How Accurate Are Your Forecasts? More Accurate than You Might Think

by Andy Hines

Futurists are frequently asked "How have your *predictions* turned out?" We quickly explain that we don't make predictions, which are specific statements about whether something either will or won't happen by a specific date. They are a yes-or-no proposition. Futurists, we say, prefer forecasting, which involves statements about the likelihood or probability of whether something will happen within a specified timeframe. Of course, if you make enough predictions, you're bound to eventually get one right, owing to the laws of chance rather than any particular insight into the future. The predictor will often then complain that "I predicted xyz, and no one listened," neglecting to mention that dozens of other predictions didn't pan out. Most futurists would say "so what" to the argument of predictions made in a vacuum. Put another way, we avoid the fool's gold of trying to make accurate predictions, but seek to inspire our clients to think and act differently about the future by offering "forecasts" instead.

Therefore, when a futurist is asked "How have your forecasts turned out?" the query is intended to get at how good or reliable we are as potential consultants — in short, what is our track record? Our first response is often to try and shift the conversation away from "accuracy of forecasts" as the standard by which to evaluate our work. We point out that forecasts are tools for stimulating thinking about the future. We explain that the future is so complex that trying to get it

right is futile. Rather, we seek to understand the range of possibilities and then monitor events as they unfold so as to determine in which direction the future seems to be unfolding. This sometimes satisfies the client, but often leads to a more polite restatement: "I understand, but could you tell us anyway."

One might suspect that futurists ought to have no difficulty answering this question. But for several reasons, this is not the case. Per our attempts at redirection noted above, we often make forecasts as merely one way among many to indicate a broad range of possibilities, not meaning to imply that any single method is necessarily accurate. Second, our forecasts are often proprietary to the client and cannot be publicly revealed. Third, the passage of time makes many prior forecasts obsolete due to changing conditions — thus there is little incentive to go back and reexamine old forecasts. The fact is, clients act — or fail to act — on a forecast at about the time when it is made, so in a sense it doesn't matter how the forecast turns out in the long run. For all these reasons, futurists often lack credible responses to the accuracy question.

Introducing the Forecasts

Clients do occasionally ask for our most probable or best-guess forecast, and this provides us the best avenue to address the accuracy question. For the purposes of this article I'll use one

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of these from 1997: *2025: Scenarios of US and Global Society as Reshaped by Science and Technology*, spearheaded by Joseph Coates and assisted by John Mahaffie and myself. This book grew out of a three-year project exploring the future of science and technology, sponsored by 18 large organizations. The clients understood the principles of a range of forecasts, but nonetheless insisted that we "take our best shot" in describing how the year 2025 might look through the lens of science and technology. The goal for this project was to provide a set of ideas and concepts that would challenge our clients to think differently about the long-term prospects of science and technology in order to influence the R&D decisions they would be making in the present and near future.

The forecasts were presented as underlying assumptions that framed or provided the context for our specific forecasts for science and technology in the year 2025. These assumptions about the context of 2025 were grouped into the following eight categories:

1. Managing our world.
2. Managing human health.
3. Managing environment and resources.
4. Automation and infotech.
5. Population trends.
6. Worldwide tensions.
7. The electronic global village.
8. Public issues and values.

All of these assumptions are, in effect, forecasts. They were crafted as "highly probable statements about the future, forming a framework around which less certain ideas can be tested" (1997). In other words, to create science and technology forecasts for the year 2025, we first had to create a forecast of what the context would look like. The team originally came up with 83 of these highly probable assumptions or forecasts, and later added a set of 24 "additional, but slightly less probable" ones to get at more speculative possibilities in order to further stretch the clients' thinking.

Evaluating the Individual 107 Forecasts

The evaluation of how these 107 forecasts are tracking today — roughly 15 years later — uses the following five-point scale:

1= **already happening**

2= **coming soon** — closer to today than 2025

3= **needs a boost** — not currently tracking, but still plausible

4 and 5 = **on track** are grouped together

Managing Our World

1. Movement toward a totally managed environment will be substantially advanced at national and global levels. Oceans, forests, grasslands, and water supplies will make up major areas of the managed environment. Macroengineering — planetary-scale civil works — will make up another element of that managed environment. Finally, the more traditional business and industrial infrastructure — telecommunications, manufacturing facilities, and so on — will be a part of managed systems and subsystems. Note that total management does not imply full understanding of what is managed. But expanding knowledge will make this management practical. Total management also does not imply total control over these systems.

Needs a boost: The George W. Bush administration slowed, if not reversed, a trend toward greater global cooperation, but there is still progress in this direction. Kyoto, for all its troubles, was signed, albeit without U.S. participation. There is still more talk and plans than action on global cooperation. A third cause for concern is the state of macroengineering. We haven't seen much progress here, and there have been growing questions about whether this is a desirable strategy.

2. Everything will be smart — that is, responsive to its external or internal environment. This

will be achieved either by embedding microprocessors and associated sensors in physical devices and systems or by creating materials that are responsive to physical variables such as light, heat, noise, odors, and electromagnetic fields, or by a combination of these two strategies.

On track: There has been a lot of progress in sensing, but still plenty of work to do in terms of integrating it into smart systems — but this seems quite achievable by 2025.

Managing Human Health

3. All human diseases and disorders will have their linkages, if any, to the human genome identified. For many diseases and disorders, the intermediate biochemical processes that lead to the expression of the disease or disorder and its interactions with a person's environment and personal history will also be thoroughly explored.

On track: Substantial progress has been made in identifying the linkages, but there is still a way to go on the second aspect involving all the connections and interplay. This second element is turning out to be more complex than initially anticipated, but it still seems plausible that they will be "fully explored" by 2025.

