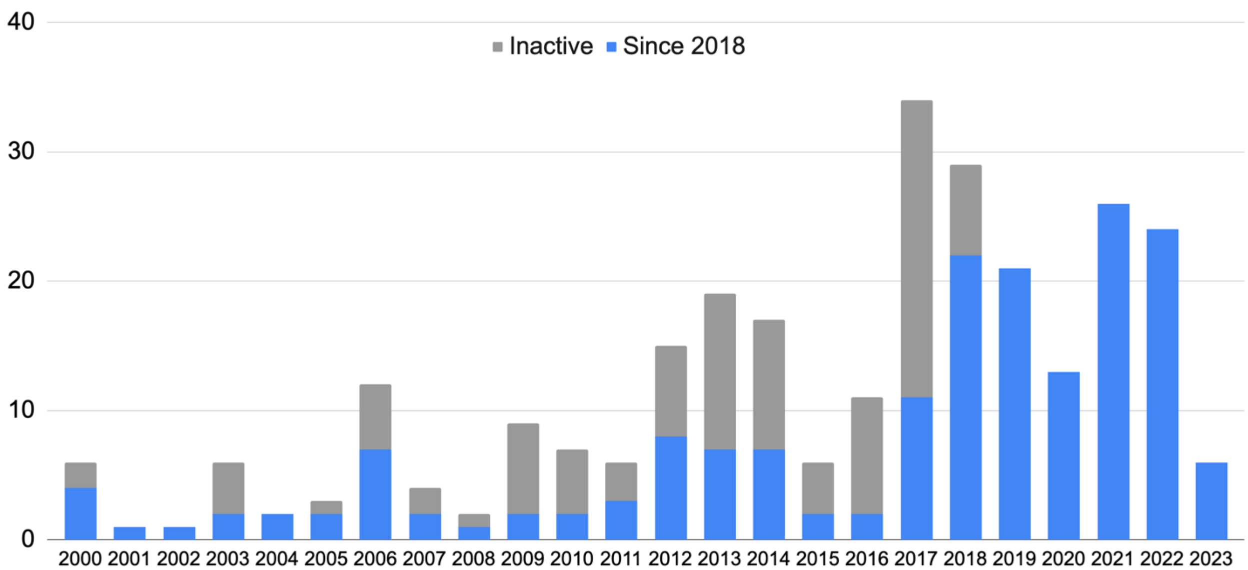

Figure 16. Count of Schools by Year of First Launch

Chicken, Meet Egg?

For those loyal readers who have read and remembered earlier papers (thank you), get ready for something new!

As hinted at in the previous section, one of the many challenges facing university-class programs is sustainability. This problem can be observed by counting the total number of missions flown by a school, and then accounting for whether the school is still flying. We define "still flying" as any mission launching within the last 5 years. One could argue that this is too generous, as the average time between launches for all multi-mission schools is just under 3 years. However, the author's personal experience gives credence to the 5-year number. (His next launch is in 2024, 5 years after his previous flight.)

Figure 15 requires some explanation. On the x-axis is the total number of missions flown by a school. The y-axis is the count of schools who have flown that many missions. Each school is counted only once; if School X has flown 3 missions, they are counted in Column 3. If they later fly a fourth, they would be removed from

Column 3 and added to Column 4. Finally, if the latest mission from that school has occurred within the last five years, the school is counted in blue, otherwise it is in grey.

With that in mind, Figure 15 illustrates what has been anecdotally conveyed in prior papers: if a school can somehow managed to produce 3 missions, it is highly likely to continue producing missions. However, the dropout rate is very high: about half of the schools that fly one mission never make it to two. Put another way: half of the universities have flown only one mission, and with half of those entering the field in the last 5 years, it is unlikely that many will be active 5 years from now.

The author doesn't have any optimistic spin; Figure 16 tells the same story in the format of the year of first launch. A few stalwart schools persist, but more than two-thirds of the schools that launched their first mission between 2000-2017 have not launched anything in the last five years. As any university-class builder can tell you, the first spacecraft is a lot more difficult to complete than expected. And many (most?) schools don't have the resources (time, money, emotional reserves) to attempt a second.

How does a school reach the magic threshold of three missions? The author strongly suggests that you, the reader, review the other papers in this conference and ask a lot of questions. My own advice is to emphasize modest missions and aim low for capabilities. A passively-stabilized, 9600-baud Beepsat may not be "cool", but low-Earth orbit is literally littered with cooler non-functional university missions.

