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KInn. Part-23. Professional Profile of MiMi Aung

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Conspectus: Aung was born in USA in 1968 to a Burmese couple who were pursuing their doctoral studies. Her parents moved her to Myanmar when she was two and a half years old along with them. Mimi became interested in space science in high school days. She was amazed to gaze at sky, stars and it was a wonder tale to know about life beyond mother earth.

Academic career: She returned to US when she was sixteen years old to continue her education. Aung was inspired through her professor by the space science activities at JPL. She was an electronic engineering graduate fromUniversity of Illinois Urbana–Champaign.

Professional career: Mimi's first position in JPL (in the year 1990) was signal processing engineer in Deep Space Network affecting replacement of analogue receivers with digital ones. Later, she was a lead of teams working on applicability of the monopulse technique,240-GHz radiometer for the Earth Orbiting System, Microwave Limb Sounder instrument to StarLight two spacecraft interferometer, Guidance, Navigation & Control (GN&C) Sensors Group, opticalcommunications, autonomous systems etc.

Mars Ingenuity helicopter:The idea began at the Jet Propulsion Laboratory NASA with a team of dedicated engineers who believed in making a product seemingly impossible. From 2015, Aung is lead for the Mars Helicopter technology demonstration venture. It is a 150-scientist-engineer-technologist team.On February 18, 2021, Ingenuity arrived on Mars along with perseverance rover. Helicopter ingenuity (Hi) took its first 39-sec flight on 19th April. During these eight months Hi successfully flew eighteen times creating records of first-of-its- kind.

MiMi Aung will go down in history as the lead-engineer-of- remarkable feat-of-flying-a-helicopter-on-Mars for the first-time-in-the-human-scientific-endeavours.

Keywords:JPL; NASA; Helicopter ingenuity; Mars; MiMi Aung; Engineering lead-Manager

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President Biden

is briefed aboutFirst flight of NASA's Ingenuity helicopter on Mars on Monday, April 19, 2021

by MiMi Aung

Biological family: Aung was born in Illinois, USA in the year 1968 where her parents were pursuing their doctoral studies. Her parents shifted her to Myanmar when she was two and a half years old.Her mother was the first women in Myanmar to get a PhD in mathematics and father was a doctorate degree holder in chemistry.

Biological Family (Parents) ofMiMi Aung

Father	Thein Aung , Ph D in Chemistry
Mother	Hla Hla Sein, Ph.D in Science

Biological Family (Spouse and children) ofMiMi Aung

Husband	$$$
Children	Two

Childhood ofMiMi Aung : What Aung, as a child, use to wonder was

- ? how is it that one always sees the sky up above and innumerable stars, whereever (any part of globe) he is at that momnet?

Further, the questions those linger in her little brain were

- ? What's out there in the sky?
- ? Is there life (we know here) elsewhere also?
- ? Or are we alone on our mother earth, a planet in our solar system?

Inspiration from Big Questions: space and life: These curious thoughts fascinated her later to purse means of finding true ansers.MiMi says her mother was very technical, practical and logical. She was inspired by her mother to study science, maths and engineering. She became interested in space science whilst she was a student at the British high school.

Born in 1968 in Illinois

Deputy Division Manager,
Autonomous Systems,
NASA Jet Propulsion Laboratory
Pasadena, California

Academic profile of MiMi Aung

1979			She attended St. Christopher's School
1984 - 1988	B.S. EE	Electrical engineering	Grainger College of Engineering, University of IllinoisUrbana–Champaign
1990	MS	Electronic engineering ➔ Communications and signal processing.	University of IllinoisUrbana–Champaign

Mimi moved to the United States at the age of 16 to pursue her education. She travelled by herself andlivedthere with familyfriendsher parents.

Inspiration from her teachers: One of the professors in the university made MiMi aware of NASA Jet Propulsion Laboratory and its pursuit of signal processing in the Deep Space Network activity. The systems at JPLtrack tiny little signals with, large antennas and extremely low-noise amplifiers. Then they amplify the signals, process very carefully to retrieve the signals employing state-of-knowledge-tools. It inspired her to really work hardto get an interview with NASA's Jet Propulsion Laboratory.