4. In several parts of the world, the understanding of human genetics will lead to explicit programs to enhance people's overall physical and mental abilities — not just to prevent diseases.

On track: Tough call here. There is clearly a lot of discussion in the media about performance enhancement, but not at the level of genetic performance enhancement. It probably requires more sophisticated understanding of genetics, which is likely to emerge, and thus it is still plausible that attempts will be made in this area by 2025.

5. The chemical, physiological, and genetic bases of human behavior will be generally understood. Direct, targeted interventions for disease control and individual human enhancement will

be commonplace. Brain–mind manipulation technologies to control or influence emotions, learning, sensory acuity, memory, and other psychological states will be in widespread use.

Needs a boost: Approaching a tipping point here, as the discipline moves from understanding the structure of the brain to how it works. Early applications and experiments are emerging. "Needs a boost" is appropriate in terms of the interventions being commonplace, and manipulations being widespread, which does not appear imminent.

6. In-depth personal medical histories will be on record and under full control of the individual in a medical smart card or disk.

On track: The technology is already here, and the demand for control of medical history is growing. Political, organizational, and infrastructure issues abound and will keep this from happening sooner, but they seem resolvable by 2025.

7. More people in advanced countries will be living to their mid-80s while enjoying a healthier, fuller life.

On track: Progress in this direction is well under way, with 23 countries now possessing a life expectancy at birth of over 80.

8. Custom-designed drugs such as hormones and neurotransmitters (chemicals that control nerve impulses) will be as safe and effective as those produced naturally within humans or other animals.

Needs a boost: Tough call — human growth hormone is here, but evidence suggests that this area is going to be more complex than anticipated. Nature continues to amaze us with its complexity and surprises. Biological knowledge will need to ramp up faster for this to happen by 2025.

9. Prostheses (synthetic body parts or replacements) with more targeted drug treatments will lead to radical improvements for people who

are injured, impaired, or have otherwise degraded physical or physiological capabilities.

On track: Already seeing significant progress here. A case could be made for "coming soon," if the qualifier "radical" were replaced with "incremental."

Managing Environment And Resources

10. Scientists will work out the genome of prototypical plants and animals, including insects and microorganisms. This will lead to more-refined management, control, and manipulation of their health and propagation, or to their elimination.

On track: The inclusion of the qualifier "more-refined" in this forecast enables it to be rated "on track." Again, matters in the biological realm are turning out to be more complex than the team thought. There is an interesting, perhaps macabre, twist regarding "elimination." While that idea referred to pests, it may turn out that whatever traits a particular society judges to be undesirable might be targeted, and that an incomplete understanding in this realm could lead to unintended "eliminations."

11. New forms of microorganisms, plants, and animals will be commonplace due to advances in genetic engineering.

On track: This one seems to be on track, though more advanced with microorganisms and plants than with animals. It is difficult to characterize what constitutes a new form versus an enhancement. As with many of the biotechnology-based forecasts, there is a social dimension that could slow or stop the developments.

12. Foods for human consumption will be more diverse as a result of agricultural genetics. There will be substantially less animal protein in diets in advanced nations, compared with the present. A variety of factors will bring vegetari-

anism to the fore, including health, environmental, and ethical trends.

Needs a boost: A lesson the team perhaps neglected to learn from its exploration of technological forecasting from 1970-1993[1] was the routinely slow progress in the food arena. The forecasts of the 1990s looked much the same as those from the 1970s. Potential technical advances are slowed by social resistance to changes in food. Additionally, one could argue that genetics might have a better chance of reducing food diversity in the forecast period. The animal protein and vegetarian forecasts still have a chance, but progress to date has been slower than anticipated.

13. There will be synthetic and genetically manipulated foods to match each individual consumer's taste, nutritional needs, and medical status. Look for "extra-salty (artificial), low-cholesterol, cancer-busting French fries."

Needs a boost: The capabilities for a more tailored diet appear on track, but as noted in the analysis of Forecast 12 above, social acceptance is not there yet.

14. Farmers will use synthetic soils, designed to specification, for terrain restoration and to enhance indoor or outdoor agriculture.

On track: The unarticulated assumption underlying this forecast was that there would be a growing demand for agricultural land use that would in turn drive a need for restorative agriculture. This would in turn lead to greater use of synthetic soils. There is a lot packed into this one. Nonetheless, the emergence of the "land use" issue suggests this one is on track.

15. Genetically engineered microorganisms will do many things. In particular, they will be used in the production of some commodity chemicals as well as highly complex chemicals and medicines, vaccines, and drugs. They will be widely used in agriculture, mining, resource upgrading, waste management, and environmental cleanup.

On track: This one emphasizes industrial biotechnology, which is quietly making an impact. There is a lot more attention paid to health-related developments, and even agriculture-related applications, but industrial biotechnology continues to progress, albeit quietly.

16. There will be routine genetic programs for enhancing animals used for food production, recreation, and even pets. In less developed countries, work animals will be improved through these techniques.

Needs a boost: This strong interventionist approach will need a boost to become "routine" by 2025, and will have social issues to address along the way.

17. Remote sensing of the earth will lead to monitoring, assessment, and analysis of events and resources at and below the surface of land and sea. In many places, in situ sensor networks will assist in monitoring the environment. World-wide weather reporting will be routine, detailed, and reliable.

On track: Solid progress here. Interesting how Google Maps have really brought these capabilities to public notice and usage. It is perhaps risky, however, to suggest reliable weather reporting.

18. Many natural disasters, such as floods, earthquakes, and landslides, will be mitigated, controlled, or prevented.

Needs a boost: While prediction capabilities are on track, societies have not yet shown sufficient willingness to invest the dollars in mitigation, control, or prevention.

