NASA Innovative Advanced Concepts (NIAC) Program

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The NASA Innovative Advanced Concepts (NIAC) Program nurtures visionary ideas that could transform future aerospace missions with the creation of breakthroughs — radically better or entirely new aerospace concepts — while engaging America's innovators and entrepreneurs as partners in the journey. NIAC is unique within NASA. It is a program that values both technical acumen and imagination, inspired by curiosity and the quest for knowledge. We encourage innovators to be creative and attempt great leaps forward in aerospace. NIAC studies explore innovative, technically credible, advanced concepts that could one day "Change the Possible" in aerospace. NIAC is open to all categories of U.S. organizations. Non-U.S. organizations may partner in, or lead, NIAC studies on a no-exchange-of-funds basis, and subject to NASA's policy on foreign participation. NIAC supports innovative research through multiple phases of study, all competitively awarded. Phase I studies are nine-month efforts to explore the overall viability of visionary concepts. Phase II studies further develop the most promising Phase I concepts for up to two years, addressing key challenges and developing a technology roadmap for eventual implementation. Phase III studies further advance, for up to two years, those technologies which uniquely require NIAC support to facilitate transition into other NASA, government, or commercial programs. A NIAC concept must be relevant to NASA's Vision and Mission, innovative, of high potential impact, credible and reasonable, and examined in a reference mission. The reference mission is a key feature of NIAC studies, facilitating concept assessment in a space or aeronautics mission context to demonstrate that it would be worth further development. This paper provides an update to NIAC's history and current role including process, additional summary statistics about its selections, status of outreach, and examples of some visionary and credible studies and impacts.

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Nomenclature

NIAC	=	NASA Innovative Advanced Concepts
NEC	=	NIAC External Council
CIF	=	Center Innovation Fund
ECI	=	Early Career Initiative
JPL	=	Jet Propulsion Laboratory
MPP	=	Mandatory Preliminary Proposal

I. NIAC Goals and Objectives

The NASA Innovative Advanced Concepts (NIAC) Program is unique within NASA. It is a program that values both technical acumen and imagination, inspired by curiosity and the quest for knowledge. We encourage innovators to be creative and attempt great leaps forward in aerospace. NIAC studies explore innovative, technically credible, advanced concepts that could one day "Change the Possible" in aerospace. Concepts are solicited from any field of study that offers a radically different approach or disruptive innovation that may significantly enhance or enable new human or robotic science and exploration missions.

NIAC supports innovative research through multiple phases of study. Phase I awards are for efforts up to nine months funded at up to $175,000 per award to explore the overall feasibility and viability of visionary concepts. Phase II awards are for efforts up to two years with total funding of up to $600,000 per award to further develop the most promising Phase I concepts, and to explore potential infusion options within and beyond NASA. Concepts should be sufficiently well developed at the end of Phase II to seek follow on development funds from other NASA programs, external government programs, or commercial partners. However, in rare instances there may be a compelling need for the strategic investment of additional NIAC funds to further advance Phase II concepts with clearly defined transition paths into other NASA, government, or commercial programs. Phase III awards are designed to meet this need, with the anticipated selection of no more than one new award per year. Phase III studies are funded for a maximum duration of two years at a total funding level of up to $2,000,000 per award. At the completion of each NIAC study, a final report is required which is posted on the publicly available NIAC website.

NIAC is unique in that it requires the study of a specific exemplar mission to demonstrate the feasibility and benefit of the innovation. A general list of missions that could benefit from the innovation is not sufficient. A representative mission depends on the concept, but generally involves the architecture, objectives, operations, logistics, system-level design, etc. that frame the innovation being proposed. For example, an advanced space transportation concept study includes assessments of the full vehicle mass and payload for an identified destination. Instrument concept studies demonstrate that the instrument fits within or operates in conjunction with a spacecraft or system capable of supporting its operation and data collection in the intended environment. Life support and other human health concepts identify the mission application (lunar, Mars transit, Mars surface, etc.) and show that the inclusion of the innovation has a substantial benefit over alternatives, after accounting for the equivalent system mass needed to enable it. Advanced robotic concept studies show the innovation supports one or more needs, with reasonable and attainable mass, power, and volume consistent with a selected specific mission objective in the relevant environment. These examples are meant to be representative, not exclusive or limiting.

NIAC also seeks to foster a community of innovators whose interactions and collaborations may persist well beyond the performance of their funded studies. NIAC award recipients are required to participate in a Phase I Orientation Meeting soon after award, and at an annual Symposium in September where all active NIAC Fellows present the status of their research in a publicly open forum.

II. NIAC History

While an overview is provided herein, much of the history of NIAC has been described in more detail in two previously published NIAC Program overviews ([1], *2013 and* [2]*2017*). One significant change since the previous paper is the introduction of Phase III, which will be discussed more below.

The NASA Institute of Advanced Concepts (known widely as "NIAC" but referred to herein as "the Institute" to avoid confusion with the current program), was led by Dr. Robert Cassanova and started in 1998 under a NASA contract to Universities Space Research Association. The Institute continued until its termination in August 2007. During its nine years of operation, the Institute received 1309 proposals and awarded 126 Phase I studies and 42 Phase II studies.

In 2008, Congress directed NASA to commission a National Research Council (NRC) study to evaluate the Institute's performance and to make recommendations concerning whether the Institute should be reinstated. If so, the NRC was also asked to provide recommendations to increase NIAC effectiveness. The NRC responded with a report in 2009, "*Fostering Visions of the Future*" ([3,] 2009) which was highly supportive of the Institute, endorsing the Institute's vision, scope, and selection process. In the report, the NRC recommended that NASA reinstate a NIAC-like entity, with a few suggested changes from the Institute. Most substantially, the NRC recommended the program be managed within NASA, and that eligibility be extended to include NASA researchers. NASA largely followed the committee recommendations when NIAC was reestablished in late 2010/2011.

Notably, NIAC did not initially incorporate the NRC-recommended inclusion of a "Phase III" follow-up for successful studies:

> *The committee recommends that future NIAC2 proposal opportunities include the potential selection of a small number of Phase III "proof of concept" awards for up to $5 million each for 4 years to demonstrate and resolve fundamental feasibility issues*.

In 2019 however, NASA expanded NIAC's scope to include Phase III awards. The intent of the two-year, $2M Phase III study, as implemented by the Agency, is to strategically transition NIAC studies to other NASA programs, other government agencies, or commercial investment. Two Phase III awards were made in the inaugural year. Subsequent years have seen no more than one award per year. Notably in 2023, no Phase III was awarded, as none of the submissions were deemed as adequately focused on transition.