3. Solution: Human endeavors—Science and Technology

Professional Career: Her first drive on Oak Grove to reach Jet Propulsion Laboratory for facing an interview created a nitche of good-feeling in her brain. She was selected as an engineer, grew up in technical knowledge and cadre over years. Now Mimi rose to a pivotal position in Mars-2020 mission and helicoptor-inguneity flights on Mars. Still, she had the same good feeling, not faded even after three decades, but multiplied. She relishes and enjoys her walking into lab every day with heart felt sparkles of looking for happenings/miracles/surprises/stumble blocks/yester-day's impossibilities rendering into possibilities/plausibilities, yester day's successful-tools getting stuck while solving that day's tasks and so on.

	Technical cadre ladder of MiMi Aung and typical chores
1990	Signal processing Engineer
2000	Project element manager for the autonomous formation flying sensor on the StarLight two-spacecraft interferometer mission 📖 Applied her knowledge of transmit/receive systems to the determination of inter-spacecraft range and bearing measurement for precise formation flying of multiple spacecraft.
	Project element manager for formation flying on the Terrestrial Planet Finder project - Funding for the TPF was indefinitely delayed in 2006, - Project was postponed - Formally canceled in 2011
2003	Additional duty of technical group supervisor, a line management position, for the Guidance, Navigation & Control (GN&C) Sensors Group, 📖 Involved in next-generation sensor technologies required for future spaceflight missions. 📖 Designed systems for DSN and new technology for the next generation of spacecraft
2010	Manager of the section Guidance, navigation, and control sensors group 📖 Emphasized the development of advanced GN&C technologies 📖 Created sensor technologies for spaceflight missions 📖 Infusion in future missions for precision entry, descent, and landing on planetary surfaces
2011	Project element manager of formation flying the Terrestrial Planet Finder's formation flying program 📖 Designed the autonomous formation radio frequency flying sensor for StarLight two spacecraft interferometer
2013	Deputy Manager of the Autonomous Systems Division, 📖 Responsible for spacecraft GN&C, power, avionics, flight software, robotics 📖 Worked on making sure that signals sent from spacecraft were received clearly on earth station
2015	Lead for the Mars Helicopter Helicopter technology demonstration 📖 Oversees the diverse team that designed, built, tested and flew Ingenuity
2019	First flight tests for the Mars helicopter

Professional experience of Mimi: In 1990, Mimi joined JPL as signal processing engineer. She started her technical career working in the Radio Frequency and Microwave Subsystems Section of the DSN (Deep Space Network). At that time, the ongoing operation in Block-V Receiver group (a subsection of DSN) was development of operational Block-V digital Receiver, first of its kind, and replacing the then functional analogue receivers. Her job was analysis of the signal processing in

communications areas. The group

- ✓ designed the algorithms
- ✓ got implemented into the hardware and software
- ✓ performed integration and tested
- ✓ deployed into the DSN across California, Spain, Australia etc.

It was just a fantastic experience to see, participating all the way from the algorithms to deployment and making a system work through the implementation. It is stunning that these receivers are functional till date.Aung expresses that she has been cutting through all the complexities in operations,surmounting hurdles and surprises. She feels it a privilege to say loudlythat DSN was her lovable initial home to growin technology, developmentand line managementwithnatural traits.

She led a multidisciplinary team to evaluate the applicability of the monopulse technique for precise pointing of the 34-meter-diameter antennas, leading to operational use in the DSN. Mimi worked also on the 240-GHz radiometer for the Earth Orbiting System and Microwave Limb Sounder instrument to StarLight two spacecraft interferometer.

Outreach (public awareness) activity of MiMi Aung: Aung installed a webcam in the cleanroom at JPL that allows the public to watch the development of the helicopter. Aung featured in the 2019 documentary Space Queens along with several other women who were inspired by Apollo 11. She talked about taking humanity to Mars till 2020 with the Perseverancerover.

- Image acquired on Apr. 22, 2021 by NASA's Mars Perseverance rover using its left Mastcam-Z camera.
- Mastcam-Z is a pair of cameras located high on the rover's mast. This is one still frame from a sequence captured by the camera while taking video.