19. Per capita energy consumption in the advanced nations will be at 66% of per capita consumption in 1990.

On track: A tough call — if present trends continue, this will not happen by 2025. But clearly a sense of limits is emerging in public consciousness. Rising energy prices combined with advances in information technology could enable a conservation movement to bring this about. Thus, the stage appears to be set for significant change.

20. Per capita consumption in the rest of the world will be at 160% of per capita consumption in 1990.

On track: Paradoxically, in comparison with the previous forecast, present trends continued and this will happen. A key question is whether the conservation "turn" suggested above makes it to the emerging markets in time. Probably not.

21. Resource recovery along the lines of recycling, reclamation, and remanufacturing will be routine in all advanced nations. Extraction of virgin materials through mining, logging, and drilling will be dramatically reduced, saving energy and protecting the environment.

On track: Still a way to go to be routine, but steady progress here and a growing sense of limits suggest that more attention will be paid to resource management.

22. Restorative agriculture (i.e., "prescription" farming) will be routine. Farmers will design crops and employ more-sophisticated techniques to optimize climate, soil treatments, and plant types.

On track: Similar to #14 on the use of synthetic soils, the conditions promoting the need for this one are emerging, and thus this one can be judged to be "on track."

Automation and Infotech

23. There will be a worldwide, broadband network of networks based on fiber optics; other techniques, such as communications satellites, cellular, and microwave, will be ancillary. Throughout the advanced nations and the middle class and prosperous crust of the developing world, face-to-face, voice-to-voice, person-to-data, and data-to-data communication will be available to any

place at anytime from anywhere.

Already happening.

24. Robots and other automated machinery will be commonplace inside and outside the factory, in agriculture, building and construction, undersea activities, space, mining, and elsewhere.

On track: Advances in robotics have been slow, steady, and almost quiet. After the hype about robotics failed to materialize in the past, there is perhaps reluctance in the media to get fooled again. But technical development has been proceeding and new applications continue to emerge.

25. There will be universal online surveys and voting in all the advanced nations. In some jurisdictions, this will include voting in elections for local and national leaders.

On track: The "hanging chads" in Florida hastened a move to electronic voting machines, laying the groundwork for online voting. Despite hiccups and protests, growing confidence in the online infrastructure positions this one well. Examples to keep in mind are all the similar concerns that were raised about e-commerce and online banking.

26. Ubiquitous availability of computers will facilitate automated control and make continuous performance monitoring and evaluations of physical systems routine.

On track: The capabilities are here, and it is just a matter of time for the applications to emerge. From a technical perspective, one could argue for "coming soon," but social acceptance, particularly in the workplace, will likely push this out closer to 2025.

27. The ability to manipulate materials at the molecular or atomic level will allow manufacturers to customize materials for highly specific functions such as environmental sensing and information processing.

On track: Despite some exaggerated nano-hype, developments here are progressing and suggest this one is on track.

28. Totally automated factories will be common but not universal for a variety of reasons, including the cost and availability of technology and labor conflicts.

Needs a boost: The key word is "common." They will likely be in existence, but it appears that there is plenty of "cheap labor" left to absorb in the emerging markets. While automation is likely to eventually be more cost-effective, it appears to be taking longer than anticipated. An interesting development to monitor here is whether a move to small-scale and local manufacturing will emerge within this timeframe.

29. Virtual-reality technologies will be commonplace for training and recreation and will be a routine part of simulation for all kinds of physical planning and product design.

On track: Virtual reality is another victim of hype. When the reality of VR turned out to be far less than the promise, it disappeared from the headlines. As with robotics, developments continue apace but outside the glare of the mainstream media.

30. In text and — to a lesser extent — in voice-to-voice telecommunication, language translation will be effective for many practically significant vocabularies.

On track: There has been significant progress in text translation, and some in voice. This one is close to "coming soon," but that has been for a long time, and it hasn't quite been able to get beyond the fringe.

31. Expert systems, a branch of artificial intelligence, will be developed to the point where the learning of machines, systems, and devices will mimic or surpass human learning. Certain low-level learning will evolve out of situations and experiences, as it does for infants. The toaster will

"know" that the person who likes white bread likes it toasted darker, and the person who chooses rye likes it light.

Needs a boost: Tough call. Low-level learning is on track, as is the ability to mimic human learning. The challenging word is "surpass," which would "need a boost" for 2025. So, a split decision: mimic is on track, and surpass needs a boost, but to be on track requires both.

32. The fusion of telecommunications and computation will be complete. We will use a new vocabulary of communications as we televote, teleshop, telework, and tele-everything. We'll e-mail, tube, or upload letters to Mom. We'll go MUDing in cyberspace and mind our netiquette during virtual encounters.

Already happening.

33. Factory-manufactured housing will be the norm in advanced nations, with prefabricated modular units making housing more flexible and more attractive, as well as more affordable.

On track: Slow and steady progress here. This is another area that is always seemingly just around the corner.

34. In the design of many commercial products such as homes, furnishings, vehicles, and other articles of commerce, the customer will participate directly with the specialist in that product's design.

Coming soon: Some of this is already happening, but it's still more hype than reality. But clearly, it will be widespread closer to today than 2025.

35. New infrastructures throughout the world will be self-monitoring. Already, some bridges and coliseums have "tilt" sensors to gauge structural stress; magnetic-resonance imaging used in medical testing will also be used to non-invasively examine materials for early signs of damage so preventive maintenance can be employed.

On track: The challenge here is a general unwillingness to invest in infrastructure, but decay in affluent nations and development needs in the emerging market eventually turn the tide. Interestingly, the recession and the resulting stimulus packages could give this one a boost, but that is probably necessary to get this one on track for 2025.

