The APL Workforce of Today and Tomorrow

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ABSTRACT

When the Johns Hopkins University Applied Physics Laboratory (APL) reaches its 100th anniversary in 2042, its workforce can be expected to comprise a broad set of technical capabilities and staff attributes, some new and others enduring and recognizable from the Lab's history. This article reviews APL's workforce of 2020, discusses how that workforce and the work being performed are changing, and looks ahead at the workforce of APL at its centennial.

INTRODUCTION

APL was founded in 1942 with a small group of engineers and scientists tasked with a singular goal: to perfect and field the radio proximity fuze during World War II. Their success with the fuze resulted in APL's charter being extended beyond wartime support, and over the next few years, the staff and facilities grew to support the expanded scope of work. This trend—of growth in work and the staff to support it—has persisted throughout APL's history.

By the mid-1980s, APL's work had expanded to focus on seven major areas—Fleet Systems, Aeronautics, Strategic Systems, Submarine Technology, Space, Research, and Naval Warfare Analysis. Today APL is the nation's largest university-affiliated research center, with a staff of over 7,200 doing important work in 12 mission areas.

When APL celebrates its 100th anniversary, its workforce can be expected to have a diverse set of technical capabilities and staff attributes. Some of these capabilities and characteristics will be new, while others will largely resemble those of the Lab's past. This article describes the workforce at APL in 2020, discusses how that workforce and the work being performed are changing, and looks ahead at APL's future workforce.

APL'S CURRENT AND FUTURE WORKFORCE

Science fiction writer William Gibson said, "The future is already here—it's just not very evenly distributed."[1] That can be said of the APL workforce and workplace of the future. Several dimensions of the APL workforce of today might provide early indications of the Lab's workforce when it reaches its 100th anniversary in 2042. Those dimensions are described below.

Size

As of January 2020, APL employed 7,251 regular full- and part-time staff plus several hundred temporary staff (mostly interns and retirees who have returned in an on-call capacity). Of these, 5,722 (79%) are technical professional staff. Since the end of fiscal year (FY) 2015, the staff has increased by 1,665—a 30% increase. This increase was not driven by APL's desire to grow but by the steadily increasing demand for APL's services from across its sponsor base.

Our current best management forecast is that APL will grow at 3.5% annually over the next 10 years—a lower rate than in recent years. At that rate of growth, the number of APL staff would surpass 10,000 in the
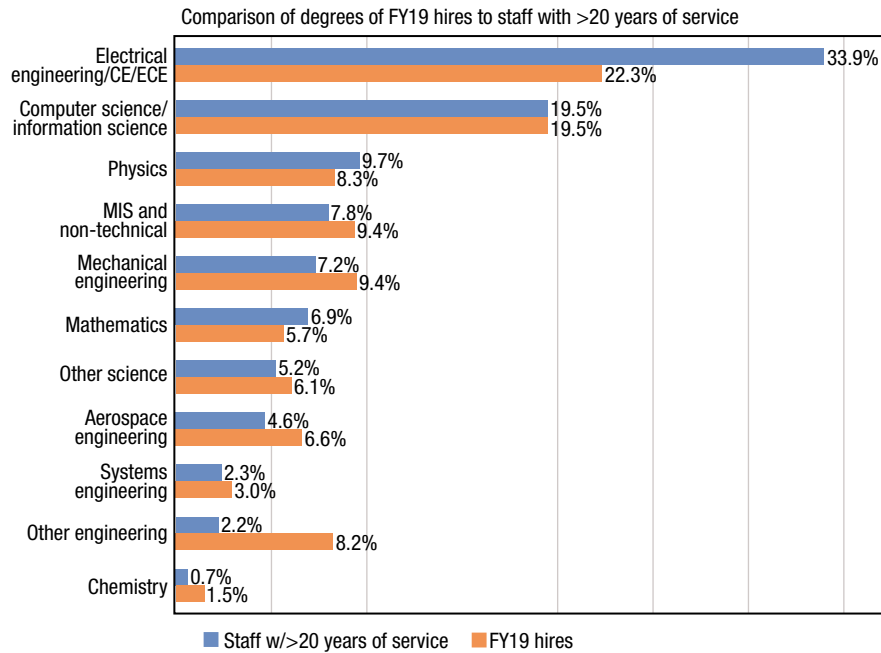
Comparison of degrees of FY19 hires to staff with >20 years of service