Another significant change to NIAC occurred during 2024, when NASA formally changed the program structure to align with that of other NASA programs. The new program structure includes a Headquarters office, with primary responsibility for program strategy, and a Langley Research Center office with primary responsibility for program operations. This change also combined program oversight of NIAC with NASA's Center Innovation Fund and Early Career Initiative programs. While NIAC personnel continue to operate as a cohesive and collaborative team, certain functions are now formally distributed:

NASA HQ

- Strategic Planning
- Program Direction & Goals
- Cross-Program Integration
- Assessment and Evaluation
- Delegated Decision Authority

NASA LaRC

- Program Implementation
- Achievement of Technical Objectives within Schedule and Resources Procurement Administration
- Program Integration

NIAC retains a feature of the original Institute, an External Council, consisting of distinguished individuals whose role is to assess how well NIAC is meeting its vision and goals. The NIAC External Council (NEC) attends NIAC's Phase I Orientation and public symposia and meets formally after each to discuss any issues and to provide feedback. Note the NEC is not a formal Recommendation body. Members may not submit proposals and they do not participate in proposal evaluations. Figure 1 shows NIAC organization in 2025, while Figure 2 shows NIAC leadership since 2010 and the Chairs of the NEC.

Figure 1. NIAC Team in 2025

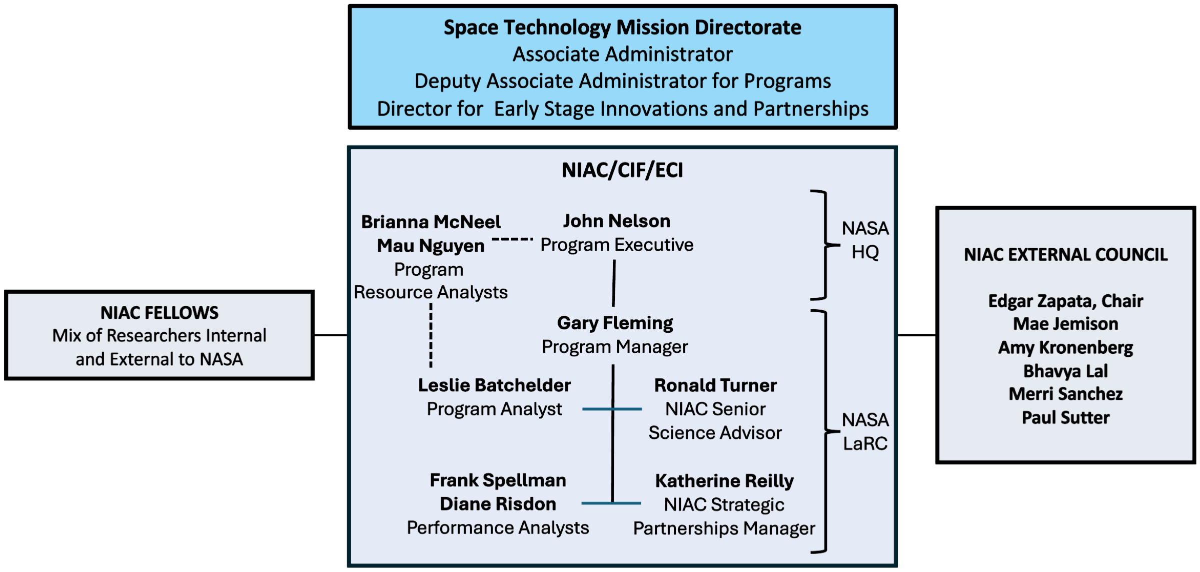


Figure 2. NIAC and External Council Leadership Since 2010

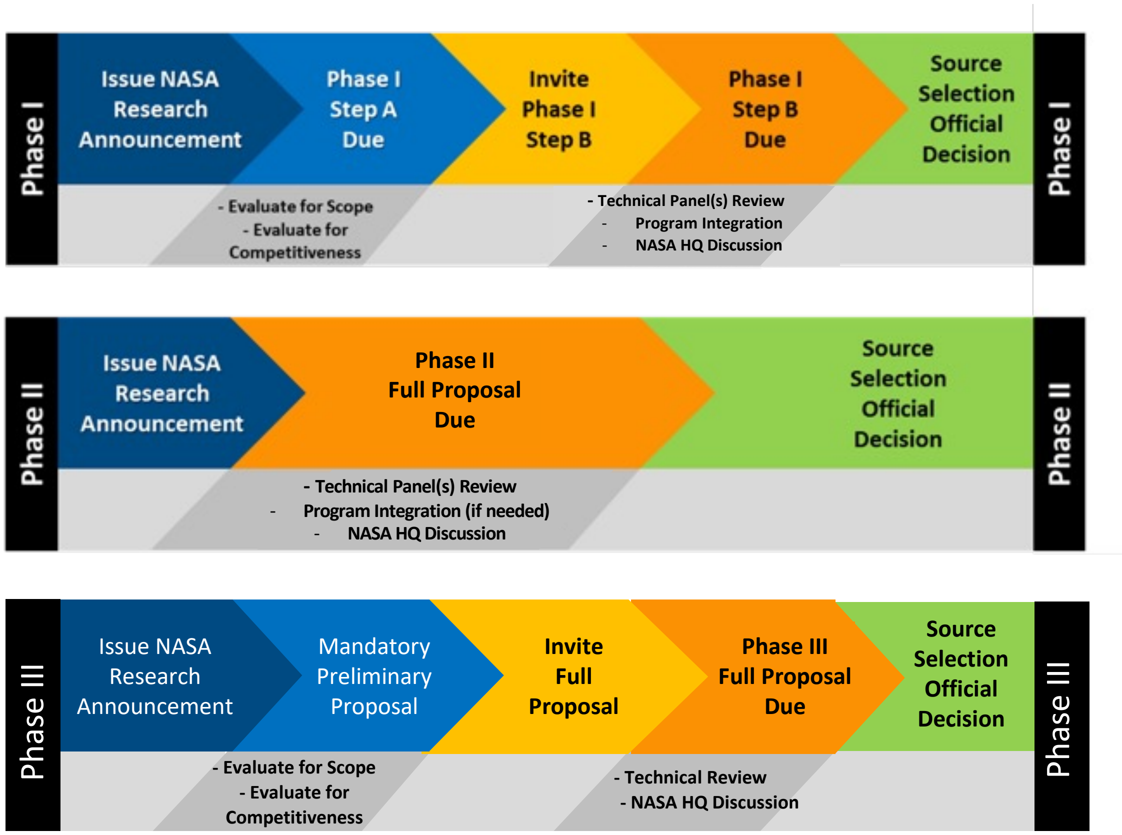
NIAC Leadership			
Years	**Program Executive**	**Deputy Program Executive**	**Program Manager**
2010-2011	Jay Falker	---	---
2011-2015	Jay Falker	---	Jason Derleth
2015-2017	Jason Derleth	---	Alvin Yew
2018-2020	Jason Derleth	---	Michael LaPointe
2020-2021	Jason Derleth	---	Eric Eberly
2021-2022	Michael LaPointe	---	Eric Eberly
2022-2024	Michael LaPointe	John Nelson	---
2024-Present	John Nelson	---	Gary Fleming

NEC Chairs	
Chair term start	**Name**
2010	Bob Cassanova
2012	Frank Martin
2015	Larry Young
2018	Louis Friedman
2020	Ariel Waldman
2022	Mae Jemison
2025	Edgar Zapata

III. NIAC Study Selection Process

NIAC studies are selected by merit as determined by a thorough peer review process. Anyone is eligible to submit a NIAC Phase I proposal (while NASA can fund only U.S. organizations, foreign entities may propose but if selected the study will be conducted on a "no exchange of funds" basis). Phase II proposals must be based on a completed Phase I study. Phase III solicitations are limited to those proposers whose Phase II has attracted the attention of a potential transition partner, but NIAC funding is uniquely required to address some remaining issues. The solicitation steps are shown in Figure 3.