CONCLUSIONS

University-class missions are a relatively small element of the overall secondary launch market, but their significance is outsized. University-led spacecraft programs are an important source of recruitment and training for engineers and scientists entering the workforce. Such programs can flight-test novel or risky concepts – with no example more obvious, or more significant than the very CubeSat itself.

While the failure rate of university missions is too high, the high rates are concentrated with "one-and-done" schools; schools that produce multiple spacecraft see significant improvements in success. The failure rates of university programs should not approach zero, as universities are uniquely situated in the space industry to approach higher-risk, novel missions and technologies.

Finally, it was extremely rewarding to review the earlier papers we have published on this topic, and compare the concerns of five and ten years ago to the situation today. We can happily report that we were wrong about all of most dire predictions, and even our optimistic predictions were not optimistic enough. Ten years ago, a launch rate of 8-10 university-class missions per year was thought to be too good to be sustainable, whereas now 8 missions is the average quarterly output.

Such an observation causes us to be thankful for all of the industry professionals who went far out of their way to support university projects – too many to name in this paper, but AFRL, NSF and NASA ELaNa deserve special recognition, as do the organizers and sponsors of this conference. We hope that they are able to see and enjoy the fruits of their efforts. We look forward to revisiting this topic in another 2-3 years to see how much everything has changed, again. We hope that it is as pleasant a paper to write as this one has been.

ACKNOWLEDGMENTS

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APPENDIX

It is traditional in these papers to list all of the University-class missions in the Appendix. However, with more than 700 missions, that table alone would exceed the page limit of this paper, even when I use tiny font. Contact the author if you want the list.

I can, however, fit the list of universities (barely).

Table A: Schools that have flown at least one university-class spacecraft

	School	Nation	First Launch	Total
1	Melbourne University	Australia	1/23/1970	2
2	Moscow Power Engineering Institute (MPEI)	Russia	10/26/1978	1
3	Moscow Aviation Institute	Russia	10/26/1978	4
4	University of Surrey	UK	10/6/1981	9
5	Weber State	USA	4/29/1985	2
6	ESIEESpace Club	France	7/17/1991	1
7	Technical University of Berlin	Germany	7/17/1991	28
8	Samara State Aerospace University (SSAU)	Russia	7/22/1993	2
9	Korean Advanced Institute of Science and Technology	South Korea	9/26/1993	10
10	University of Bremen	Germany	2/3/1994	1
11	Technion Institute of Technology	Israel	3/28/1995	5
12	National Autonomous University of Mexico (UNAM)	Mexico	3/28/1995	3
13	Polytechnic University of Madrid (UPM)	Spain	7/7/1995	3
14	Instituto Universitario Aeronautico De Cordoba	Argentina	8/29/1996	1
15	US Air Force Academy	USA	10/25/1997	9
16	University of Alabama-Huntsville	USA	10/24/1998	2
17	US Naval Postgraduate School (NPS)	USA	10/29/1998	3
18	Stellenbosch University	South Africa	2/23/1999	2
19	Arizona State University (ASU)	USA	1/27/2000	5
20	Stanford University	USA	1/27/2000	8
21	Santa Clara University	USA	2/10/2000	3
22	Tsinghua University	China	6/28/2000	5
23	Sapienza – Università di Roma	Italy	9/26/2000	13
24	Umeå University / Luleå University of Technology	Sweden	11/21/2000	1
25	US Naval Academy	USA	9/30/2001	10
26	Chiba Institute of Technology	Japan	12/14/2002	2
27	Technical University of Denmark (DTU)	Denmark	6/30/2003	2
28	Aalborg University	Denmark	6/30/2003	6
29	Tokyo Institute of Technology (TITech)	Japan	6/30/2003	6
30	University of Tokyo	Japan	6/30/2003	17
31	Universidade Norte do Paraná	Brazil	8/22/2003	1
32	Mozhaiskiy military academy	Russia	9/27/2003	2
33	Harbin Institute of Technology (HIT)	China	4/18/2004	9
34	New Mexico State University	USA	12/21/2004	2
35	Moscow State University (MSU)	Russia	1/20/2005	6
36	Norwegian Universities	Norway	10/27/2005	2
37	University of Wurzburg	Germany	10/27/2005	5
38	University of Kansas	USA	7/26/2006	1
39	University of Turin (Torino)	Italy	7/26/2006	1
40	University of Arizona	USA	7/26/2006	2

