The decadal dinner club

As hundreds of US astronomers draft their latest decadal wish list of new projects, *Nature* took a short-cut by convening a small survey around a dinner table. **Eric Hand** listens in.

In a Lebanese restaurant in Washington DC, seven astronomers are sitting down to dinner. It is a crisp evening in January, and the researchers are here at *Nature's* request to discuss the challenges faced by their discipline and the future directions it might take.

Although the group is in town for the annual meeting of the American Astronomical Society, the dinner has been convened to consider the next 'decadal survey', which is set for release this September. Since the 1960s, astronomers have been drawing up these surveys to present funders with a prioritized wish list of new facilities they would like to see built over the coming decade, together with price estimates and a discussion of the science they would perform.

The decadal surveys carry significant weight with Congress and funding agencies, which use them to guide their spending decisions. But they are a huge undertaking: by the time the 2010 survey is complete, it will have involved 218 scientists, at least 37 committee meetings and consumed some \$4 million in funds from NASA, the National Science Foundation (NSF) and the Department of Energy. This is in stark contrast to the first survey in 1964, which consisted of just eight astronomers — a set-up more closely aligned with the dinner group convened by *Nature*.

The seven guests at the dinner table, representing a cross-section of their community (see 'Who's who'), are not involved in the formal decadal survey. But they are well aware of the challenges it faces. They know that it would be hard to justify building, say, a billion-dollar, 30-metre-diameter telescope on the basis of it being newer and more sophisticated than the dozens of large ground-based telescopes that already exist. For any project, "bigger and better is not going to sell it," says Josh Grindlay. Matt Mountain agrees. "It's got to be, 'Here is the science that we are going to do with this,'" he says.

Even after the community agrees on what the key science goals are, explaining those goals to non-astronomers can be fraught with pitfalls. The most recent survey, in 2001, suffered because it lacked a cohesive 'narrative', the diners note. "There was no story behind it," says Mountain. Or rather, there were too

many stories and no overarching theme, unlike the way the 1991 survey framed its wish list around 'the decade of infrared astronomy'. "I remember talking to a [congressional] staff member who said 'Why do you want all these things?'" Mountain continues. "Why should the federal government fund astrophysics?" is the fundamental question that the decadal survey ultimately has to answer.

Alycia Weinberger agrees: "Part of the goal is to sell the project of astronomy to the American people or to Congress as their proxy," she says.

In some ways that sale can be straightforward. "If you sit on an airplane and say you're an astronomer, people talk to you," says Bruce Partridge. "If you sit on the airplane and say you're a physicist, they read their book."

Many aspects of astronomy can readily grab the public's imagination, says David Silva. "When you talk about our connection to the general public — the people who are ultimately paying for what we do — the search for life in the Universe is one of the fundamental questions that we want to answer as a species: are we alone in the Universe?"

"We walk out there and we say, 'We're really about origins,'" adds Garth Illingworth. "That excites people and it's easy to communicate."

A question of time

That search for habitable worlds is likely to figure prominently in the forthcoming survey. The hunt for exoplanets — worlds orbiting stars outside our Solar System — has "exploded virtually out of nowhere," says Silva. First detected in the mid-1990s, exoplanets were still a comparative rarity in 2001. Detection techniques have now improved to the extent that the list now contains more than 400 planets and is growing fast. "Now we're looking at [spectral] signatures and atmospheres," says Silva. "We're in an amazing, amazing era."

Many astronomers are betting that the first Earth-sized exoplanet will be discovered within a few years — and then the race will be on to see whether its atmosphere shows the spectral signatures of oxygen and water, possible signs of life.

The rapid developments in the hunt for exoplanets highlight another problem faced by

the decadal surveys. "Science changes on time scales that are often shorter than the distance between two decadal surveys," says Silva.

A similar case in point is dark energy, which is also likely to dominate the forthcoming wish list. So far, little is known about dark energy other than it pervades the Universe, comprises three-quarters of its mass and seems to be accelerating its expansion. "At the last decadal survey, we were just absorbing the conclusion of an accelerating Universe and what that impact was," says Silva. "Now [understanding the nature of] dark energy is the *raison d'être* of a lot of projects."