Figure 3: Phase I/II/III Solicitation Process



A. Phase I Selection Process

Details of the Phase I selection process were described in previous NIAC overviews (2013 and 2017) and remain largely unchanged. Herein we provide only an overview, with some additional statistical information.

The process begins with the release of the call for proposals, an appendix to the Space Technology Mission Directorate NASA Research Announcement (NRA): Space Technology REsearch, Development, Demonstration, and Infusion (REDDI). Since 2020, the call has been released in early June. It is a two-step process, with Step A due in July, Step B invitations sent in August, Step B due in September, Technical Review Panels in October/November, selection in December, announcements in early January.

The full scope of NIAC Phase I concepts was described earlier. Other programs at NASA have the responsibility to explore and develop new technologies, materials, or subsystems. A continuing challenge in the NIAC Program is to articulate the unique niche that NIAC fills: the opportunity to explore bold new ideas that may fundamentally change the way NASA embarks on future missions, by looking at concepts in mission context. In line with the approach used by the Institute, and to further clarify what NIAC is looking for in a study, NIAC solicitations also note what the program is not looking for. This list, informally referred to as “NIAC’s thou shalt not” list, has evolved incrementally for clarity to the community. Figure 4 is the list as published in the NIAC Call for Proposals for FY 2025, released in June, 2024. Out of Scope examples, which are not considered for award, include narrowly focused technology studies, proposals for scientific studies, and broad literature reviews of advanced technology or approaches.

Figure 4 Out of Scope criteria for NIAC, Call for FY25 Proposals

1. **Unclear relevance to NASA's Vision and Mission**. Fails to sufficiently address national government and commercial benefits related to space or aeronautics.
2. **Unclear or not adequately articulated**. It fails to identify or propose to study a specific innovative concept. NIAC does not fund studies that identify a difficult challenge coupled with a plan for a thorough literature search or systems analysis study of known alternative concepts.
3. **No representative mission**. There is insufficient description of a representative mission. The proposal must include a specific representative mission and its architecture in sufficient detail to demonstrate the benefit of the concept.
4. **Previously explored**. Does not identify a new factor that substantially differentiates the proposal from prior efforts.
5. **Incremental**. Proposes typical next steps or aims at only modest improvement, rather than investigating far-term or high risk "breakthrough" concepts.
6. **Not technically credible**. Conflicts with established physics or engineering principles, without acknowledging this and offering a sufficiently plausible defense.
7. **Not programmatically credible**. There is no reasonable path to implementation, without acknowledging the barriers (e.g., requiring unrealistic budgets or policy changes) and offering a sufficiently plausible approach.
8. **Too narrowly focused**. There is insufficient evidence of incorporation into a reference mission. While some focused work may be appropriate to establish the credibility of the underlying technology, a NIAC study must also include a detailed mission analysis. Examples of narrow focus include too much emphasis on technology or subsystems development of smaller scope (e.g., components, instruments, materials) or too much emphasis on science research (e.g. laboratory characterization or fieldwork).
9. **Develops pre-mission tools or processes**. Focus is on the development of systems engineering tools or processes applied in early stages of mission development to improve design, decision-making, or algorithm development without sufficient incorporation into a representative mission.

After a review for scope according to this list, a further screening of the remaining Step A proposals evaluates the potential competitiveness of the concept, which is based on the proposed concept's potential impact if fully successful and the clarity with which the Step A describes the essential elements of the concept and addresses the concept's plausibility and feasibility. Principal Investigators (PIs) of the highest rated eligible proposals are invited to submit a more complete Step B proposal.

NIAC Phase I Step B proposals are assigned to technical panels for review. The number of panels is determined by the number and technical mix of the proposals: for the last several years there have been four to five technical panels, organized roughly by concept scope (typically: robotic, scientific, transportation, human systems). The technical panels are charged to evaluate the proposals against the review criteria. Just as the scope criteria have evolved, the evaluation criteria have evolved to better communicate NIAC goals and objectives. Figure 5 includes the criteria categories for the most recent Phase I, II, and III calls for proposals.

Figure 5. Criteria categories for the most recent Phase I, II, and III calls for proposals

NIAC Evaluation Criteria

(from the most recent calls for proposal)

Phase I	Phase II	Phase III
1. Innovation	1. Concept Progression	1. Concept Progression
2. Impact	2. Technical Study Approach	2. Technical Study Approach
3. Representative Mission	3. Representative Mission	3. Transition Strategy
4. Technical Approach	4. Potential Impact	4. Management Approach

The technical panels consider the proposals and submit a technical evaluation against the criteria resulting in an overall technical score for each criterion and an overall "Color Score" informed by the criteria scores. While rare, a panel may issue a recommendation (color score) that is higher or lower than the technical scores would suggest, provided with an accompanying justification. Figure 6 is a description of the color score criteria and instructions provided to the review panel. Figure 7 shows the distribution of Color Scores for Phase I and II since 2020.

Figure 6. Description of Color Criteria and instructions provided to the technical reviewers

In addition to scoring each criterion and providing strengths and weaknesses, the panel will be asked to indicate whether the proposal is recommended for award. The panel will indicate whether the proposal is recommended by assigning it to one of the following categories:

- **BLUE – Highly Recommended**
  - **Exceptional Quality. Well-conceived and technically sound concept pertinent to the goals of the program and the solicitation's objectives.**
- **GREEN – Competitive**
  - **High Quality. Proposal meets the expectations of this solicitation and provides a strong opportunity, but at a lower priority than BLUE.**
- **YELLOW – Marginally Selectable**
  - **Acceptable Quality. Proposal marginally meets the expectations of this solicitation, but at a lower priority than GREEN.**
- **RED – Not Selectable**
  - **Low Quality. Proposal does not meet the minimum expectations of this solicitation; proposal has one or more major weakness.**
- **BLACK – Out of Scope**
  - **Proposal does not meet the scope requirements of this solicitation and should not have been included for review. (Note that this does not imply poor quality; it merely reflects appropriateness for NIAC Phase I study.)**

"Blue" should be reserved for the truly Outstanding

"Green" should be your baseline score for a concept that you believe is selectable

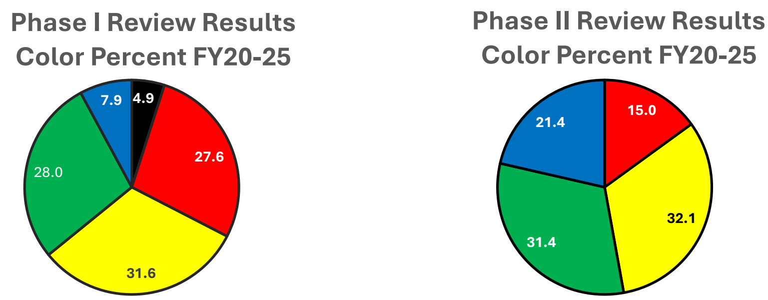
"Yellow" concepts are eligible for funding, and may be selected

"Red" are not to be considered for funding

"Black" are not compliant

The Color should be informed by the Numerical Scores but need not be constrained by it if adequate justification, based on the evaluation criteria is provided. Green is a good, selectable proposal. Blue should be reserved only for the few truly outstanding proposals.