36. Interactive vehicle–highway systems will be widespread, with tens of thousands of miles of highway either so equipped or about to be. Rather than reconstruct highways, engineers may retrofit them with the new technologies.

Needs a boost: Bits and pieces — isolated trials, emergence of GPS, and some early collision avoidance — are appearing here and there. On-board navigation systems are a positive step in this direction. But, as with #35, investing in infrastructure is not a political winner, and this requires a systems approach and infrastructure. Thus, developments lag, even with stimulus spending, which is likely to aim more at jobs than automation.

37. Robotic devices will be a routine part of the space program, effectively integrating with people. Besides the familiar robotic arm used on space shuttles, robots will run facilities in space operating autonomously where humans are too clumsy or too vulnerable to work effectively.

Coming soon: Some of this is already here, and current programs are heading in this direction.

38. Applied economics will lead to a greater dependency on mathematical models embodied in computers. These models will have expanded capabilities and will routinely integrate environmental and quality-of-life factors into economic calculations. One major problem will be how to measure the economic value of information and knowledge. A Nobel Prize will be granted to the economist who develops an effective theory of the

economics of information.

On track: While it may have looked like the laws of economics were about to be repealed during the dot-com boom, we've come back to earth and are still working out the economics of information. Data mining, micropayments, and other approaches will lead to lots of experimentation and trial-and-error, but progress seems likely on this front.

Population Trends

39. World population will be about 8.4 billion people.

Needs a boost: It appears that population growth is slowing faster than we anticipated. The most recent Census Bureau projections anticipate 8 billion people around 2025.

40. Family size will be below replacement rates in most advanced nations but well above replacement rates in the less-developed world.

Needs a boost: The UN has recently suggested that the globe will hit replacement level fertility by 2025. The forecast for below replacement in advanced nations is on target, but the less-developed world is reducing fertility rates faster than anticipated.

41. Birth control technologies will be universally accepted and widely employed, including a market for descendants of RU-486.

On track: Progress in slowing population growth suggests this is in play — though not the only factor. The component about the descendants of RU-486 is less clear, as it has diffused slower than expected due to political and social objections.

42. World population will divide into three tiers: at the top, World 1, made up of advanced nations and the world's middle classes living in prosperity analogous to Germany, the United States, and Japan; at the bottom, World 3, people living in destitution; and in the middle, World 2, a vast range of people living comfortably but not extravagantly in the context of their culture. We use the terms World 1, World 2, and World 3 for the emerging pattern of nations that moves us beyond the post–World War II nomenclature.

On track: This taxonomy has proved useful in our work with clients. One could make a case for splitting World 2 into fast-growing and stable "worlds," as there are pretty significant differences between the some of the fast-growing Asian nations and the slower-growing nations of Latin America. Our firm has also added "World Zero" to account for the rapid growth of the virtual world.

43. The population of World 1's advanced nations will be older, with a median age of 42.

On track: The aging of World 1 is proceeding as anticipated.

44. The less-developed Worlds 2 and 3 will be substantially younger but will have made spotty but significant progress in reducing birthrates. However, the populations of these countries will not stop growing until sometime after 2025.

Needs a boost: As suggested in #39 and #40 above, the progress has been more significant than spotty, and it looks like the rates will need to accelerate again for the forecast to be on track.

45. The majority of the world's population will be metropolitan, including people living in satellite cities clustered around metropolitan centers.

Coming soon: The world just recently passed the 50% urban mark, and urbanization continues to grow.

46. A worldwide middle class will emerge. Its growth in World 2 and to a lesser extent in World 3 will be a powerful force for political and economic stability and for some forms of democracy.

On target: The global middle class is certainly emerging and is making progress toward

economic stability. But it will take some time to translate that into the political realm and into more democratic forms of government.

Worldwide Tensions

47. There will be worldwide unrest reflecting internal strife, border conflicts, and irredentist movements. But the unrest will have declined substantially after peaking between 1995 and 2010.

Needs a boost: Certainly, there is plenty of strife and conflict, but some progress in peacekeeping as well. While a decline may still take place, it is likely going to take longer than 2010, and it will likely be less "substantial" than anticipated.

48. Under international pressures, the United Nations will effectively take on more peacemaking to complement its historic peacekeeping role.

Coming soon: Substantial steps have already been taken in this direction and more are likely to come. International cooperation show signs of coming back in vogue, particularly with a new U.S. political administration.

49. Supranational government will become prominent and effective, though not completely, with regard to environmental issues, war, narcotics, design and location of business facilities, regulation of global business, disease prevention, workers' rights, and business practices.

Needs a boost: Less progress than anticipated here. The previous U.S. administration's anti-internationalist stance slowed the move in this direction.

50. Widespread contamination by a nuclear device will occur either accidentally or as an act of political/military violence. On a scale of 1 to 10 (with Three Mile Island a 0.5 and Chernobyl a 3), this event will be a 5 or higher.

On track: Unfortunately, this is on track, as controls over nuclear weapons loosened and nu-

clear technology has proliferated. Terrorist groups will likely get hold of a device. Nuclear power may enjoy a renaissance as an alternative to CO_2-producing fossil fuel technologies, thus providing more opportunities for an incident.

51. Increasing economic and political instabilities will deter business involvement in specific World 3 countries.

On track: This looks pretty clear on the face of it, with the possible wild card being a concerted effort on the part of the rest of the world to intervene at the "bottom of the pyramid," both for altruistic and/or economic/environmental reasons.

52. Despite technological advances, epidemics and mass starvation will be common occurrences in World 3 because of strained resources in some areas and politically motivated disruptions in others.

On track: Same as #51 above. Likely to be the case, unless a concerted intervention takes place.