41	Hankuk Aviation University	South Korea	7/26/2006	2
42	Nihon University	Japan	7/26/2006	4
43	Bauman Moscow State Technical University	Russia	7/26/2006	4
44	Montana State University	USA	7/26/2006	12
45	University of Illinois (UIUC)	USA	7/26/2006	5
46	Cornell University	USA	7/26/2006	9
47	California Polytechnic State University	USA	7/26/2006	16
48	University of Hawai'i at Manoa	USA	7/26/2006	5
49	Hokkaido University of Science	Japan	9/22/2006	1
50	Universidad Nacional Del Comahue	Argentina	1/10/2007	1
51	University of South Arboleda	Colombia	4/17/2007	1
52	University of Louisiana at Lafayette	USA	4/17/2007	3
53	Zhejiang University	China	5/25/2007	6
54	FH Aachen, University of Applied Science	Germany	4/28/2008	2
55	Delft University of Technology (TU Delft)	Netherlands	4/28/2008	3
56	Tokyo Metropolitan College of Industrial Technology	Japan	1/23/2009	1
57	Kagawa University	Japan	1/23/2009	3
58	Tohoku University	Japan	1/23/2009	6
59	Anna University	India	4/20/2009	1
60	Texas A&M University	USA	7/15/2009	2
61	University of Texas - Austin	USA	7/15/2009	7
62	UFA State Aviation Technical University (UGATU)	Russia	9/17/2009	1
63	Polytechnic School of Lausanne (EPFL)	Switzerland	9/23/2009	1
64	Istanbul Technical University (ITU)	Turkey	9/23/2009	4
65	Soka University	Japan	5/20/2010	1
66	University Space Engineering Consortium	Japan	5/20/2010	1
67	Kagoshima University	Japan	5/20/2010	3
68	Waseda University	Japan	5/20/2010	3
69	SUPSI Space Lab	Switzerland	7/12/2010	1
70	University of Michigan	USA	11/20/2010	9
71	University of Southern California	USA	12/8/2010	1
72	Kentucky Space Consortium	USA	3/4/2011	3
73	University of Colorado	USA	3/4/2011	6
74	Nanyang Technological University (NTU)	Singapore	4/20/2011	8
75	IIT Kanpur - Indian Institute of Technology Kanpur	India	10/12/2011	1
76	Auburn University	USA	10/28/2011	1
77	Nanjing University of Science and Technology	China	11/9/2011	6
78	Sharif University of Technology, Tehran	Iran	2/3/2012	2
79	University of Bologna	Italy	2/13/2012	1
80	University of Bucharest	Romania	2/13/2012	1
81	Polytechnic University of Turin	Italy	2/13/2012	2
82	Warsaw Polytechnic (Warsaw University of Technology)	Poland	2/13/2012	2
83	University of Vigo	Spain	2/13/2012	3
84	Budapest University of Technology and Economics (BME)	Hungary	2/13/2012	3
85	University of Montpellier 2 (UM2)	France	2/13/2012	5
86	Kyushu Institute of Technology (KIT)	Japan	5/17/2012	22
87	FSpace Laboratory	Vietnam	7/21/2012	1
88	Fukuoka Institute of Technology	Japan	7/21/2012	1
89	Wakayama University	Japan	7/21/2012	2
90	Osaka Institute of Technology	Japan	9/9/2012	1
91	University of California, Berkeley	USA	9/13/2012	2
92	Morehead State University	USA	9/13/2012	5