Figure 1. Academic disciplines of APL staff members. The figure compares the fields of study of degreed technical staff hired in FY2019 with those who have been at the Laboratory for more than 20 years.

year 2030. The Lab will continue to need to evolve its practices to suit an organization of that size or greater.

Technical Backgrounds

Among the degreed technical professional staff, electrical engineering and computer science are the most common fields in which degrees are held, while 1 in 5 technical staff has a management information systems, business, or liberal arts degree. The academic backgrounds of those the Lab is currently hiring are not very different from the backgrounds of those who were hired many years ago. Figure 1 compares the academic disciplines of degreed technical staff hired in FY2019 with those who have been at the Laboratory for more than 20 years. Although the percentage of newly hired electrical engineers is lower, electrical engineering/computer engineering remains the most common academic background of APL new hires.

There is no indication that the kinds of technical backgrounds needed in the Laboratory's workforce will change markedly. However, as Dr. Jerry Krill, APL's assistant direc-

tor for science and technology notes, "many titles might be the same—electrical engineer or software engineer—but the work performed in those fields will be different, just like what an electrical engineer does now is different than what an electrical engineer did in 1950."

Diversity

APL's staff has been becoming more diverse in all dimensions, the result of years of efforts to reach a diverse candidate pool and to build an inclusive work environment (see https://www.jhuapl.edu/Careers/DiversityandInclusion). This is most evident in the increase in staff diversity in terms of ethnicity and gender. Figure 2 shows trends for the past 5 years. "The further we go along, the more we look like the population we are hiring from," says Lisa Blodgett, head of APL's Force Projection Sector. If predicted national trends (see the section on increasing workforce diversity) are reflected in the science and technology workforce from which APL makes most of its hires, APL's workforce is likely to continue to become more diverse.

Actively Fostering Collaboration and Innovation

APL's recent investment in programs and facilities intended to foster collaboration and innovation, both internally and externally, are indicative of how
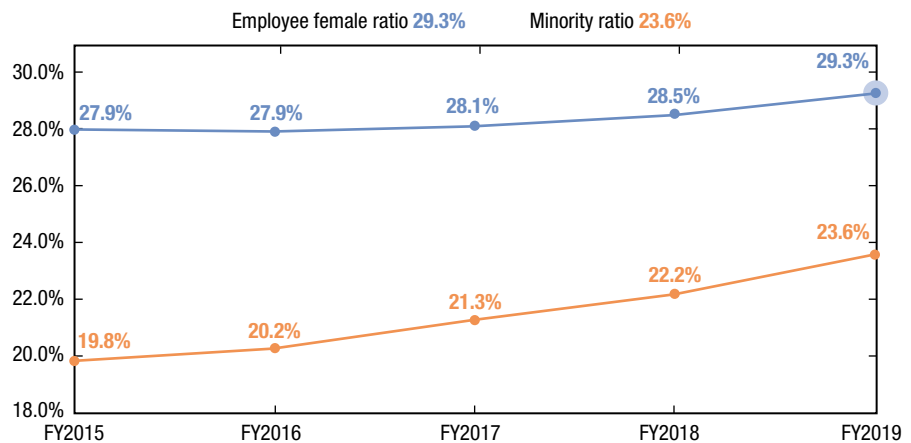

Figure 2. Diversity at APL. This figure shows the growing percentages of APL staff who are women and minorities, graphing data for the past 5 (fiscal) years.