In addition to dark energy and exoplanets, the diners expect to see several other science horizons in the survey, such as gravitational waves — infinitesimal ripples in space-time caused by ultraviolet events such as the collision of two black holes. Upgrades to existing facilities such as the ground-based Laser Interferometer Gravitational-Wave Observatory (LIGO) are beginning to reach the required sensitivities to detect one of these waves. "We may get it in five years," says Jay Lockman, who notes that radio telescopes are also aiming for a detection by measuring variations in the timing of pulsars. The proposed space-based Laser Interferometer Space Antenna (LISA) would go further, pinpointing the source and shape of the gravitational waves — if it gets the green light.

"The search for life in the Universe is one of the fundamental questions that we want to answer as a species."

Who's who

(Clockwise from left)

Jay Lockman is a radio astronomer at the National Radio Astronomy Observatory in Green Bank, West Virginia.

Josh Grindlay works on X-rays and cosmic rays at Harvard University in Cambridge, Massachusetts.

Matt Mountain is director of the Space Telescope Science Institute in Baltimore, Maryland.

Bruce Partridge is a cosmologist at Haverford College in Pennsylvania.

Alycia Weinberger works on stellar and planetary evolution at the Carnegie Institution of Washington.

David Silva is director of the National Optical Astronomy Observatory in Tucson, Arizona.

Garth Illingworth works on galaxy evolution at the University of California, Santa Cruz.

ILLUSTRATIONS BY DAVID PARKINS

Getting that approval from funders is likely to hinge on one major factor in the survey: believable cost estimates. The 2001 survey gave the community “a black eye”, says Silva, for claiming that its entire slate of 7 major and 12 medium-sized projects could be built for \$4.4 billion (about \$5.3 billion today). In fact, that figure barely covers the survey’s number one priority, the James Webb Space Telescope (JWST), which is now expected to cost \$4.9 billion. “I think many projects have recognized that,” says Silva, “and really tried to step up the credibility of their cost estimates this time.”

Escalating costs also mean that astronomers need to be realistic in their expectations, especially when it comes to the billion-dollar-plus ‘flagship’ missions. The survey should recommend “two in space, two on the ground”, says Grindlay. “And it should clearly prioritize — as it’s unlikely that we probably will even do one in the current climate.” Historically, notes Mountain, “it’s a flagship per decade” — one in space and one on the ground.

In the current budgetary climate, completing even that many projects before the end of the decade may be tough. NASA will probably not take on any major new mission until later in the decade, after the JWST launches in 2014. And the NSF is just as unlikely to undertake another major astronomy project until the Atacama Large Millimeter/Submillimeter Array (ALMA) in Chile is finished in 2012.

This makes the ranking of the projects in the wish list that much more crucial. Putting a project first instead of second can have a huge influence on the direction of astronomy — and in the process, shape careers. Lockman recalls one colleague saying that: “If this one project gets funded, he has a salary for three years; if another project gets funded, he doesn’t have a salary for three years.”

High priorities

To get a sense of the 2010 survey’s likely priorities, the diners filled out ballot papers giving their personal rankings for the projects expected to figure in the real survey (see ‘Astronomy priorities’).

The straw poll’s number one pick is the Large Synoptic Survey Telescope (LSST), which would use its 3,200 megapixel camera and ultrawide field of view to scan the heavens continuously in search of things that don’t stay fixed: from near-Earth asteroids, to the optical counterparts of γ -ray bursts and X-ray flashes. The LSST should also contribute to the understanding of dark energy, by systematically measuring the gravitationally distorted shape of 3 billion galaxies.

Number two in the poll — the same spot it held in the 2001 survey — is the Giant Segmented

ASTRONOMY PRIORITIES

Each of *Nature*’s dinner guests was asked to rank up to five missions, mixing ground and space. A project got five points for a first place vote, four for a second, and so on. Only projects ranked by at least two panellists made the cut. Many projects from 2001 reappear, reflecting the cost overruns of the James Webb Space Telescope — but the rise of the TPF and the LSST could be a sign of the growing importance of Earth-like planets and dark energy, respectively.