- Teddy Tzanetos, MiMi Aung and Bob Balaram monitoring a helicopter flight Jul 9, 2021

Awards to MiMi Aung
o Top 100 Women in the world by the BBC in 2019
o Expert of The Planetary Society
o Mentioned her involvement in taking humanity to Mars with the Perseverance rover in 2020

A few select Rearch papers ofMiMi Aung

Title	Field Testing of Lunar Access and Navigation Device (LAND)
Highlights	A laser radar system has been constructed. It is based on a commercial PC with digitizer, pulse delay instrument, National Instruments IO card and an optical head from a previous laser radar program. The laser radar was mounted on a gyro stabilized gimbal on the nose of a helicopter and flown in the Mojave Desert in September 2006.
Publisher	IEEE Aerospace Conference Proceedings, 2007 Jan DOI:10.1109/AERO.2007.353018
Authors	Carl Christian Liebe, James Alexander, **Mimi Aung**, Michael Wilson

Title	An overview of formation flying technology development for the Terrestrial Planet Finder mission
Highlights	The objective of the Terrestrial Planet Finder (TPF) mission is to find and characterize earth-like planets orbiting other stars. Three architectural options are under consideration for this mission: a formation-flying interferometer (FFI), a structurally-connected interferometer, and a coronagraph
Publisher	April 2004 IEEE Aerospace Conference Proceedings 4:2667 - 2679 DOI:10.1109/AERO.2004.1368062
Authors	**M. Aung**; A. Ahmed; M. Wette; D. Scharf; J. Tien; G. Purcell; M. Regehr; B. Landin

Title	System design and technology development for the Terrestrial Planet Finder infrared interferomete
Highlights	Recently, we generated a real-time IPM for the Mars landing path-planning problem that was successfully validated in three flights onboard a NASA test rocket, and was used in real-time to generate the optimal landing trajectories that guided the rocket (JPL et al., 2013;Scharf et al., 2014;Açıkmeşe et al., 2013;JPL and Systems, 2012;Aung et al., 2013). To the best of our knowledge, this was the first time that a real-time embedded IPM algorithm was used to control such a large vehicle, where mission success and safety critically relied on the real-time optimization algorithm
Publisher	November 2003 Proceedings of SPIE - The International Society for Optical Engineering

	DOI:10.1117/12.521311
Authors	Gary H. Blackwood, Eugene Serabyn, Serge Dubovitsky, **MiMi Aung**, Steven M. Gunter, Curt Henr

Appendixes

Appendix 1: Advice of MiMi Aung to under graduate-female students interested in STEM

- Oh, follow your heart.
  - I know it sounds motherhood, apple pie, you know, but it matters.
- It's important for everyone to really figure out what makes you passionate
  - what do you want **to make happen** for the world?
  - what do **you** really want to **make happen**?
- And it turns out, each of us have different callings
- all of you out there, the next generation, it will be your own quest that draws you, okay?

- for me (MiMi Aung**)** of course
- I wanted first-of-a-kind systems that answers big questions or big causes should come
  - Is there life elsewhere? Are we alone?
- NASA is first of a kind system that make apparently impossible a working module
- As an engineer, things that I can do to help make systems, that really will help answer the questions (vide supra)
- So for all these 30 years, you know, I've been here, that's what's drawn me

- In your case, once you find that, find an intersection of

  - what you can do for that cause and an area, that you're good in and that you love to do and what is needed in the world that you really believe in.
  - And once you find that something, go after it, go after it, and

- **Don't don't say**, “Oh, I'm only this. Or you know, I don't have opportunities.”
- Don't let anybody talk you out of it.
- Don't let yourself talk out of it.
- Don't say I'm not good enough.
- I have to share with you,
-
- **One step at a time**, really, you can get there, if you believe in it, you know
- it comes all the way from talking to people or, you know,
- searching for more information and
- starting at even a remote opportunity that you can work your way up to get there. And because you're passionate about it, you will find a way.
- So that's my advice. (laughs)

Appendix 2: NASA culture

- ✓ The beauty is, everybody just chips in, and gives their very best
- ✓ And there were so many technical challenges
- ✓ We all overcame
- ✓ The reason we did was we thought together, and we solved together.