93	Technical University of Dresden	Germany	4/19/2013	3
94	Tartu University	Estonia	5/7/2013	1
95	Colorado Space Grant Consortium	USA	9/29/2013	2
96	Utah State University	USA	9/29/2013	4
97	Drexel University	USA	11/20/2013	1
98	University of New Mexico	USA	11/20/2013	1
99	Vermont Technical College	USA	11/20/2013	1
100	West Point Military Academy	USA	11/20/2013	1
101	Saint Louis University	USA	11/20/2013	3
102	University of Florida	USA	11/20/2013	5
103	Thomas Jefferson High School For Science and Technology	USA	11/20/2013	2
104	Institute of Space Technology (IST) - Pakistan	Pakistan	11/21/2013	1
105	Narvik University	Norway	11/21/2013	1
106	Pontifical Catholic University of Peru (PUCP)	Peru	11/21/2013	2
107	Technical University of Munich (TUM)	Germany	11/21/2013	1
108	University of Maryland, Baltimore County	USA	11/21/2013	1
109	Kyung Hee University	South Korea	11/21/2013	3
110	Cape Peninsula University of Technology (CPUT)	South Africa	11/21/2013	5
111	City University of New York (CUNY)	USA	12/6/2013	1
112	Lithuanian Space Association	Lithuania	1/9/2014	1
113	Universidad Alas Peruanas	Peru	1/9/2014	1
114	Vilnius University	Lithuania	1/9/2014	2
115	Universidad Nacional Ingenieria, Peru	Peru	2/5/2014	1
116	Shinshu University	Japan	2/27/2014	1
117	Tama Art University	Japan	2/27/2014	2
118	University of Tsukuba	Japan	2/27/2014	2
119	Osaka Prefecture University (OPU)	Japan	2/27/2014	2
120	Teikyo University	Japan	2/27/2014	2
121	Taylor University	USA	4/18/2014	1
122	Universidad de la Republica (UDELAR)	Uruguay	6/19/2014	1
123	University of Montreal	Canada	6/19/2014	1
124	Herzliya Science Centre - Space Laboratory	Israel	6/19/2014	10
125	SPUTNIX Ltd	Russia	6/19/2014	6
126	National Technical University of Ukraine (NTUU KPI)	Ukraine	6/19/2014	2
127	National Cheng Kung University (NCKU)	Taiwan	6/19/2014	4
128	Nagoya University	Japan	11/6/2014	4
129	University of Brasilia (Serpens Consortium)	Brazil	8/19/2015	1
130	Xidian University (University of Electronic Science and Technology - UESTC)	China	9/19/2015	1
131	Salish Kootenai College	USA	10/8/2015	1
132	University of Alaska Fairbanks	USA	10/8/2015	1
133	St Thomas More Cathedral School	USA	12/6/2015	1
134	National University of Singapore (NUS)	Singapore	12/16/2015	4
135	Tomsk Polytechnic University	Russia	3/31/2016	1
136	University of Liege	Belgium	4/25/2016	1
137	College of Engineering Pune (COEP)	India	6/22/2016	1
138	Sathyabama University	India	6/22/2016	1
139	Northwestern Polytechnical University (NPU)	China	6/25/2016	2
140	Polytechnic University of Catalonia (UPC)	Spain	8/15/2016	2
141	IIT Bombay - Indian Institute of Technology Bombay	India	9/26/2016	1
142	PES University Bangalore (formerly PES Institute of Technology)	India	9/26/2016	1
143	Qian Academy of Youth Academy of Astronautics	China	11/9/2016	1
144	Escola Municipal Presidente Tancredo de Almeida Neves	Brazil	12/9/2016	1

145	Beijing Bayi High School	China	12/28/2016	1
146	Ben-Gurion University of the Negev	Israel	2/15/2017	1
147	Al-Farabi Kazakh National University (KazGU)	Kazakhstan	2/15/2017	2
148	Cal State Northridge	USA	4/18/2017	1
149	Democritus University of Thrace	Greece	4/18/2017	1
150	Ecole Polytechnique	France	4/18/2017	1
151	Lulea University of Technology	Sweden	4/18/2017	1
152	Mines ParisTech (ENSMP)	France	4/18/2017	1
153	Universidad del Turabo	USA	4/18/2017	1
154	University of Adelaide	Australia	4/18/2017	1
155	University of Patras	Greece	4/18/2017	1
156	University of Sydney	Australia	4/18/2017	1
157	Aalto University	Finland	4/18/2017	3
158	University of New South Wales	Australia	4/18/2017	6
159	Seoul National University	South Korea	4/18/2017	5
160	University of Alberta	Canada	4/18/2017	2
161	All Nations University (ANUC)	Ghana	6/3/2017	1
162	BRAC University	Bangladesh	6/3/2017	1
163	National University of Mongolia (NUM)	Mongolia	6/3/2017	1
164	Nigerian Federal University of Technology Akure (FUTA)	Nigeria	6/3/2017	1
165	SWSU - South-West State University (YuZGU)	Russia	6/14/2017	**2**
166	Mullard Space Science Laboratory, UCL	UK	6/23/2017	1
167	Noorul Islam University	India	6/23/2017	1
168	School of Industry and Trade, Bozen	India	6/23/2017	1
169	University of Applied Sciences, Wiener Neustadt	Austria	6/23/2017	1
170	Ventspils University College	Latvia	6/23/2017	1
171	University of Chile - SPEL	Chile	6/23/2017	5
172	University of Stuttgart - IRS (Institute for Space Systems)	Germany	7/14/2017	1
173	Ecuador UTE (Universidad Tecnologica Equinoccial)	Ecuador	7/14/2017	2
174	Pennsylvania State University (PSU)	USA	8/14/2017	1
175	MIT SSL (Space Systems Laboratory)	USA	8/14/2017	3
176	Fudan University	China	11/14/2017	1
177	Embry-Riddle Aeronautical University (ERAU)	USA	11/18/2017	1
178	Northwest Nazarene University (NNU)	USA	11/18/2017	3
179	KTH Royal Institute of Technology	Sweden	11/28/2017	2
180	Chungnam National University - CNU	South Korea	1/12/2018	1
181	l'Observatoire de Paris (OBSPM)	France	1/12/2018	1
182	Chosun University	South Korea	1/12/2018	3
183	Yonsei University	South Korea	1/12/2018	5
184	Urumqi 20 High School	China	2/2/2018	1
185	University of Nairobi	KEN	4/2/2018	1
186	University of Iowa	USA	5/21/2018	1
187	Colorado State University	USA	5/21/2018	1
188	The Ohio State University	USA	5/21/2018	1
189	Brown University	USA	5/21/2018	2
190	Sirius Education Center	Russia	7/9/2018	2
191	University of California, Los Angeles (UCLA)	USA	9/15/2018	2
192	University of Central Florida (UCF)	USA	9/15/2018	2
193	Shizuoka University	Japan	9/22/2018	4
194	Aichi University of Technology	Japan	10/29/2018	1
195	Belarusian State University (BSU)	Belarus	10/29/2018	1
196	Irvine Public Schools Foundation (IPSF)	USA	11/11/2018	2

