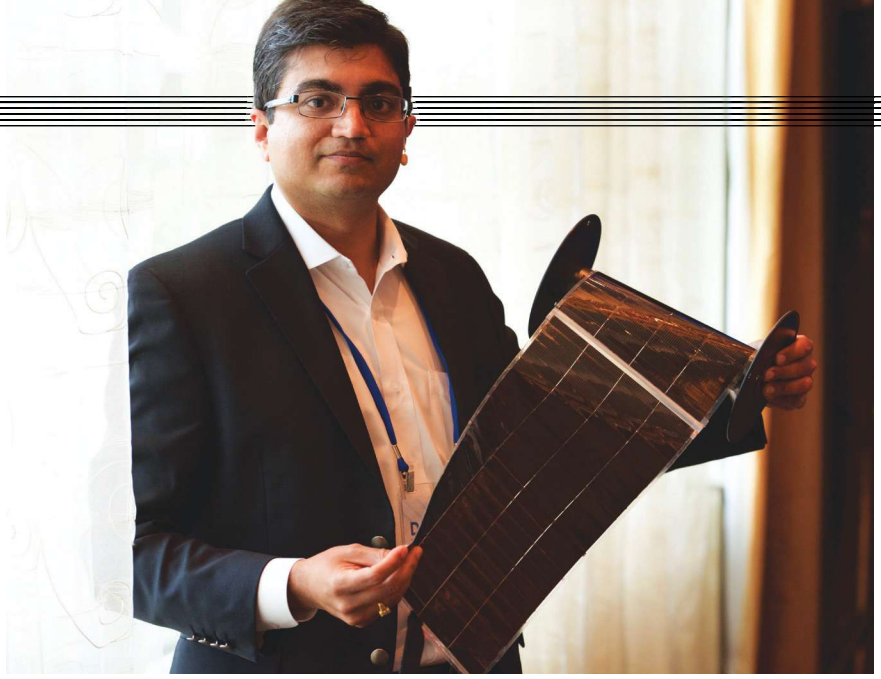


Dr. Aarohi Vijh, engineer, Alta Devices. Alta flexible solar cells hold the single- and dual-junction record for ray-capturing efficiency.

Sustainable Aviation

Dream and reality

BY BETH E. STANTON

Aviation is an essential component of the world economy and global security. The success of aviation is due to technological innovations that have provided an unprecedented level of capability, capacity, and efficiency.

—American Institute of Aeronautics and Astronautics

AN INTERNATIONAL ASSEMBLY OF scientists, engineers, and experts convened on May 6 and 7, 2016, for the Sustainable Aviation Symposium, held at the Sofitel Hotel in the heart of Silicon Valley in California. Visionaries from around the world presented the latest developments from a wide range of technologies. Topics encompassed electric and solar power, batteries, motors, propulsion, fuel cells and hydrogen, alternative fuels, design, safety, environmental impact, affordable personal aircraft, autonomous flight, unmanned aerial vehicle applications, and regional sky transit. Luminaries in academic, government, commercial, and amateur sectors shared a stunning array of developments in their respective fields.

The very real pressures of increased population, pollution, traffic density, and noise and dwindling fossil fuel resources are compounding rapidly. With some experts predicting that Middle East oil supplies will dry up in about 50 years, countries are investing heavily in alternate energy. People and products are moving around the globe at an ever-increasing volume and pace. It's easy to react to the words "sustainable," "renewable," and "green" with inner eye-rolling or immediate dismissal. For many, it's tempting to write off these concepts as outlandish and idealistic. But these guys are dead serious about the feasibility and real-world application of their ideas. And they're smart. Like NASA scientist, elite university professor, and pioneer in their industry smart. Instead of marginalizing these extraordinary ideas, perhaps we should pay attention.

A NEW FUTURE

The symposium featured 27 lectures from different disciplinary approaches that aimed to address key issues that need to be resolved to pave the way for progress in sustainable aviation. The overarching themes were energy, systems, design, safety, affordability, and new models to control air traffic in increasingly crowded skies.

Current state of the art battery, solar, and hydrogen technologies continue to evolve as issues of weight, safety, and storage improve. Some of the novel aircraft designs presented used hybrid technology. An implicit understanding is that hybrids will continue to be necessary until the technology is developed to maturity. Progress continues to be made with batteries, including new chemistry and

increased stability. Solar cells are becoming more lightweight and flexible with increased ray-capturing efficiency. Dr. Joseph Kallo from the DLR Institute of Engineering Thermodynamics in Germany introduced a hydrogen-powered aircraft on the drawing board that would use pressurized and liquid hydrogen. Germany is installing a nationwide hydrogen generating and fueling infrastructure that aviation would share with automobiles.