53. There will be substantial environmental degradation, especially in World 3. Governments will commit money to ease and correct the problem, but many will sacrifice long-term programs that could prevent the problem from happening in the first place.

On track: Ditto with #51 and #52. One could argue for raising the profile of World 2 in this forecast, as rapid economic development at the expense of the environment is a fairly routine state of affairs.

54. There will be shifts in the pattern of world debtor and creditor countries. Japan's burst economic bubble, the ever-growing U.S. debt, and Germany's chronic unemployment problems are harbingers of things to come.

On track: Tough one to call. The shifts in patterns of debtors and creditors is tracking well. Even with the current global recession, the sec-

ond half of the forecast could be seen as overly harsh on the fate of the affluent nations.

55. NIMBY ("Not In My Back Yard") will be a global-scale problem for a variety of issues, ranging from hazardous-waste disposal to refugees to prisons to commercial real-estate ventures.

Coming soon: A bit more precision would have helped here. Clearly this is happening in the affluent areas in all three worlds. On the other hand, less-affluent areas may actually seek these out in efforts to grow their economy and provide jobs.

56. Migration and conditions for citizenship throughout the world will be regulated under new international law.

On track: While not much positive progress to date on this — with the focus being on security issues and restriction of movement — the scale and intensity of the issue continues to build. It is plausible that it will become increasingly clear that only a systemic approach has a chance of working, as individualistic approaches simply shift the problem to someone else.

57. Terrorism within and across international borders will continue to be a problem.

On track: No explanation required.

The Electronic Global Village

58. Global environmental management issues will be institutionalized in multinational corporations as well as through the United Nations and other supranational entities.

On track: Sustainability has caught on in the business world, and although one could argue with the depth of the commitment, the trend is overall moving toward it becoming an important factor. Some progress on the supranational front with NGOs an indicator, and Kyoto, for all its faults, points in this direction as well.

59. A global currency will be in use.

On track: Despite struggles with the euro, it is a step in the direction toward a global currency. The growing integration of financial markets also suggests this forecast is on track.

60. English will remain the global common language in business, science, technology, and entertainment.

On track: Despite the rise of Chinese economic power, English continues to be the predominant second language, and it is difficult to see that changing in the next 15 years.

61. Schooling on a worldwide basis will be at a higher level than it is today. Education may approach universality at the elementary level and will become more accessible at the university level through distance education technologies.

On track: There is growing recognition of the vital importance of education, with distance education having huge potential to broaden access.

62. In the advanced nations, lifelong learning will be effectively institutionalized in schools and businesses.

Coming soon: This is clearly on pace, with perhaps some more time required to achieve "institutionalized" status.

63. There will be substantial, radical changes in the U.S. government. National decisions will be influenced by electronically assisted referenda.

Needs a boost: The component about electronically assisted referenda is on track, but whether that, or other factors, will lead to radical change remains to be seen — nothing has yet emerged to suggest this.

64. Throughout the advanced nations, people will be computer literate and computer dependent.

Already happening.

65. Worldwide, there will be countless vir-

tual communities based on electronic linkages.

Coming soon: Already happening in the affluent nations, and will like spread into World 2 closer to the present than to 2025.

66. There will be a worldwide popular culture. The elements of that culture will flow in all directions from country to country. In spite of the trend toward "demassification" in both information and production, the global links of communications and trade will ensure that ideas and products will be available to all whether they like it or not.

On track: We have identified "cultural multipolarity" and "cultural flows" as important trends today, and it is likely they will drive a move toward a global popular culture that is informed by a wide variety of cultural influences.

67. The multinational corporation will be the world's dominant business form.

On track: While one could argue that this is already here, this forecast suggests it will continue to 2025, and the evidence suggests this will continue to be the case.

68. Economic blocs will be a prominent part of the international economy, with many products and commodities moving between these porous blocs. The principal blocs will be Europe, East Asia, and the Americas.

On track: Smaller blocs are proliferating. This forecast suggests a consolidation of smaller blocs into bigger ones, which looks to be on target. Blocs are viewed as transition stages to a more unified global economic system.

69. Universal monitoring of business transactions on a national and international business basis will prevail.

On track: Current technological developments in transparency suggest the capability will be available, and citizen/consumer desires for openness of information are likely to overpower privacy issues.

70. Identification cards will be universal. Smart cards will contain information such as nationality, medical history (perhaps even key data from one's genome), education and employment records, financial accounts, social security, credit status, and even religious and organizational affiliations.

On track: Smart cards have made greater inroads in some places than others, but the trend toward more universal availability of personal information, driven in large part by security concerns, is well under way.

Public Issues and Values

71. Within the United States there will be a national, universal health-care system.

Needs a boost: The Clinton administration's attempt failed, but it is likely to be tried again, albeit in different form and with a different approach. Resistance has proven tough and the stigma against "socialized medicine" has proven effective in catalyzing resistance.

72. In the United States, the likely collapse of the Social Security system will lead to a new form of old-age security such as one based on need-only criteria.

On track: Unfortunately, the evidence suggests the U.S. is heading in this direction, unless a fairly dramatic intervention takes place. The move to individual responsibility for providing for one's retirement seems well under way.

73. Genetic screening and counseling will be universally available and its use encouraged by many incentives and wide options for intervention.

On track: Already happening to a limited extent, with it likely to spread as more becomes known, society gets more comfortable, and knowledge about genetics grows. This is clearly more advanced in World 1 and many World 2 nations, and it can be expected they will help spread the

information to the emerging world.

74. There will be more recreation and leisure time for the middle class in the advanced nations.

On track: This one routinely draws catcalls from audiences who feel that more and more is demanded of them from their organizations. There is a measurement issue here, as the line between work and leisure blurs with knowledge work. Overall, however, most measures suggest a decrease in the average workweek. It suggests people feel busier, as they multitask and continue to fill up their free time with new activities.