Figure 7. Distribution of Color Scores for Phase I and II since 2020.



The final Technical Panel evaluation forms the basis of all further deliberation and discussion, and provides the formal evaluation feedback to the proposers. Earlier NIAC papers referred to an Integration Panel responsible for merging the results from the technical panels. This process became unwieldy and somewhat arbitrary as the number of panels expanded from three to four or more. Instead, since 2023, following the technical panel review the Program Office merges the lists provided by the individual panels respecting the color and priority of the individual panels.

No subsequent step changes the technical evaluation. However, there are additional steps in the selection process, to include presentation of selectable proposals to technical representatives from throughout NASA for comment on the benefit they may have on their discipline (called the "Mission Directorate Review"). The list of selectable proposals is presented to the Source Selection Official for final selection decisions.

B. Phase II Selection Process

The Phase II selection process is very similar to that of Phase I, with the exception that it is not a two-step process. Phase I NIAC Fellows, or their designate, may submit a Phase II proposal provided it is based substantially on the Phase I study, and the Phase I Final Report has been submitted prior to submission of the Phase II proposal. Proposals that had previously been declined for award may be resubmitted and are encouraged to identify and address prior reviewer comments in their resubmitted proposal.

C. Phase III Selection Process

The goals and objectives of the NIAC Phase III have been discussed earlier. Phase III is fundamentally different from Phases I and II. Phase III is not intended to just be a logical extension of the Phase II study. Rather, it is intended for those concepts that may be on the cusp of further development, with an identified transition opportunity, provided some specific milestones that uniquely need NIAC funding are achieved. Phase III selection is a two-step process. The proposers first submit a "mandatory preliminary proposal (MPP)". As described in the FY24 Call for Phase III Proposals, the Program Office reviews the MPP to down-select to invite full proposals based on evaluation of:

- Innovation and Benefits
- Prior Performance
- Proposed Milestones
- Transition Strategy

All competitive MPPs (high scores in 3 of 4 categories, and no low score in any category) are invited to submit a full proposal. Full proposals are evaluated against the following categories:

- Concept Progression (in Phases I and II)
- Technical Study Approach
- Transition Strategy
- Management Approach
- Price

The transition strategy is unique and critical for Phase III. For the MPP, the FY24 criterion read:

> Offeror outlines a realistic strategy to transition the results of the Phase III research into a future aerospace mission or project and demonstrates why NIAC funding is uniquely required to support a successful transition. Offeror identifies any transition opportunities, such as the development of critical technology demonstrations,

development of commercial products, or potential transition into other non-NASA government or industry programs. Transition strategy includes potential partners identified during or since the Phase II study that have expressed an interest in further funding or transitioning the Phase III technology into an aerospace mission or other future project. Letters of commitment for additional resource support may be included with the MPP submission.

For the full proposal the transition criterion in FY24 included the following:

a. Outlines a realistic strategy to transition the results of the Phase III research into a future aerospace mission
b. Demonstrates why NIAC funding is uniquely required to support successful transition.
c. Identifies any transition opportunities, such as the development of critical technology demonstrations, development of commercial products, or potential transition into other non-NASA government or industry programs.
d. Transition strategy includes potential partners identified during or since the Phase II study that have expressed an interest in further funding or transitioning the Phase III technology into an aerospace mission or other future project.

Six Phase III studies have been selected, as shown in Figure 8.

Figure 8. NIAC Phase III awards, FY 19-FY 24

NIAC Phase III Awards, FY 19-24

FY19

William Whittaker
Robotic Technologies Enabling the Exploration of Lunar Pits
Carnegie Mellon University
Pittsburgh, PA

Joel Sercel
Mini Bee Prototype to Demonstrate the Apis Mission Architecture and Optical Mining Technology
TransAstra Corporation
Lake View Terrace, CA

FY20

Slava Turyshev
Direct Multipixel Imaging and Spectroscopy of an Exoplanet with a Solar Gravitational Lens Mission
NASA Jet Propulsion Laboratory
Pasadena, CA

FY21

Nickolas Solomey
Cube-Sat Space Flight Test of a Neutrino Detector
Wichita State University
Wichita, KS

FY22

Amber Dubill
Diffractive Solar Sailing
Johns Hopkins University/Applied Physics Laboratory
Laurel, MD

FY24

Lynn Rothschild
Mycotecture off Planet: En route to the Moon and Mars
NASA Ames Research Center (ARC)
Moffett Field, California

A Phase III was not selected in FY 23

IV. Overview of Funded Projects

D. General Statistics

Since 2011 and through May of 2025, NIAC has funded 329 studies (229 Phase I, 94 Phase II, and 6 Phase III). See Figure 9 for a breakdown of proposals and awards. Figure 10 is a further breakdown of proposals and awards by Fiscal Year and Phase. Figure 11 shows dollars awarded by Fiscal Year and Phase for FY11-FY25 as of May 2025. Figure 12 shows the distribution of awards dollars ($M) by organization type: NASA (including JPL), Academia, and Other (including large and small businesses, not-for-profit and research institutions, National Laboratories, and other US Government). They are grouped by the Principal Investigator's (the Fellow's) organization, so the dollar distribution does not reflect funds that may have been subcontracted or otherwise allocated to other organizations. Note the approximately equal distribution, which is not by a pre-established quota, but happened organically from the technical selection process. Figure 13 shows Phase I and Phase II award percentage by Fiscal Year. Figure 14 shows how NIAC awards have been distributed throughout the United States (as of May 2025): 27 states are home to one or more NIAC Fellows.

Figure 9. Overview statistics on NIAC proposals and Awards, through May 2025.

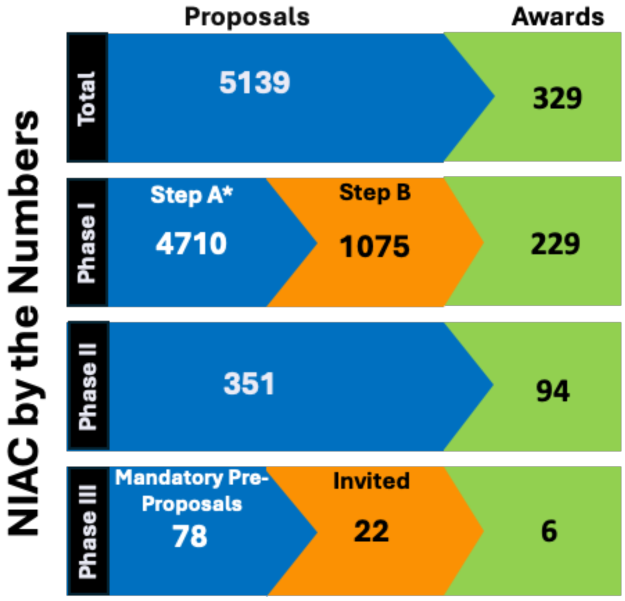


Figure 10. Further breakdown of proposals and awards by fiscal year and Phase.