the Lab will do its work in 25 years. As Krill explains, "the volatility of technology and the need for speed in responding to pop-up technologies—whether perceived as opportunities or threats— demand collaboration and innovation. There too many new technologies for any one organization to maintain in-house expertise on all of them. It is challenging to even become aware of all of them in a timely fashion, let alone be able to assess whether they have significant or disruptive potential for the nation. Part of APL's mission is to be out in front on technologies for its sponsors. The Lab's challenge is finding ways to better connect to the broader global ecosystem in technical areas that are not yet part of its sponsored work, but could well be in the future." In response, APL is experimenting with ways to foster external awareness, establish long-term strategy to identify priority research and beneficial collaborations, and connect with major technology organizations that have their own innovation ecosystem networks.

How APL staff members work is being changed by a set of innovation- and collaboration-focused initiatives. These initiatives are aimed at doing two things:

- **Empowering staff:** A few years ago APL leadership concluded that the way new ideas were reviewed and evaluated too often had the unintended consequence of discouraging innovation. "We want to get to a culture of 'yes,'" says Krill. "We want every staff member to feel empowered to innovate." Project Catalyst, which offers APL staff members funding opportunities for bold, high-risk, transformational ideas, is a central element of APL's strategy to stimulate and support innovation.

- **Increasing our connectivity with the broader innovation ecosystem:** For the reasons Krill notes above, as APL develops guide-star concepts for 20–30 years out, it seeks to expand its interactions beyond those it has had in the past with traditional sponsors, peer organizations, professional societies, and university communities. The Janney program was established to support this thrust. By providing funding for staff members to attend conferences in emerging technical areas, host technical conferences at APL, and take on new thought leadership roles, the program encourages staff members to nurture a culture of discovery, embrace risk, and be at the center of a vibrant innovation ecosystem. Through this approach, Lab leadership is beginning to see staff motivated and empowered to propose fresh ideas resulting in innovative proposals for traditional independent research and development funds.

These initiatives are described in more detail in the article by Kedia and Krill in this issue.

Dr. Jim Schatz, head of APL's Research and Exploratory Development Department (REDD), points to REDD's core strategy of achieving breakthroughs by acquiring staff with deep technical backgrounds, as opposed to those with more generalist backgrounds, and bringing them together in collaboration with other deep experts. He believes that this model will endure.

Collaboration is also a central consideration in the design of new facilities. The Intelligent Systems Center (https://www.jhuapl.edu/ISC/), a state-of-the-art research facility for cross-disciplinary research in machine learning, robotics, autonomous systems, and applied neuroscience, is one example. In addition to its labs for hardware and software development, modular test platforms, and unmanned vehicle test areas, it is equipped with open seating and innovation space for cross-disciplinary activities. The APL Executive Council has established three guiding principles for facility development: agility, connectivity, and identity. These principles, proposed by APL's campus master planner Brian Cornell, all directly or indirectly facilitate collaboration. See the article by Cornell in this issue for more on the current and future APL campus.

In general, information sharing through digital means is becoming more immediate, informal, and open. In these digital environments, collaborations can become more superficial and transactional and less intimate and empathetic. However, some technology is making digital collaboration *more* intimate—as with Skype and Zoom interactions compared to conference calls. This kind of technology was put to a novel use within the Laboratory in 2019, when for the first time, APL teleworkers had a virtual holiday party that included activities such as drawing on a common board and sharing screenshots of staff dressed for the occasion. More recently, the sudden increase in remote work caused by the COVID-19 pandemic has broadened and deepened APL's experience with the tools, potential, and challenges of digital collaboration.

Augmented reality technologies being incorporated into collaboration tools may well prove able to create the equivalent of face-to-face interactions when users interact with others across the country or a mile away on the same campus—beyond the Zoom of today. These technology advancements could help preserve APL culture as the organization continues to grow in size and spread out in physical footprint.