LARGE SYNOPTIC SURVEY TELESCOPE (LSST)

2010 POINTS: 22
2001 RANKING: 5

GIANT SEGMENTED MIRROR TELESCOPE (GSMT)

2010 POINTS: 19
2001 RANKING: 2

TERRESTRIAL PLANET FINDER (TPF)*

2010 POINTS: 13
2001 RANKING: 6

CONSTELLATION-X OBSERVATORY/ INTERNATIONAL X-RAY OBSERVATORY (CON-X/IXO)

2010 POINTS: 11
2001 RANKING: 3

LASER INTERFEROMETER SPACE ANTENNA (LISA)

2010 POINTS: 7
2001 RANKING: N/A

JOINT DARK ENERGY MISSION (JDEM)

2010 POINTS: 5
2001 RANKING: N/A

SQUARE KILOMETRE ARRAY (SKA)

2010 POINTS: 3
2001 RANKING: N/A

* The voters mostly called for a medium-sized TPF mission of less than a billion dollars, rather than the multibillion-dollar flagship mission called for by the 2001 survey.

Mirror Telescope (GSMT): a workhorse observatory that would dwarf existing telescopes with a main mirror roughly 30 metres across. The NSF would ultimately need to choose between two competing designs, although it would not have to bear the entire cost: each has already attracted millions of dollars from private philanthropists. “You can convince people to give money for a giant telescope on the ground,” says Weinberger. “There’s hardly any other field where you can make an impact like that.”

A planet-hunter mission — the Terrestrial Planet Finder (TPF), which would seek to capture the spectrum of an Earth-like planet — was ranked as the most important space mission to pursue, and third overall. “If you delivered the spectrum of a living planet, that would be the most memorable thing of the decade,” says Mountain. The ranking is a big jump up from the last decadal survey, when the TPF was ranked sixth. However, the TPF of the 2001 report was an expensive flagship mission that would have taken the form of either many telescopes flying in formation, or a large telescope with an internal filter. Most of the

diners agree that although the TPF is important, it should be realized in a far cheaper configuration.

The straw poll is interesting not just for the leaders but also the laggards. For example, next to last in the poll was the Joint Dark Energy Mission (JDEM), a small space telescope optimized to pin down the nature of dark energy. As recently as 2007, the JDEM received the top-priority endorsement in a report from the National Academies on NASA’s Beyond Einstein astrophysics programme. With the energy department committing a portion of the money — and with the European Space Agency also expressing interest in becoming a partner — the JDEM seemed to be on the fast track. But since then, bureaucratic squabbles and scientific disagreements on the telescope’s design have left it in limbo (see *Nature* 461, 1182–1183; 2009). The poll could reflect a growing belief that, for now, the mystery of dark energy is best attacked from the ground with instruments such as the LSST.

Difficult decisions

What took an hour and seven pieces of paper in *Nature*’s mock survey will have taken two years and some 600 white papers in the real thing. “It’s shocking to think about how many person hours of effort went into all of those white papers,” says Weinberger.

So the question is inevitable: has the whole process become too cumbersome? Or is the complexity necessary — a product of the scientific ambition, technological sophistication and staggering expense of modern astronomy?

It’s the latter, says Grindlay, who credits Roger Blandford, director of the 2010 survey, with trying to involve the whole field. “It’s an impossible organizational task,” he says. “I’m not sure whether it will work in the end, but he’s made the right effort.” And as Grindlay points out, the final priorities will be decided by a group only slightly larger than that gathered for *Nature*’s dinner: the 23 members of the survey committee itself. “They’re going to make the hard decisions,” he says.

They may face an unenviable task and a difficult funding landscape, but that is no reason for the community to lower its sights. “You should be ambitious,” says Weinberger. After all, adds Mountain, citing Galileo and an associated 400 years of history, “Astrophysicists have the power to change society.”

Eric Hand is a reporter for *Nature* in Washington DC.

For the panel’s views on data accessibility, career prospects and the rise of chemistry, see the full transcript of the round-table discussion at go.nature.com/ITkwWr