FY	Proposals Submitted and Awarded								
	Phase I				Phase II		Phase III		
	Step A	Invited	Step B	Awarded	Submitted	Awarded	MPP	Submitted	Awarded
11	728	(*	)	30					
12	614	89	87	18	38	10			
13	514	75	66	12	26	6			
14	263	69	66	12	23	5			
15	244	73	66	15	25	7			
16	211	74	73	13	25	8			
17	213	74	70	15	23	7			
18	235	79	74	16	26	9			
19	197	89	81	12	25	6	25	5	2
20	299	109	99	16	25	6	17	4	1
21	292	110	100	16	19	6	9	4	1
22	293	114	108	12	25	5	10	3	1
23	271	93	84	14	25	6	4	2	0
24	336	108	101	13	25	6	13	4	1
25	351	123	116	15	21	7	(	**	)

*FY 11 did not have a two-step process **There was no FY 25 Phase III solicitation or award

Figure 11. Dollars awarded by Fiscal Year and Phase for FY11-FY25 as of May 2025 (Phase III was not solicited or awarded in FY25)

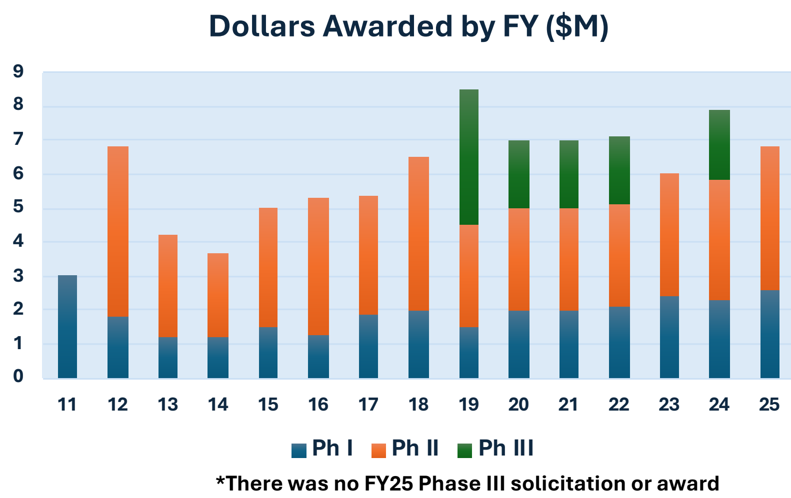


Figure 12. Distribution of Awards dollars ($M) by organization type: NASA (including JPL), Academia, and Other (Industry, not-for-profit and research institutions, National Laboratories, and other US Government)

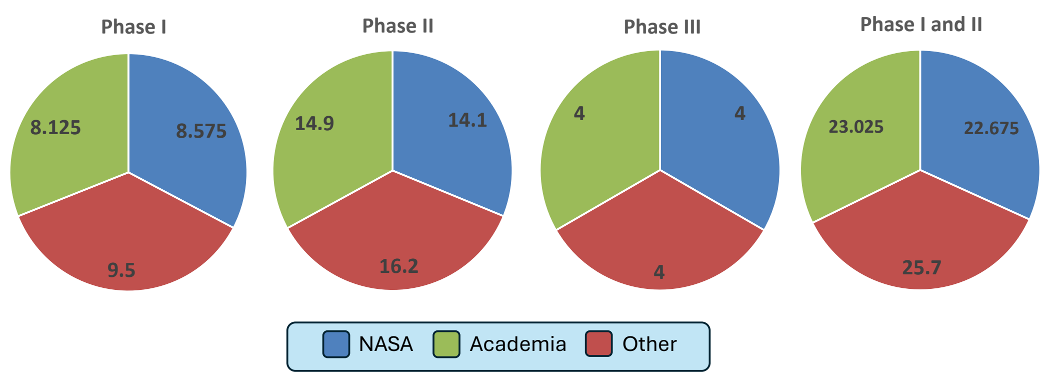


Figure 13. Phase I and Phase II award percentage by Fiscal Year.

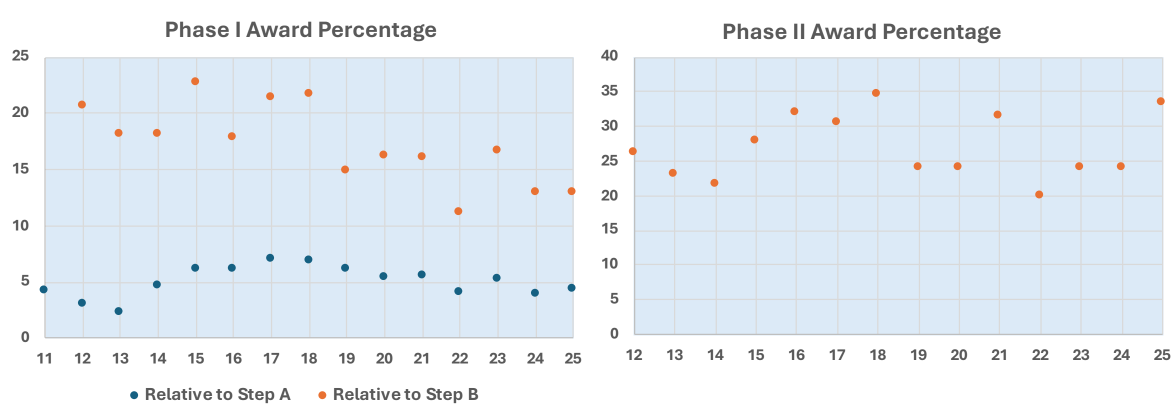
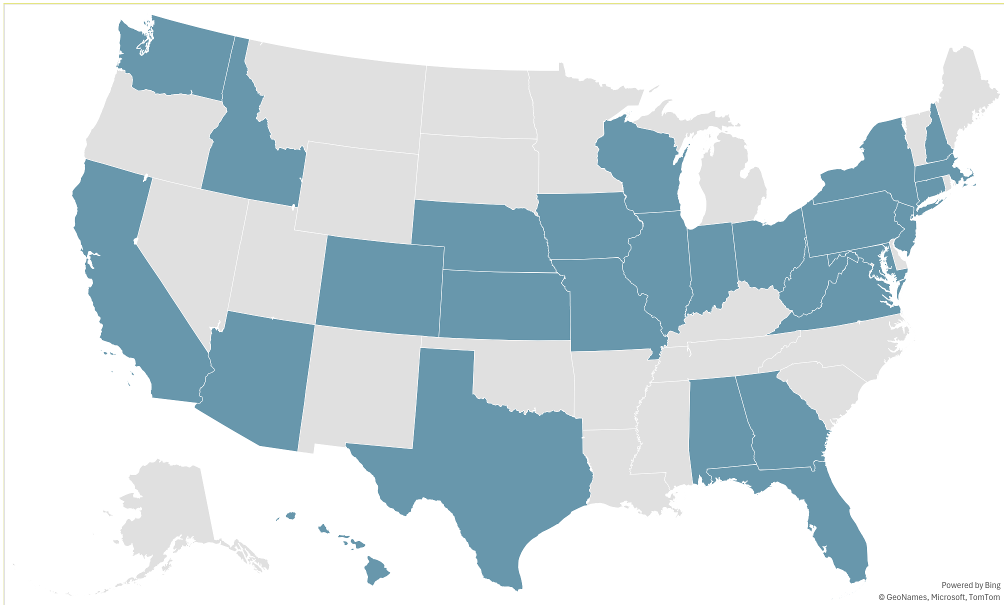


Figure 14. Distribution of awards by state.