EXTERNAL TRENDS THAT MAY IMPACT THE FUTURE APL WORKFORCE

Continued technological innovation and macroeconomic trends promise to reshape APL's workforce. In addition to shifting employee demographics, these developments, or megatrends, will influence job responsibilities and the way employees approach their work. In this section, we examine several such trends being forecast and the challenges they may pose to APL by the end of its first century.

ONE THING THAT PROBABLY *WILL NOT* CHANGE

Most of APL's staff members work on classified programs—as of January 2020, over 85% of staff members held a clearance, a majority of which were at the Top Secret level or for highly classified program access. This limits both who APL can hire (only US citizens meeting clearance requirements) and where work can be done (generally on-site or in other classified facilities).

Dick Weaver, APL's previous chief security officer, said the following about the prospect for change that could impact who the Lab could hire in the future or how and where its work is performed: "The basic requirements to hold a clearance, including US citizenship, are unlikely to change." Regarding facility requirements—and APL's ability to hire people to work remotely—he does not foresee any change that would enable more work to be done remotely outside of secure facilities. If anything, he notes, pending requirements pertaining to Controlled Unclassified Information (CUI) are expanding the scope of information to which access must be tightly controlled, potentially making working remotely more challenging.

APL's workforce at the Lab's centennial is likely to be concentrated at APL and sponsor facilities in much the same manner it is today, except to the extent that the Lab takes on new missions concentrated in unclassified work.

An Aging American Population and Stagnating Workforce Growth

Over the next two decades, workforce growth will decrease as more baby boomers reach retirement age. According to a report from consulting firm Bain & Company, "the population of those age 65 and older will grow faster than the working-age population in OECD countries for the first time in history" during this period.[2] Put more concretely, from now until 2029, we can expect about 10,000 working Americans to reach retirement age each day.

Fortunately, research indicates that actual retirements will occur at a considerably slower rate. Thanks to advances in health care and increasing life spans, many Americans are delaying retirement. In a 2018 survey, the Pew Research Center found that nearly a third (29%) of Americans 65–72 years old were working or looking for work.[3] This rate is significantly higher than it was among members of the greatest generation (born in 1901–1927) and silent generation (born in 1928–1945) when they were the same age. As a result, the number of retirements per day has averaged only about 5,900 in America and will likely remain much lower than 10,000 per day in the coming decade (see Figure 3).
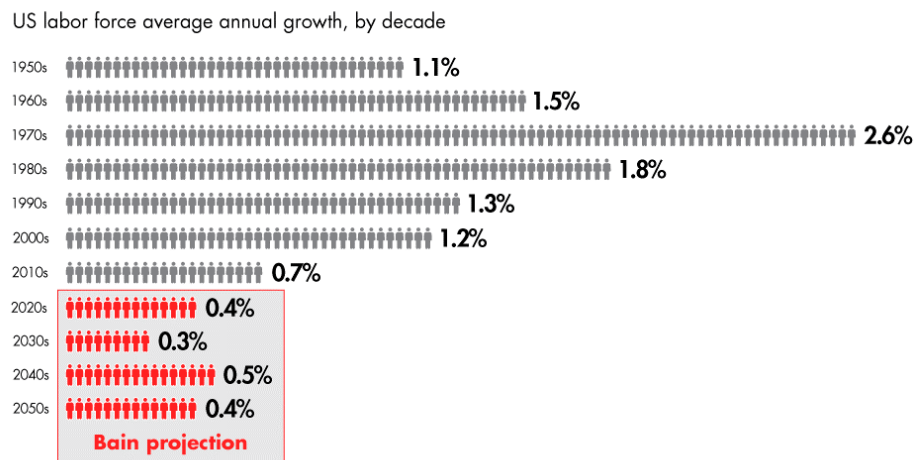
However, these retirements will occur at a time of decreasing population and labor participation rates among younger workers. Facing rising costs of education and homeownership, teens and young adults have increasingly delayed their entry into the workforce.