75. The absolute cost of energy will rise, affecting the cost of transportation. Planners will reallocate terrain and physical space to make more-efficient use of resources. In other words, cities will be redesigned and rezoned to improve efficiencies of energy in transportation, manufacturing, housing, etc.

On track: The first component about rising energy costs is clearly on track, but there is still plenty of work to do in terms of reallocating space along the lines of efficiency. The rise of green buildings is an indicator pointing in this direction.

76. There will be a rise in secular substitutes for traditional religious beliefs, practices, institutions, and rituals for a substantial portion of the population of the advanced nations and the global middle class. The New Age movement, secular humanism, and virtual communities built on electronics networking are a few harbingers.

On track: The trend in this direction is more advanced in Europe, with the United States lagging. Long-term values trends suggest an increase in spirituality, which includes traditional religion, but will also include a host of new approaches.

77. Socially significant crime — i.e., the crimes that have the widest negative effects in the advanced nations — will be increasingly economic and computer-based. Examples include disruption of business, theft, money laundering, introduction of maliciously false information, and tampering with medical records, air traffic control, or national-security systems.

On track: This is on pace, with identity theft and computer viruses being among the many indicators. The range of socially significant crimes is likely to expand as well.

78. Tax filing, reporting, and collecting will be computer-managed.

On track: Computer-based filing and online banking are increasingly common and are setting the stage for complete automation. The technical capability will arrive sooner, but it will take some time for the public to gain sufficient trust in the technology for its use to become widespread.

79. Quality, service, and reliability will be routine business criteria around the globe.

Already happening.

80. Customized products will dominate large parts of the manufacturing market. Manufacturers will offer customers unlimited variety in their products.

On track: Customization is picking up momentum, but there is still a way to go in terms of unlimited variety. Businesses are experimenting with business models that work with this approach, as traditional models focused on producing large amounts of standardized products at increasingly lower cost. Economies of scale must give way to economies of scope for this forecast to succeed.

81. Economic health will be measured in a new way, including considerations of environment, quality of life, employment, and other activity and work. These new measures will become important factors in governmental planning.

On track: Organizations are increasingly recognizing the importance of these considerations in attracting the talent they need. Similarly, mu-

nicipalities are recognizing these factors in attracting organizations. The progress has been piecemeal and slow, but should still be in place by 2025.

82. GDP and other macroeconomic measures and accounts will include new variables such as environmental quality, accidents and disasters, and hours of true labor.

On track: Some progress here, as evidenced by the rise of socially responsible investing and similar schemes that rate organizations according to their performance across a wider range of factors. The groundwork is in place for wider adoption of these new measures moving forward.

83. Sustainability will be the central concept and organizing principle in environmental management, while ecology will be its central science.

Coming soon: Sustainability is clearly here, but it's less clear that ecology is its central science. There is still more talk than action, and more politics than science, or otherwise this could have been cast as already here.

Additional, but Slightly Less Probable, Developments by 2025

84. Telephone communications within the United States and within Europe will be so cheap as to be effectively free.

On track: Several cities are experimenting with free WiFi, but vested interests in charging for services will slow this transition. In the meantime, new business models are likely to emerge that capture value elsewhere, thus making the basic communications effectively free.

85. Telecommunication costs will be integrated into rent or mortgage payments.

On track: Similar to #84 above, we see these costs for telecommunications proceeding along a path similar to electricity.

86. The greening of North Africa will begin, with mega-technologies to promote rain and build soil along the coast.

Needs a boost: While there are discussions along these lines, and there are some cloud seeding efforts in China for example, the relatively poor economic conditions in Africa and accompanying relative apathy among the affluent nations about those conditions suggest that this is not likely to happen without a change of course.

87. Antarctic icebergs will be harvested for watering the west coast of South America, Baja California, the Australian outback, Saudi Arabia, and other arid areas.

On track: Growing concern over water issues and water rights suggests that the search for water will get increasingly desperate and lead nations to pursue water wherever it is available.

88. Going to work will be history for a large percentage of people. By 2020 or 2025, 40% of the workforce will be working outside the traditional office.

On track: This forecast was clearly aimed at the affluent nations focused on knowledge work. It most likely happens closer to 2020 than 2025. While the infrastructure is in place, inertia and transition time to adapt to the new culture of telecommuting will likely keep the threshold from being crossed sooner.

89. The home work/study center will be the centerpiece of the integrated, fully information-rich house and home. Mom and Dad will work there, the kids will reach out to the resources of the world, and the whole family will seek recreation, entertainment, and social contacts there.

On track: This was a tough one to call, as portable computing and communication devices to a large extent make the need for a dedicated room superfluous. Nonetheless, a dedicated space is proving practical, helpful, and even necessary in separating work or study from other household

activities.

90. Inorganic chemistry will rise to parity with organic chemistry in profit and importance in such areas as ceramics and composites.

Needs a boost: Seems as though some of the excitement from inorganic chemistry has worn off at the same time that organic, particularly life sciences, has picked up momentum.

91. Biomimetic materials and products that imitate natural biological materials will be common.

On track: Biodesign has emerged as the more popular term. There has probably been more excitement about its potential than actual delivery to this point, but that should change as more is learned and experience with it grows.

92. Micromachines the size of a typed period will be in widespread use. Nanotechnological devices 10,000 times smaller will have been developed and will be in use.

On track: Micromachines are not yet widespread, but they are in use and should continue to emerge. Nanotechnology is also emerging, and the interest and research behind it suggest applications will develop by 2025.

93. Radical cosmetics will leave no component of the body or mind beyond makeover. This will be accompanied by a melding of cosmetics, medicine, and surgery.