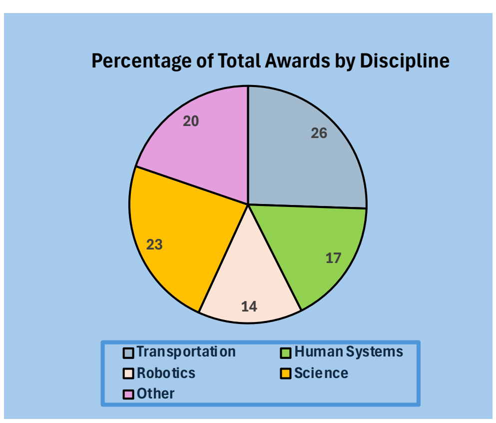


E. Technical Disciplines

NIAC is open to any technical area that is relevant to NASA, and NIAC has funded concepts that span a broad range of disciplines. Figure 15 gives a flavor of what areas have been studied in the Phase I, II and III studies in five broad categories. Figure 16 breaks these categories down further into subcategories. Since NIAC studies are sometimes inherently multidisciplinaryand put the underlying concept in a mission context, it is sometimes difficult to place a concept into a specific "box" to say it is deep space transportation, for example, if it includes multiple disciplines and objectives. The categories, selected to match the categories in (2017) include:

- Transportation (Earth to Orbit, In Space, Entry/Descent/Landing, Infrastructure, and Aeronautics)
- Human Exploration (Environment Control, Radiation Mitigation, Space Suits, Habitats, Infrastructure)
- Robotics (Mobility, Sample Collection)
- Science (Astronomy, Planetary, Heliophysics, Earth Science)
- Other (Navigation, Power, Communications, Structures, Asteroid/Orbital Debris Mitigation)

Figure 15. Number of NIAC Studies by broad technical area



Number of Awards by Phase and Discipline

	Ph I	Ph II	Ph III	Total
Transportation				
	58	25	1	84
Human Systems				
	41	14	1	56
Robotics				
	35	12	0	47
Science				
	48	26	3	77
Other				
	47	17	1	65

Figure 16. Further breakdown of NIAC studies

Transportation														
Surface to Orbit			In-Space			E D L			Infrastructure			Aeronautics		
Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III
4	0	0	35	15	1	6	2	0	6	4	0	7	4	0

Human Systems																	
ECLSS			Radiation			Health			Space Suit			Habitat			Infrastructure		
Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III
8	2	0	4	2	0	6	3	0	3	1	0	4	2	1	16	4	0

Robotics					
Mobility			Sample Collection		
Ph I	Ph II	Ph III	Ph I	Ph II	Ph III
29	11	0	6	1	0

Science											
Planetary			Heliophysics			Earth			Astrophysics		
Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III
19	8	1	1	1	1	7	3	0	21	14	1

Other														
Navigation			Power			Communications			Structures			Asteroid/Debris Mitigation		
Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III	Ph I	Ph II	Ph III
2	0	0	13	5	0	4	0	0	14	6	0	14	6	1

V. NIAC Strategic Partnerships, Communications, and Outreach

NIAC aims to capture and inspire the ingenuity of visionaries to build the future of tomorrow. This exciting work allows NIAC to successfully engage a wide ranging, diverse global audience. NIAC's audience includes members of technical and scientific communities, independent researcher groups, government institutions, industry, academia, and the public. NIAC has developed unique partnerships and collaborations with institutions around the U.S. that help the program expand its reach. NIAC engages educators and students with educational outreach that encourages a young audience to consider Science, Technology, Engineering, and Mathematics (STEM) careers through NIAC Fellows' innovative research. NIAC innovations have the potential to fuel economic growth, the creation of new industries, companies, jobs, products and services, and the global competitiveness of the U.S. NIAC's strategic partnerships, communications and outreach serves as a critical element of NASA's public and educational value to the nation.

A. Community

NIAC inspires an atmosphere of innovation with its Fellows that stretches the imagination and encourages creativity. The program actively cultivates a sense of community with its Fellows. This is fostered by both an Orientation Meeting for all new Phase I Fellows, and required attendance at an annual Symposium, where the Fellows present progress and time is provided for interaction between the Fellows. Many continue to follow up with the program alerting the team years later, of awards or notable achievements that grew from their original NIAC studies. This community has prospered and continues to grow.

B. NIAC website

NIAC's website (www.nasa.gov/niac) is the central hub of communicating program information to the public. NIAC's online followers use this site to stay current on NIAC upcoming events, funded studies, solicitations, presentations, press releases, external media, videos, and podcasts. Each NIAC Fellow is given a web-based research page devoted to their study. Each page includes a brief abstract, graphics and related visual media and the final report. Past NIAC Symposia have also been archived to the site via LiveStream and Vimeo. NIAC staff and External Council biographies are available, as well as links to other NASA Space Technology programs.

C. NIAC Annual Symposium

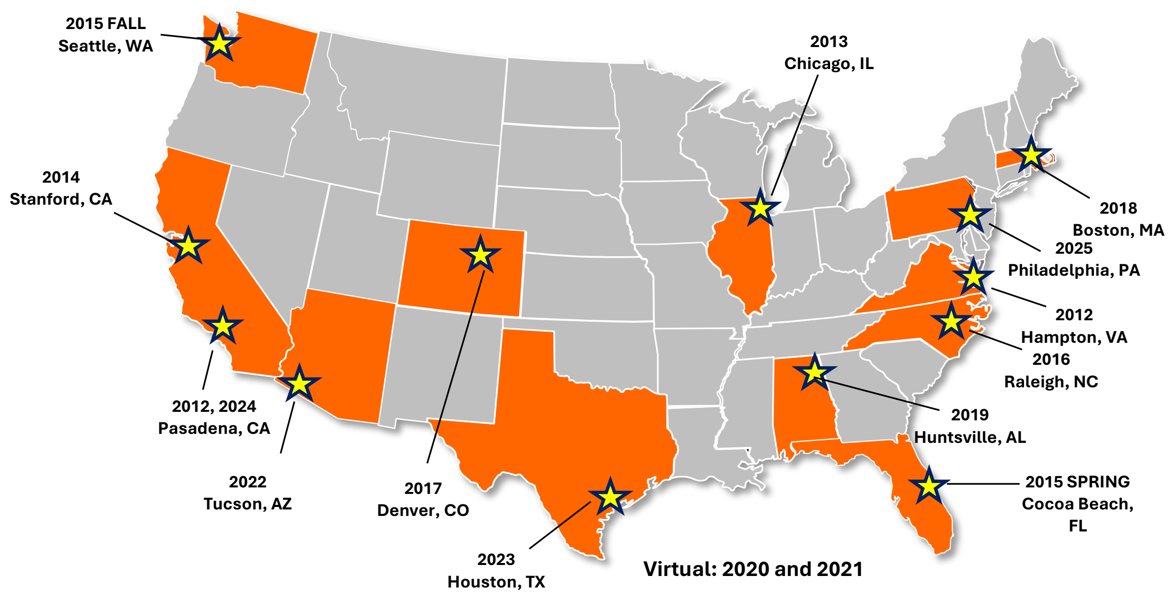
Since 2012, the NIAC Symposium has been the program's premier annual meeting and an essential strategic venue. NIAC thus has required Fellow (i.e., NIAC Principal Investigator) participation in the Symposium for every study awarded by the program. The NIAC Symposium is open to the public and its objectives include:

- Discuss progress on each currently funded NIAC concept study to ensure that NIAC continues to push boundaries and pave the way for America's technological future
- Provide valuable feedback to NIAC Fellows to help maximize the impact of NIAC-funded studies

- Foster public-private follow-on collaboration across sectors including industry, defense, other government agencies, startups, and academia
- Create new connections between visionary thinkers and entrepreneurs that often result in future NIAC proposals for disruptive capabilities

Figure 17 shows locations of the NIAC symposia since 2012.