The Bain report indicates that this trend will persist over the next 20 years. Consequently, workforce growth will decrease with retirements in the near future.

APL and other organizations across the country will be challenged to attract and retain talent during this time. According to Bain, doing so will require placing increased importance on employee engagement. *This will mean offering more flexible and collaborative work, especially to acquire young workers with advanced technical skills, and providing cutting-edge technical challenges that are appealing to top technical talent.* Awareness of this need is already evident in the collaboration and innovation initiatives discussed and in how APL staff members do their day-to-day work. "We are challenging young staff more, putting them in front of sponsors sooner," says Blodgett, adding that "to be a magnet for top talent, we have to be a really, really good place to work."

APL has a strong history of retaining expertise through flexible use of part-time and on-call work at

US labor force growth will remain low for the foreseeable future

US labor force average annual growth, by decade

Decade	Growth
1950s	1.1%
1960s	1.5%
1970s	2.6%
1980s	1.8%
1990s	1.3%
2000s	1.2%
2010s	0.7%
2020s	0.4%
2030s	0.3%
2040s	0.5%
2050s	0.4%

Bain projection

Sources: US Bureau of Labor Statistics; US Census Bureau; Bain Macro Trends Group analysis, 2017

Figure 3. Slowing workforce growth. (Used with permission from Bain & Company.[2])

all life stages but especially among those approaching retirement. This is likely to remain important.

Increasing Workforce Diversity

The US workforce is getting more diverse and will continue to do so as APL approaches its 100th anniversary. An article in the Bureau of Labor Statistics journal, *Monthly Labor Review*, suggests that from now until 2024, the number of women and minorities in the labor force will continue to grow faster than the number of men and nonminorities.[4] Additionally, as younger workers, a demographic generally concerned with social responsibility, enter the workforce, many companies are beginning to hire more people from other minority groups, such as those with disabilities.[5] Nish Parikh, writing for *Forbes*, notes that this diversity trend is also likely to continue well into the future, as millennials and members of Generation Z represent an increasing share of the workforce.

The trend of increasing diversity is also likely to continue to be driven by the developing business case for diversity. Research by the Boston Consulting Group shows that innovation revenues at companies with diverse leadership are 19% higher than those with below-average diversity in leadership.[6] The organization asserts that this research shows a statistically significant correlation between innovation and the diversity of management.

Finally, new technology, including artificial intelligence (AI), is helping to increase workforce diversity by eliminating bias in hiring decisions. A recent article in the *Harvard Business Review* states that fair, well-designed AI will help recruiters assess a broader pool of better, more diverse job candidates.[7] Even less-sophisticated technology currently in use at APL has helped to improve workforce diversity in the same way. Augmented writing and talent recruiting platforms have helped the Lab share work opportunities in an unbiased manner and reach more diverse groups of potential candidates.

AI and Increasing Automation

Often, the concept of automation, or machines completing the work of humans, is associated with low-wage jobs and routine tasks, such as those prevalent in manufacturing. Indeed, a study by consulting firm McKinsey determined that 78% of "predictable physical work" could soon be automated.[8] However, even high-paying, "knowledge work" positions in sectors from health care to financial services have potential to be partially automated with the rise of AI technologies. Repetitive tasks within these roles, such as processing data and even exchanging emails, could be completed by AI assistants. In its Global Human Capital Trends survey, Deloitte found that 84% of respondents believed that they needed to "rethink their workforce experience" in response to such innovation.[9]

Fortunately, the automation of more complex job responsibilities is unlikely to eliminate the need for knowledge workers. Rather, their roles will be redesigned, forming what Deloitte calls "superjobs." These new jobs will incorporate a variety of high-level, creative tasks once delegated to multiple personnel.[9] Deloitte argues that by consolidating a broader range of such tasks into fewer roles, superjobs will position organizations to better leverage new technologies and experience higher productivity.