On track: The growth of cosmetic surgery continues to surge in the affluent nations and among the well-to-do. It is reasonable to anticipate that as more and more practices become mainstream, the frontier will expand to more regions of the body and with greater impact. The one area giving pause here is "the mind," which is unlikely to be widely impacted, but some experimentation is quite plausible.

94. Ocean ranching and farming for food and energy will be widespread.

On track: Though not yet achieving much media attention, lots of activity is going on here. Given continued pressure on food and energy resources, it is reasonable to expect much greater attention will be paid to the ocean and its potential in these areas.

95. The asteroid watch will become a recognized institution. Among its most notable achievements will be several trial runs at altering an asteroid's path before it intersects Earth's orbit.

On track: This forecast is poised to emerge from the fringes today into mainstream, as growing knowledge about the possibilities will lead to calls for developing a defensive capability.

96. Moon mining and asteroid harvesting will be in their early stages.

Needs a boost: Not enough interest or activity is going on here yet to suggest that this is going to take off within the forecast timeframe without some kind of discovery or breakthrough to ignite it.

97. Artificial intelligence devices will flower as aids to professionals, as adjuncts to ordinary workers, as doers of routine tasks, as checks on the functionality of software and complex systems, and as teaching and training tools.

On track: Slow, steady progress in this area suggests that person–machine partnerships will be routine in the world of work.

98. Privatization of many highways, particularly beltways and parts of the interstate system, will occur. This will be tied to the evolution of an intelligent vehicle–highway system.

On track: Privatization is well under way, though clearly having a big impact in some regions and very little in others. The lack of interest in government spending on infrastructure suggests privatization will continue, though recession stimulus spending could slow it temporarily. It is a bit of a reach to tie the development to intelligent-vehicle highway systems, but private roads

could possess the funds to enable experimentation with state-of-the-art tools and techniques.

99. Restoration of aquifers will be a standard technology.

Needs a boost: Not enough activity to suggest this will be standard. Pressure on water supplies suggests there will eventually be interest and capability development, but it looks like other solutions will be pursued first.

100. Fuel cells will be a predominant form of electromechanical energy generation.

On track: One could group this with several technologies that seem perpetually on the verge of breaking through. Nonetheless, pressure to develop alternative, clean energy and continued slow, steady progress suggest the promise will be increasingly realized over the next decade and beyond.

101. Mastodons will walk the earth again and at least 20 other extinct species will be revived.

Needs a boost: Species revival remains an intriguing possibility, but it appears that it's a lot more complicated than suggested by *Jurassic Park*.

102. Biocomputers will be in the early stage of development and applications.

On track: There are already small-scale experiments and working prototypes, but their capabilities pale in comparison to conventional computers. Advances in biotech and nanotech, combined with the search for new and creative ways to keep Moore's law continuing, suggest interest and developments will continue in this area.

103. Squaring-off of the death curve will make substantial progress in World 1 and some progress in World 2, leading to most people living to 85 years.

On track: The unspoken "forecast" here was that there would not be a dramatic expansion in

life expectancy by 2025, but incremental. Forecast #104 speculates on radical extension.

104. Critical experiments in life extension to move the average lifetime of our species from 85 to 105 will begin. One hundred thousand people will be in a lifelong monitoring program. Massive numbers of other people will apply the treatments on a nonexperimental basis.

Needs a boost: It is plausible to envision such experiments, but the scale suggested here doesn't seem to follow from present trends. A breakthrough, however, could trigger interest and activity.

105. Cars capable of 120 miles per gallon will be in widespread use.

On track: Tough call. One could perhaps argue that combustion engines will not be in widespread use, but it doesn't appear that all-electric or fuel cell vehicles are poised to displace them completely. Hybrids achieving this efficiency are plausible.

106. Hypersonic air carriers will be common.

Needs a boost: While technically available, the economics have not been compelling enough to overcome social/environment resistance.

107. Brain prostheses will be one of the practical applications of brain technology.

On track: Perhaps a bit of a reach, but there has been an explosion of interest, research, and growing knowledge of how the brain works. It is plausible to expect more and more applications to emerge.

Checking the Evaluation

Recognizing the subjective nature of the scale and evaluation, and the potential bias of evaluating one's own work, the author asked colleagues at the Association of Professional Futurists (www.profuturists.org) to do the evaluation as well. More than a dozen respondents scored each of

the 107 forecasts. Their average scores for each of the nine categories are shown next to the author's in Table 1.

Not surprisingly, the author is more optimistic about how the forecasts are faring than his colleagues, and would like to believe that given the time to explain his position to everyone, they would adjust their scores upward appropriately. It is left to the readers to make up their own minds on that question as they reflect on the analysis of the author's forecasts above. Even with the tougher scoring of the APF colleagues, the averages are all above "ok or good" with the exception of the "slightly less probable developments," which by definition are suggested to be less likely to be accurate forecasts for 2025.

In looking across the scores in the eight categories of forecasts, a few patterns emerge. As expected, demography ("population trends") came out with the highest average scores according to my APF colleagues. The slow rate of demographic change, barring disaster, and its quantitative nature make it routinely the most accurate area to forecast. The author was a bit tougher in this area, relatively speaking, finding the forecasts to have

been somewhat pessimistic in light of the success of population control.

Our biggest differences were in "Managing Our World" and "Worldwide Tensions." The author ranked these as his two most accurate categories, while the APF colleagues ranked them below their average accuracy score. In reflecting on some of the comments attending the rankings, the author's sense is that his colleagues are perhaps too caught up in current events — granted they could make the opposite charge that I am ignoring present reality in hopes of a happier future. My response would be that forecasts rarely progress in a linear fashion. Progress toward them often accelerates, stabilizes, and even occasionally reverses along the way. The author, upon further reflection, is willing to stand by the accuracy of the forecasts despite some current slowdowns and reversals.