197	Masdar Institute of Science and Technology	UAE	11/17/2018	1
198	Crown Prince Foundation	Jordan	12/3/2018	1
199	Korea Aerospace University	South Korea	12/3/2018	1
200	Republic of Korea Air Force Academy	South Korea	12/3/2018	1
201	King Mongkut's University of Technology North Bangkok (KMUTNB)	Thailand	12/3/2018	2
202	Georgia Tech	USA	12/3/2018	5
203	The Weiss School	USA	12/3/2018	2
204	Aarhus University	Denmark	12/5/2018	1
205	University of Southern Indiana	USA	12/5/2018	1
206	New Mexico Institute of Mining and Technology	USA	12/16/2018	1
207	North Idaho STEM Charter Academy	USA	12/16/2018	1
208	West Virginia University	USA	12/16/2018	1
209	Amir Kabir University of Technology - Tehran	IRAN	1/15/2019	1
210	Space Kidz India	India	1/24/2019	3
211	AGH University of Science and Technology (Akademica Gorniczo-Hutnicsa)	Poland	4/17/2019	1
212	Institut Superiuer de l'Aeronautique et de l'Espace (ISAE)	France	4/17/2019	1
213	Old Dominion University	USA	4/17/2019	1
214	University of Virginia (UVA)	USA	4/17/2019	1
215	Virginia Polytechnic Institute (Virginia Tech)	USA	4/17/2019	1
216	Merritt Island High School	USA	6/25/2019	1
217	Michigan Technical University	USA	6/25/2019	2
218	Universidad del Ejercito y Fuerza Aerea (UDEFA)	Mexico	6/29/2019	1
219	Amur State University	Russia	7/5/2019	1
220	Tallinn University of Technology (TalTech)	Estonia	7/5/2019	2
221	Beijing Institute of Technology (BIT)	China	7/25/2019	1
222	Beijing Normal University (BNU)	China	9/12/2019	1
223	University of Minnesota	USA	11/2/2019	1
224	University of Washington	USA	11/2/2019	1
225	Cosmiac	USA	12/5/2019	1
226	Sonoma State University (SSU)	USA	12/5/2019	1
227	University of Puebla UPAEP	Mexico	12/5/2019	1
228	von Karman Institute (VKI)	Belgium	12/5/2019	1
229	Federal University of Santa Catarina (UFSC)	Brazil	12/20/2019	1
230	Iran University of Science and Technology	Iran	2/9/2020	1
231	Universidad del Valle de Guatemala (UVG)	Guatemala	3/7/2020	1
232	Boston University (BU)	USA	6/13/2020	**2**
233	Xibaipo Middle School	China	7/3/2020	1
234	Centre Spatial Universitaire de Grenoble (CSUG)	France	9/3/2020	1
235	University of Maribor	Slovakia	9/3/2020	2
236	Novosibirsk State University (NSU)	Russia	9/28/2020	1
237	Khalifa University of Science & Technology (KUSTAR)	UAE	9/28/2020	3
238	Ohio University	USA	10/3/2020	1
239	University of Georgia UGA	USA	10/3/2020	1
240	York University, Toronto	Canada	10/3/2020	1
241	Ariel University	Israel	10/3/2020	3
242	Taiyuan Jinshan Middle School	China	11/6/2020	1
243	Brigham Young University (BYU)	USA	1/17/2021	2
244	Capitol Technology University	USA	1/17/2021	1
245	National Central University - NCU (Taiwan)	Taiwan	1/24/2021	1
246	National Taiwan Ocean University (NTOU)	Taiwan	1/24/2021	1
247	University of South Florida (USF)	USA	1/24/2021	3
248	Technical University of Moldova (UTM/TUM)	Moldova	2/20/2021	1