- ! what got us going forward whenever there were difficult moments
- ! **MiMi Aung:** And whenever there were difficult moments, what got us going forward was this
- ! dream of flying at Mars, right. And so really, for me, the most important flight. There are beautiful, much more challenging flights going on, as we, you know, that we have proceeded on with, but
- ! I think the first flight will be ever, forever, will be the most important flight. It was a dream come true moment, and not just even dreams, like, you know, when you work for a reward, you know, this is like the absolute definition of a reward right, in every dimension.

Appendix 3: NASA JPL is gravity assist to Mimi

- ! I'm here (in JPL) as I really committed mentally. So that was one gravity assistance
- ! Why I don't make efforts to escape? Because, it is as cool as I thought with perfect matching of my goals with happenings here. Why it does not throw me out is I had been meeting/exceeding its expectations and not moving/or even thinking diagonally opposite to its targets.
- ! In Block-V receiver group, I got grounded right into how do you turn the algorithms that I learnt in the academic schedule into a really big system
- ! My first supervisor, Ernie Stone, didn't lead, but taught all of us in the group.He covered in over seven years every engineering discipline,, right from somebody soldering to climbing up the antenna to do things in a concrete fashion.Everybody really had to contribute together and so that was another huge probably gravity assist(laughs)
- ! Going from the ground side to the spacecraft side was another leap in the career. It is imperative to be passionate and you have to love what you do. Once on the spacecraft side, I just became obsessed with wanting to push the autonomous capability of systems. Then of course, that led into everything I do. And then ultimatelyMars helicopter is an example of where I actually got to then dip back down into the details to make one of those, you know, future capabilities happen.This was next gravity assist turning years into moments.

.....

This is what Mimi wants from JPL

Theonly thingMiMi expects is

<please don't forget me. I think that's what I want to leave with>

Jim Green: No, no, no, no, no, MiMi, you're well placed in history. And I certainly will not forget you

Appendix 4:First flight of Hi on Mars – Emotional state of Mimi (Brain-body-mind-complex)	
Jim Green	How did you feel when Helicopter-ingenious(Hi) really took off on Mars surface? what was it like?
MiMi Aung	Oh! it was phenomenal really the thing that I didn't realize until the day is coming up to it, ➔ well maybe I realized that it really hits you ➔ you really had to be prepared for every possible outcome. ➔ So until that moment, you have three or four scenarios, right, ranging from o "it didn't work" ▪ "it didn't start flying and we have to try again" ▪ "it flew but crashed" o "it flew and landed exactly the way you thought it would." there is no way of telling where it was going to be because ! we've done all the simulation. ! We've done all the tests on Earth ! → it really, you know, should work, right? ! We had no doubt. ! But you have just to be ready for everything (vide supra) and beyond like you do not what happened due communication breakdown So whole range of emotions i.e. human expression for happening ! It is because, That's what engineering is, right? o You analyze, you design, you test, it's gonna work, but o until you go over that threshold of really doing it, o you know, you don't know the results. ! So it was really exciting for me (MiMi Aung),. And they were getting hints we were starting to get, event reports that were starting to come down. The reports were looking nominal, right, like, hey, it looks like it started out right. ! Håvard and Michael were reading what visibility we have and we were starting to smile. ! But for me the thing that hit it was the altimeter plot. Once I saw the altimeter plot that just shot up to the three-meter altitude and then very quickly coming down. ! I think that's the point I jumped up, I couldn't can't stay anymore. ! So yeah, because at that point, o "Wow, we've nailed it." o we promised NASA right, at least one flight, right. o So there was our 100% success flight.

Appendix 5: Titbits in building teams MiMi Aung at NASA

- I think the first secret is
- One has to be truly passionate about the goals team is pursuing

Mars helicopter or autonomous system

- I was involved in building up team for or autonomous system (Mars helicopter) capabilities for the future.
  - It's definitely not a 9 to 5 job. And I really believe in having team members that believe and are as passionate as I am.
- I always say, you know, "I'm enrolling you deep down to your heart,"
  - People look at me funny, but I think after people who work with me after a while, get what I'm saying.
  - Because then what we do is, I really also respect every person.