Both of us ranked the accuracy of the forecasts in "Managing Environment and Resources" relatively low compared to the other categories. In particular, several forecasts around the role of genetics appear to have been overly optimistic. It has turned out that the knowledge-to-application tran-

Table 1

Category	APF	Author	Difference
1. Managing Our World	3.04	4.50	1.46
2. Managing Human Health	3.64	4.43	0.79
3. Managing Environment and Resources	3.12	3.84	0.72
4. Automation and Infotech	3.68	3.56	0.12
5. Population Trends	3.93	4.13	0.20
6. Worldwide Tensions	3.28	4.45	1.17
7. The Electronic Global Village	3.62	4.00	0.38
8. Public Issues and Values	3.58	4.31	0.73
9. Additional, but Slightly Less Probable, Developments by 2025	2.89	3.13	0.24
Average score	3.42	4.05	0.63

sition is far more complicated than originally envisioned. Interestingly, where the author saw genetics happening faster than has been the case, the opposite miscalculation has often occurred with information technology; that is, events in that category have often unfolded faster than forecast.

Only in one case were my colleagues more optimistic about the accuracy — automation and infotech. The author will admit to some tough scoring in this area toward seeing the forecasts as coming to fruition before 2025, including a perhaps overoptimistic assessment that global broadband networks of networks will happen closer to the present than 2025.

Analysis and Lessons Learned

It would be more accurate to wait another 15 years for 2025 to arrive and do a more accurate assessment — hopefully the author will be around to do this. In the interim, here's how the forecasts are faring according to the author's grading:

Table 2

Evaluation	# out of 107	Percent
On track	71	66%
Needs a boost	24	22%
Coming soon	8	8%
Already happening	4	4%

While there is a scarcity of this type of evaluation available, a similar exercise was conducted a decade ago by former World Future Society President and long-time *Futurist* editor Edward Cornish.[2] He examined 34 forecasts that first appeared in a 1967 issue of *The Futurist* and assessed how they had fared 30 years later. Using simple right or wrong evaluations, he scored 23 hits and 11 misses, an accuracy of 68%. This is amazingly close the author's 66% above — two data points

don't make a case, but they do suggest that the common perception of forecasting being mostly wrong or inaccurate — is inaccurate!

So let us turn to what we've learned from this exercise.

1. Futurists' forecasts are more accurate than commonly assumed. A common perception is that futurists are mostly wrong and focused on silly distant future possibilities such as the infamous flying cars. Typically, a reporter looking for a story will find a collection of forecasts that turned out wrong — the paperless office is another familiar target — and then poke fun at forecasting and futurists. This may be more entertaining to read than a balanced assessment of how forecasts have actually fared, so it is in a sense understandable that such stories have proliferated. As they have accumulated over the years, they have created a perception that most forecasts miss the mark. As a result, clients or potential clients new to futurists and forecasting are often predisposed to question the value of even trying to look very far beyond the present. This essay provides one piece of evidence that futurists do an accurate job in forecasting.

2. Language is critical. Among the key lessons for forecasters, and consumers of forecasts, is the importance of language, and in particular the "qualifiers." A difficulty in evaluating the accuracy of the forecasts here was in trying to discern what was meant by some of the terms. For instance, many forecasts used qualifiers such as widespread, commonplace, routine, etc. While the use of these terms gives the forecasts a little "wiggle room," they also leave themselves open to a wide range of interpretations, evidenced to some degree by the disparity between the author's rankings and those of his colleagues. While we might hope for more standardized terminology in the long run, today's forecasters would do a great service to their audience by clearly defining their terms. Put simply, explain what terms such as "widespread" really mean.

3. *Don't become obsessed with precision.* A partial caveat to lesson #2 above is to be wary of trying to be more precise than is warranted. If one is truly speculating in a long-term forecast, recognize that the use of numbers helps provide a ballpark figure that can aid understanding, but that is all — an estimate — and be wary of those numbers taking on a life of their own. Remember the "500 channels of cable" truism that was simply tossed out there to provide a sense of the scale, but became a mantra.

4. *In the end, it's still subjective.* The evaluation of accuracy depends largely on the mental model or view of the world of those who make the evaluation. We bring our own views and biases to the task. For instance, part of the author's mental model is that growing social awareness of energy, environment, and resource issues would eventually catalyze action on the "solutions" front and speed up developments that might otherwise fall outside the 2025 timeframe. Others who do not share this view might easily reach a different conclusion about how well the forecasts were faring. There is no totally objective evaluation superstore that one can take evaluations to — though perhaps some evaluators are more objective than others. There can always be reasonable differences of opinion concerning the evaluations made. Yet, it is hoped that the essence of the author's representations, backed by the evaluations of colleagues, support the basic arguments that these forecasts, as well as forecasts made by professional futurists in general, are more accurate than they have often been portrayed as being by the media, or perceived to be in the general opinion of clients.

5. *Utility still trumps accuracy.* While we've focused on accuracy in this paper, it is important to reemphasize that "a good forecast is not necessarily a correct one. Rather, a good forecast is one that stimulates your thinking and leads to subsequent action.… A correct forecast may not necessarily be useful. It might just get filed away, spurring no action."[3]

Notes

1. Joseph F. Coates, John Mahaffie, and Andy Hines, *2025: Global Scenarios of US and Global Society as Reshaped by Science and Technology,* Oak Hill Press, 1996.
2. Edward Cornish, "Forecasts Thirty Years Later," *The Futurist,* January 1, 1997.
3. Andy Hines, "A Checklist for Evaluating Forecasts," *The Futurist,* November-December 1995.