Figure 17. Locations of NIAC Symposia



D. NIAC Videos

The NIAC concepts are frequently covered in short videos, with six 1-3 minute NASA 360 videos per year (over 30 million downloads) and one to two 5 to 30 minute NASA+ videos per year (reaching more than 12 million NASA Flagship subscribers). Recently, NIAC content has been included, as 5 minute episodes, in the TED ED series, *Lessons worth sharing*. Video content is captured from the Symposia to create short, 3 minute videos with animations in collaboration with the National Institute of Aerospace (https://www.youtube.com/user/FollowNASA360). Many of these videos have gone viral with one reaching over 1 million views. For examples of NASA 360 videos that have been produced, see: https://www.nasa.gov/about-niac/. Three NIAC videos have received national video awards:

- 2018 Silver Davey Award "Automaton Rover for Extreme Environments"
- 2020 Bronze Telly Award "Optical Mining"
- 2024 Silver Telly Award "Turning Science Fiction to Science Fact"

E. NIAC in the News

NIAC and its Fellows are privileged to receive extensive press coverage. Thousands of media articles have appeared detailing NIAC Fellows' concepts, and NIAC's media footprint continues to grow each year. For examples of news articles about NIAC projects, see: https://www.nasa.gov/niac-news/.

F. NIAC Social Media

Further extending NIAC's visibility to the public, NIAC concepts are routinely placed on NASA's social media sites which have a large audience of followers and subscribers. Figure 18 provides a breakdown of NIAC's presence in a variety of social media.

Figure 18. NIAC Social Media outreach

Social Media Site	URL	Audience: May 2025
Facebook	https://www.facebook.com/NASA/	26M likes
Twitter	https://twitter.com/nasa	86.7M followers
YouTube	www.youtube.com/NASATelevision	12.4M subscribers
Instagram	www.instagram.com/nasa/	96.6M followers
Pinterest	www.pinterest.com/nasa	559,000 followers

G. Science and Technology Museums

A unique partnership has developed between NIAC and numerous science and technology museums around the U.S. NIAC researchers are invited to share their research with large public audiences through an educational lecture series called, SciFi to SciFact (SFSF). Participants have included the Museum of Flight, the Museum of Natural History, the Michigan Science Center, the Museum of Science, Boston, Denver Museum of Nature and Science, the University of Arizona Flandrau Science Center and Planetarium and the Chicago Museum of Science and Industry (Griffin MSI), among others.

At MSI, the event is hosted in the OMNIMAX theater where NIAC Fellows introduce their innovations to large public audiences. NIAC Fellows also speak with MSI's Science Minors and Science Achievers Youth Program. This youth development program provides out of school learning experiences for high school aged youth. The program is designed to nurture participants in science and engineering content, to prepare them for college and to consider science-based careers. These interactions have included discussions with the Fellows about their youth, and individual career paths. This successful partnership continues to inspire the next generation of U.S. explorers and innovators.

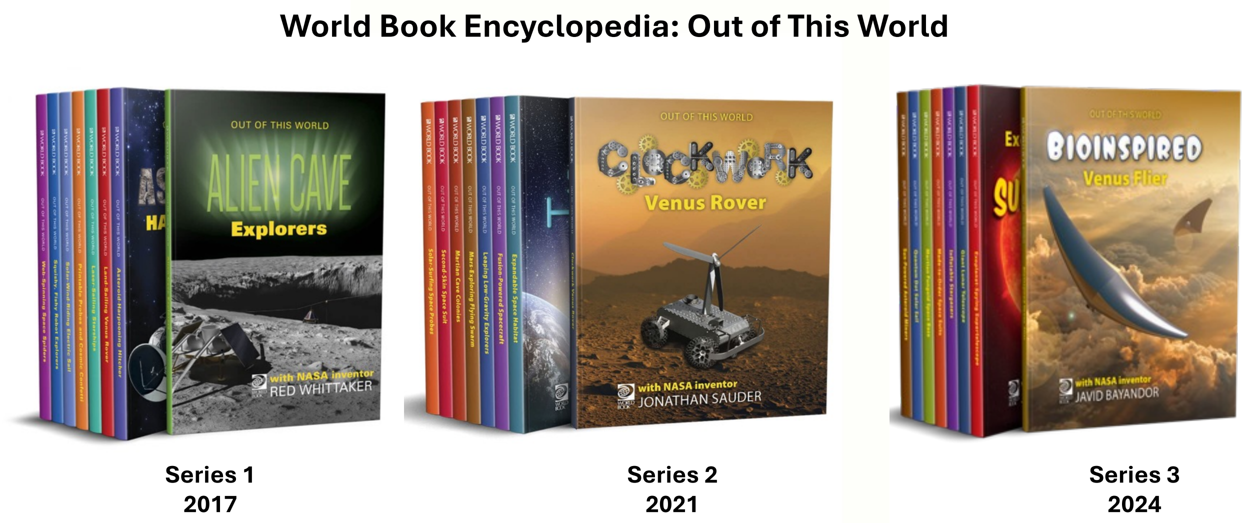
H. NIAC in the classroom

Starting in 2020, NIAC has worked with Anthony Cerqua, in the Community Unit School District 303 in St. Charles, IL, (including St. Charles East High School and St. Charles North High School) near Chicago, Illinois, to support a classroom experience called NIAC Junior. The NIAC staff describes how NIAC solicits proposals, and the students are challenged to create their own innovative space concepts. Working in teams, they carefully develop their concepts over a period of a few weeks. The initial year was virtual due to the pandemic. The program was not offered in 2021, as the school system adjusted to the return to class, but has been continuous since 2022. In 2024 a second teacher, Brian Wright, also in District 303, joined the program.

I. World Book

An exciting development is a collaboration and partnership with World Book, Inc. in Chicago, IL. World Book has published *Out of This World*, three series of eight children's books (in print and e-book form) about applications of basic science principles in advanced space sciences based on NIAC studies and the Fellows that led them. A theme in each book is the link between commonly understood science principles and the uncommon technologies to which they contribute. A feature of each title is a capsule biography of the scientist(s) associated with a NIAC research project. The purpose of the biographies is to show that today's working adult scientist was once a school child, like the reader, who became attracted to the sciences, perhaps through books he or she read or because of an inspiring teacher, and from there, fulfilled an aspiration to become a scientist. The first series was published in August, 2017. Series 2 was published in 2021, and Series 3 was published in 2024. The series was recognized by the American Library Association, making the "Top Ten Series on Nonfiction" in 2018 and the "Top Ten Series on Space Science & Exploration" in 2019.