Technical diversity

- **Aung**really believes in diversity, the technical diversity, and the technical responsibility.

Systems we do here at NASA

- The kinds of systems we do here at NASA, and myself personally in JPL
  - They are not things that are straightforward by any means
  - So you really have to respect every single discipline

No hierarchy

- There is no hierarchy
  - In terms of importance of what you can contribute, cadres or person wise
    - Everybody really needs to respect the system
    - everybody has to respect everybody else
- Have Passion, Respect Whatever Everybody's Bringing To The Table
- Really expect the excellence, the best of yourself and all the teammates
- And I really think you can make, you know, really, really, really big things happen. So I think mysecret sauce is this
- More important lessionis
  - There is no hierarchy on how easily you can also bring the entire system down

Appendix 6a: Helicopter Ingenuity (Hi)--On Mars (Om) -- Idea-to-Idol (It I)

- **MiMi Aung:** (laughs) Oh, yes. Helicopter Ingenuity flight on Mars is another major technology infusion activity, very motivated, very driven, you know, for the future.
- So, yeah, at the time the helicopter concept was born or revived, I was the deputy manager of the autonomous systems division. So, I remember, actually, there was a tour of our division by our prior director, Dr.Elachi.
- One of the demos we showed was some drones being used to demonstrate autonomous navigation algorithms, OK. This was just in a room with drones. And on the way out,he turned to René Fradet(deputy director of the engineering and science directorate at the time) and me, and said "Why aren't we doing, you know, things like this at Mars? Why aren't we flying at Mars?".
- So, from the division position, we connected Dr.Elachi with Dr. Bob Balram, right, who had done research at JPL onMars helicopters in the 90s. And so, Bob and Dr.Elachi and Dr. Jakob van Zyl (associate director of strategy at the time) quietly said "Hmmm, this, it may be worth, you know, investigating."
  - Well, over that year, Bob's analysis did show that perhaps with the advancement of

technologies now, you know, his research was in the 90s. Now, in the 2013 era, technology maybe may have advanced that maybe we can build an autonomous system light enough that we could, perhaps build the Mars helicopter.

- And then once it started to mature, it looks like it is possible, may be possible, still may be, we started to put more funding into that.

? And that was about the time I joined to lead the Mars helicopter team from the autonomous systems division deputy manager position. So, I joined Bob's dreamland of his right-brain-child. And then we started growing the team from there. And it was still internal, we first demonstrated that we could lift with a little 1/3 scale vehicle.

✓ On February 18, 2021, Ingenuity arrived on Mars along with perseverance rover. Helicopter ingenuity (Hi) took its first 39-second flight on 19th April.

📖 Aung said, "This morning our dream came true." "it was an incredible moment".

! Thishistoric incidence is comparable in letter and spiritto the first flightof Wright brothers' airplane in 1903.

Appendix 6b: Exerts from Jim Green Gravity Assist podcast Interview of MiMi Aung

Jim Green

NASA's Chief Science Officer

Charles Elachi and Jim Green pondering over helicopter on Mars Environment (Home)

Jim Green: Well, you know, about that time,I was the head of Planetary, of course, at NASA Headquarters,Charles Elachi: you know, loved that idea, gave me a call, and said

Charles Elachi: Jim, I want to fly helicopter on Mars. And, you know, how can we make that happen?

Jim Green: And I said, Charles, well we're going to put out a call for instruments on what now is Perseverance.

✓ I said,"You must propose it"

✓ "I can't just tell you to go do it."

✓ All right. And indeed, JPL put together a fabulous proposal.

✓ And eventually, as you know, we said, let's do this.

✓ A wonderful tech demo, a wonderful opportunity for us to move forward.

? **MiMi Aung:** We really started with the question of whether it was possible.

- And so the way we started is, we started with a fairly compact team.
- And one of the, you know, first thing is to really grasp the concept and map it down.