249	Tel Aviv University (TAU)	Israel	2/20/2021	1
250	G. H. Raisoni College of Engineering (GHRCE)	India	2/28/2021	1
251	Jeppiaar Institute of Technology (JIT)	India	2/28/2021	1
252	DIYSATELLITE	Argentina	3/22/2021	1
253	King Saud University (KSU)	Saudi Arabia	3/22/2021	1
254	University of Toronto (UTIAS)	Canada	3/22/2021	1
255	Shandong Institute of Industrial Technology	China	4/27/2021	2
256	Oak Ridge High School	USA	6/3/2021	1
257	University of Manchester	UK	6/3/2021	1
258	Curtin University	Australia	8/29/2021	1
259	Universidad Interamericana de Puerto Rico	USA	8/29/2021	1
260	University of Massachusetts - UMASS	USA	8/29/2021	1
261	University of the Philippines-Diliman	Philippines	8/29/2021	2
262	Hawaii Science and Technology Museum	USA	9/3/2021	1
263	Teachers in Space Inc	USA	9/3/2021	2
264	Beihang University	China	10/14/2021	1
265	Jiao Tong University	China	10/14/2021	1
266	Aoyama Gakuin University	Japan	11/9/2021	1
267	National Institute of Technology, Kochi College (KOSEN)	Japan	11/9/2021	2
268	101 Middle School, Beijing	China	12/26/2021	1
269	Carnegie Mellon University	USA	1/13/2022	1
270	Norwegian University of Science and Technology (NTNU)	Norway	1/13/2022	1
271	Zonguldak Bülent Ecevit Üniversitesi	Turkey	1/13/2022	1
272	University of Alabama (UA) - UASpace Lab	USA	2/10/2022	1
273	IIST - Indian Institute of Space Science and Technology	India	2/14/2022	1
274	Wuhan University	China	2/27/2022	2
275	Portland State University (PSU)	USA	3/15/2022	1
276	Ryazan Radio Engineering State University	Russia	6/3/2022	2
277	University of Naples	Italy	7/13/2022	1
278	University of South Alabama	USA	7/15/2022	1
279	Higher school of applied physics and space technologies	Russia	8/9/2022	2
280	Kazan National Research Technical University	Russia	8/9/2022	1
281	Kuzbass State Technical University (KuzGTU)	Russia	8/9/2022	1
282	Moscow Institute of Electronic Technology (MIET)	Russia	8/9/2022	1
283	National Research University Belgorod State University (NRU BelSU)	Russia	8/9/2022	1
284	National Research University Higher School of Economics (NRU HSE)	Russia	8/9/2022	1
285	Siberian State Aerospace University (SibSAU)	Russia	8/9/2022	1
286	Skolkovo Institute of Science and Technology - Skoltech	Russia	8/9/2022	2
287	Tyumen State University (UTMN)	Russia	8/9/2022	1
288	Kindai University	Japan	11/7/2022	1
289	Dalhousie University	Canada	11/26/2022	1
290	National Formosa University (NFU)	Taiwan	11/26/2022	1
291	University of Victoria (UVic)	Canada	11/26/2022	1
292	Kuwait University	Kuwait	1/3/2023	1
293	Aurora College	Canada	3/15/2023	1
294	McMaster University	Canada	3/15/2023	1
295	University of Arkansas (UArk)	USA	3/15/2023	1
296	Yukon University	Canada	3/15/2023	1
297	Bronco Space (Cal Poly Pomona)	USA	5/25/2022	3
298	Macao University of Science and Technology (MUST)	China	5/21/2023	2