Figure 19. World Book Encyclopedia, Out of this World series.



VI. Impact and Successes

NIAC has demonstrated a high degree of benefit through impactful early-stage research on visionary, high-risk, and potentially high-reward concepts that could transform future aerospace missions, significantly influencing space exploration beyond our current capabilities. NIAC funds studies that explore cutting-edge ideas in various areas, including space science, human spaceflight, advanced propulsion, robotics and aviation. This impact can be expressed in many ways, including:

- **Transforms future missions by introducing novel technical capability**
    - Reduces the risk of disruptive ideas for future mission infusion
    - Develops major trends in space architecture and autonomy
- **Inspires creativity, fosters innovation and pushes boundaries**
    - Visionary leadership for NASA's future
    - Seeds a culture of radical thinking inside and outside NASA
    - Catalyzes revolutionary aerospace concepts
- **Engages American innovators and incubates new commercial industry**
    - Inspires external investment and partnerships
    - Enhances American competitiveness through innovation
- **Produces tangible benefits through spinoff capability**
    - Enabling dual-use and Earth applications

NIAC encourages and supports innovative ideas that might not receive funding through traditional channels, allowing for truly groundbreaking concepts to be explored. The program aims to develop technologies and concepts that could revolutionize future aerospace missions, making them more efficient, cost-effective, or even enabling new types of exploration. By supporting high-risk, high-reward concepts, NIAC helps push the boundaries of what's possible in space exploration, paving the way for future discoveries and advancements. Even when not directly responsible for innovation through funded studies, the high visibility of NIAC's efforts to change the possible encourages independent entrepreneurial efforts to pursue breakthrough capability. While focused on aviation and space exploration, NIAC's research can have significant implications for life on Earth, generating new technologies and knowledge that can benefit various industries.

A full accounting of NIAC successes would require a paper of its own, but a few examples will suffice to illustrate the impacts.

Transforms future missions

While NIAC concepts generally aim ten or more years in the future, there have been some NIAC concepts that evolved and were implemented, in whole or in part, significantly earlier than anticipated. One example is Mars Cube One (MarCO), the twin communications relay CubeSats built by NASA's JPL. Launched in May, 2018, MarCO-A and B were the first and second interplanetary CubeSats designed to monitor the Mars mission InSight for a short period around landing and to demonstration a potential future capability. The MarCO pair carried their own communications and navigation experiments as they flew independently to the Red Planet. In October 2018, MarCO produced the first image of Mars from a CubeSat, and in November 2018 it provided a real-time communications link to Earth for InSight, during its entry, descent, and landing on Mars. This mission was explored and enabled by a 2011 NIAC Phase I study led by Bob Staehle, JPL, "Interplanetary CubeSats: Opening the Solar System to a Broad Community at Lower Cost." This success has since influenced the commercial sector, with companies now developing CubeSat technologies for deep space missions at considerable savings.

Red Whittaker's (Carnegie Mellon University) work on autonomous lunar rovers, supported by NIAC Phase I (2011), II (2012), and III (with Astrobotic in 2019), is another good example. The autonomy algorithms have since been incorporated into a suite of lunar rovers being developed for commercial lunar missions.

Inspires creativity

Direct infusion of a NIAC concept is not the only pathway to breakthrough missions. A new line of thought introduced by a NIAC concept can inspire other ideas that then lead to innovation. One example of this is the quadcopter that was included on the Mars Perseverance rover. Ingenuity was a technology demonstration mission that transitioned to an operations demonstration. It flew 72 flights for a total of 128.8 minutes, covering 10.5 miles and reaching an altitude as high as 78 feet. Ingenuity was not a NIAC concept. However, its JPL designer, Bob Balaram, credits a NASA Institute for Advanced Concepts study, Mesicopter, by Ilan Kroo, Stanford University, for the inspiration leading to Ingenuity:

> *"It was serendipity that I wandered into Ilan Kroo's presentation on mesicopters and was able to make the connection that this early NIAC work could be extended to enable helicopters on Mars – the aerodynamics regimes were the same!"*

Engages American innovators and incubates new commercial industry

NIAC's highly competitive selection process serves as a signal of credibility for visionary projects for those seeking to invest in new commercial opportunities. Several NIAC studies have contributed to the successful emergence of new companies, stimulating external investments and partnerships. TransAstra, founded in 2015 to develop breakthrough technologies for asteroid mining and space logistics, is an example. One of its core concepts—"APIS (Asteroid Provided In-Situ Supplies)" — originated with NIAC and received Phase II funding in 2017 and Phase III in 2019. TransAstra also received a 2017 Phase I award for a related concept, "Sutter: Breakthrough Telescope Innovation for Asteroid Survey Missions to Start a Gold Rush in Space," and a 2019 Phase I/2020 Phase II award to develop the "Lunar-Polar Propellant Mining Outpost (LPMO)." Each award was highly competitive and focused on enabling practical, scalable space infrastructure.

Today, TransAstra is a venture-funded aerospace company advancing from NIAC concepts to flight hardware, with multiple contracts from NASA and the U.S. Space Force. Between government and private funding to date TransAstra has raised over $24 million with more expected soon. TransAstra's orbital debris Capture Bag™, an APIS spinoff, is scheduled to fly on the International Space Station in 2025, and their global network of Sutter telescopes routinely supports the Space Force with Cislunar space domain awareness.

Produces tangible benefits through spinoff capability

Lynn Rothschild, NASA Ames Research Center, has been awarded Phase I (2018), II (2021), and III (2024) studies to examine the use of fungal mycelial (myco) composites to grow structures off-planet, from habitats to interior elements of space systems. The MycoHAB Foundation, a nonprofit organization in Namibia, has worked with her to adapt the approach to build homes from agricultural waste using mycelium to create bricks in Namibia. To help fund the project, a commercial component, MycoHAB Ltd., sells the mushrooms to local retailers.

Adrian Agogino, Jet Propulsion Laboratory, was awarded Phase I (2012) and II (2013) studies for Super Ball Bot, a tensegrity-based structure for planetary landing and exploration. The rover, with unique roaming characteristics able to traverse rough and broken landscapes, was adapted to create scouting robots to move through the rubble of damaged buildings to warn first responders of gas leaks and other dangers.

VII. Conclusion

The NASA Innovative Advanced Concepts (NIAC) program is a critical investment for the United States' leadership in space and technology. By funding visionary ideas that push the boundaries of what is possible, NIAC not only fosters groundbreaking scientific discovery but also strengthens national security, drives economic growth, inspires new industries, informs strategic direction and innovation, and ensures the U.S. remains at the forefront of space exploration. In an era of accelerating global competition, NIAC stands as a strategic engine of innovation for future readiness and technological dominance. Its legacy is not just in technologies matured, but in futures imagined, and made possible.

Acknowledgments

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