📖 I remember, I think, one of the first meetings saying,

📖 "Look, all of us have the ability to, enabling position to make this happen.

- But each of us also have the ability to bring this thing down, literally."

📖 And so that was just a principle we all worked on that if we ever made a decision that was great for just our, our own area, but are not aware of what it is, it is so easy to really destroy the entire system. And so that's the fundamental principle that we followed from that day one, I remember that meeting, I said

- "All of us have to be system engineers, as well as
- we have to be as the best we can in each of our areas, or else, it just won't work."

📖 And we were also, also jointly so excited and passionate, really, from day one about this chance to fly something in the atmosphere of another planet outside of Earth. And that passion was really deep in all of us.

📖 And it goes all the way from not just the technical, you know, technical excellence that came out of each of us.

📖 But the personal dedication. I mean, there were a lot of people that made personal career choices.

\+ So the job I was talking about the deputy division manager position, I was part time on it, but after a while, it you know, [the] helicopter really grew and you know, need it all, you know, one's attention.

- And it was the most uncertain job for you to walk away to the other one. But those are examples. And there are many of us, and so many people, you know, put off their pleasure trips for several months

Appendix 7: Psyche mission

➔ **Jim Green**: We're moving into that era where humans will be walking on the surface of the Moon and then on to Mars. We're going to want high resolution video, data, voice, and that requires these kind of communication systems for us to investigate. So that's a great step.So I was always a big proponent of technology demonstrations. All right?

➔ **Jim Green**: How you get involved in Psyche mission, another huge step in your career

➔

➔ **MiMi Aung:** Yeah, Psyche is, you know, fabulous. And, you know, in addition to the primary goal, to go to Psyche, right to the asteroid, they are also hosting a new technology

➔ And whenever there is a deep space mission, it is the ultimate platform, for a technology demonstration opportunity to mature a technology. And so,

again, the optical comm getting demonstrated in deep space, for the first time, making this successful, I was definitely motivated.

- ➔ Deep Space Optical Communications, a technology demonstration package. And so, now, they are two different objectives, you know, two different projects, so to speak, that come together on the same flight system.
- ➔ My (**MiMi)** contribution was to join, and to be the accommodation manager on Psyche, to accommodate the Deep Space Optical Communication.
  - ✓ This is a perfect position for me, because we were just talking about my fundamental belief in getting new capabilities infused into future missions.

Appendix 8: Flight number six of Helicopter Ingenuity on Mars(om)

Jim Green: It was indeed beautiful. I agree. Well, you know, to me, as you moved on to other flights, you also ran into flight number six. And that was pretty exciting. Can you tell us a little bit about what happened?

MiMi Aung: Yes, so flight number six was when we had a very long distance flight, right, and I'm trying to remember, about over 200 meters, you know, kind of flight. And then at the end of the flight, we were making maneuvers, you know, to turn and to take color pictures to construct stereo imaging, and then, in fact, come back a little bit, about 50 meters back and then land. So it's, it's very sophisticated, you know, a large distance, and then almost a little slight U turn, and then to land. Well, at the end of the long the first long leg, right? We took some color image, we took a color image, and just the activity, the increased activity on board triggered a time tagging-issue on the black and white camera, the navigation camera.

- ➔ **MiMi Aung:** What happened was because the onboard estimations were off, right, as you know,
- ➔ where we were actually were versus, you know, where what the camera time-tagging, it was telling, it became a rugged flight. And so, the vehicle thought, you know, these errors, because you're going like large errors, and I have to be here, but I'm here and there was a lot of confusion. So, flight control stability margins were stretched, but it's still within, it stayed stable, you know, the vehicle stayed stable, and the vehicle landed, and at the end, it ended up within five meters of the targeted position.
- ➔ **MiMi Aung:** It really was quite a stress test. And it was great because, because it all did, you know, work and Ingenuity, again, it landed safely within five meters, which is fantastic performance.

MiMi Aung: We really got a lot of really great data on the performance of our vehicle, so yes.

Jim Green: Yeah, you ran into an anomaly, but indeed, you were able to then overcome that. And, as you say, learn an enormous amount from that. Congratulations, that that was really exciting.