Other aircraft were clean from a design perspective, a fuel perspective, or both. Light, efficient aircraft that require less energy to operate have potentially longer range and broader applications. Tomas Brodreskrift of Norway designed the amphibious hybrid P2 Excursion. It's so clean it's efficient even with floats. The hybrid propulsion system uses biofuels with battery boost for takeoff. Dennis Bushnell of NASA conveyed that Boeing is exploring clean-burning bio-jet fuel made from salt-water plants irrigated with seawater.

More cost-effective aviation is an important rallying point for sport and recreational aviation. Chip Erwin's personal sport aircraft concepts include a small gas-powered aircraft and an electric motor aircraft at a fraction of LSA prices.

FASTER COMMUTES, LESS GRIDLOCK

Several presentations discussed provocative aircraft designs and infrastructure that could revolutionize our transportation system. This solution transfers the current technology of self-driving cars from road to sky by using autonomous flight and regional "sky taxis." What may sound improbable starts to sound sensible when you begin to grasp the exhaustive analysis behind the development of this plan. It would use an on-demand, autonomous, two-seat (since everyone wants to go to a different place) electric STOL aircraft. A modest cruise speed of 120 knots would save passengers about 30 minutes off the average ground commute of less than 100 miles. These quiet aircraft with steep approach and departure capabilities would be operated from baseball field-sized "pocket airparks" located in urban and suburban areas, eliminating the necessity of freeway travel from distantly located airports to home.

Dr. Brien Seeley's 2015 AIAA paper, Regional Sky Transit, can be found at *www.EAA.org/sportaviation* under This Month's Extras.

INNOVATION MOTIVATION

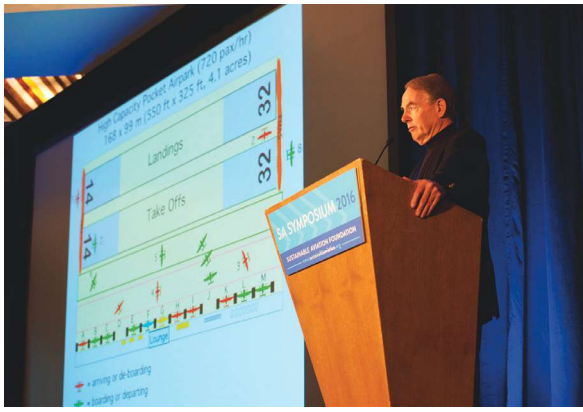
Why isn't this just happening spontaneously? Why doesn't a meeting like this just send everybody home, and magically we have the solution next year since we're all so inspired? It's the market. You've got to have to have an end game or some incentive. The solution has to be technologically and affordably conceivable. A technology prize will push that.

—Dr. Brien Seeley, president of the Sustainable Aviation Foundation

Developing new technology takes time, money, and testing in both laboratory and real-world environments. Technology readiness levels (TRL) is a system developed by NASA in the 1980s that is used to evaluate technology maturity levels. The system varies slightly between agencies and industries. An assessment is used to examine concepts, requirements, and capabilities. TRLs allow systematic appraisals of technical maturity across different types of technology, based on a scale from 1 to 9:

- TRL 1 - Basic principles observed.
- TRL 2 - Technology concept formulated.
- TRL 3 - Experimental proof of concept.
- TRL 4 - Technology validated in lab.
- TRL 5 - Technology validated in relevant environment.
- TRL 6 - Technology demonstrated in relevant environment.
- TRL 7 - System prototype demonstration in operational environment.
- TRL 8 - System complete and qualified.
- TRL 9 - Actual system proven in operational environment.

Seeley explained how technology prizes could jump-start this process. A mission of the Sustainable Aviation Foundation is to offer a series of technology prizes in the amount of $1 million or $2 million for the world's quietest two-seat aircraft with STOL characteristics that is electric and autonomous. "Ideal conditions for a technology prize are that there are some barriers to it happening all by itself or quickly. We want to see if we can do this reasonably affordably on a small-scale aircraft. If there is not an immediate market and return, then at least the prize money will induce that seed achievement that is necessary for the market to grow. The solution would create transformative and widespread benefits." He noted that prize money would be contingent upon Phase 2, which would be a demonstration of fully autonomous flight in a certificated sky taxi.



Dr. Brein Seeley, president of the Sustainable Aviation Foundation, discusses aircraft performance specs for on-demand, high capacity regional sky transit.

TECHNOLOGICAL CONVERGENCE

These emerging technologies are applicable to all sectors of aviation: sport, recreational, and commercial. Seeley was pleased to witness the interaction between the attendees. "It was not just exchanging business cards, but the flurry of connection; of potential technological convergence, the sharing of ideas, the building of brand new relationships that are going to turn into productive things or startup companies." He described the gathering as "a really authentic definition of STEM (science, technology, engineering, math) education, along with biology. Here in this one room are all these diverse people getting together to make a new future. It's so great to get these people together. Aviation is driving this innovation."

For more information on speakers and topics at the 2016 SAS, go to *www.EAA.org/sportaviation* under This Month's Extras.

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