As job responsibilities shift, so will the skill sets sought by employers. Obviously, organizations will search for more advanced technical and analytical capabilities that will enable workers to efficiently manage and use AI technologies. In addition to seeking job candidates with these skills, employers are also likely to invest in and encourage "digital upskilling" of current employees. In other words, organizations like APL will want to ensure that their workforces are equipped with the technical skills necessary to adapt to evolving job responsibilities. According to a study by the World Economic Forum, demand for these technical skills will increase 60% between 2016 and 2030.[10]

At APL, AI and machine learning skills will become pervasive—not concentrated in AI experts as they are today—says Jim Schatz. "We need PhDs in physics who can write AI algorithms when they need them." Jerry Krill adds, "There are predictions that in 25 years everyone will be enabled by an AI device or application, or even a robot." Already we see examples like APL software developers using bots to do work such as informing project staff when certain computing tasks are done.

Additionally, the World Economic Forum's research suggests that strong social, emotional, and critical thinking/analytical skills, or high cognitive skills, will also become increasingly important as technology is introduced to the workforce. As explained by Ellyn Shook, chief leadership and human resources officer for consulting firm Accenture, this is because "the truly human skills, from leadership to creativity, will remain highly relevant and winning organizations will strike the right balance—leveraging the best of technology to elevate, not eliminate their people."[11] Although AI will be helpful in increasing overall productivity, the human, decision-making aspects of the work will demand that employees possess these skills. How might high demand for both technical and cognitive skills manifest itself in APL's workforce? Given the emphasis on collaboration, these skills are likely to remain important at APL.

Climate Change

While APL leaders expect that staff members will continue to work on programs supporting the Laboratory's traditional mission areas in defense and space, several point to climate change as the most likely driver

of new areas of work. This could take many forms, says Schatz, citing warming-related biothreats and capture of energy from natural phenomena as examples.

Such work could cause some change to the skills needed in the APL workforce, though it would likely draw primarily on the staff's current and evolving areas of technical depth. To the extent such work is unclassified, opportunity to compete for talent beyond those able to work at APL or sponsor facilities, and outside the clearable US citizen workforce, could be possible.

THE FUTURE OF WORK AT APL IMAGINED

You step outside your home to head to APL for the day when the driverless car you summoned pings you that it has arrived. After all these years you still derive comfort from seeing the APL Assured Autonomy sticker on the windshield. Before the vehicle picks up a colleague who lives a few minutes away, you attach your earpiece and settle in to start your day.

Your bot greets you with a brief review of your schedule for the day. It suggests a work location for the day and, upon your agreement, reserves the spot and initiates the adjustment of your chair, lighting, and personal effects.

The car picks up your colleague and, after you chat for a few minutes, you return to your bot. The bot provides a suggested to-do list including:

- *Review a press report from India describing a new technology start-up working in an area of quantum physics that looks like it is of potential interest to you.*

- *Read a patent application filed the previous day.*

- *Consider joining a meetup proposed by the bots for several members of your project team. While the topic appears to be of only peripheral interest to your current work, you do see some benefit to joining if you can.*

- *Log into your personal benefits portal. You have a message identifying a new preventive therapy announced by the Mayo Clinic yesterday that may be of interest to you based on your medical history. You just opted in to that system and are pleased that it is already paying dividends.*

- *Schedule the online learning session and follow-up project you concluded you needed to invest in after you found out about something from a newly hired PhD that made you marvel at how much things had changed since you completed your PhD 10 years ago.*

The car drops you and your colleague off at your respective buildings. As you approach the front door, a retinal scan clears you for entry. The door swings open to a day of challenging problem-solving through a stimulating mix of focused personal work and collaboration with a highly capable set of colleagues and intelligent systems.

CONCLUSION

Throughout APL's history, its workforce has grown in response to changes in its scope of work, advances in technology, and the need to support new and expanding missions. We anticipate similar changes in the future, some the result of external factors such as demographics of the future workforce. Still, we expect many things about APL's staff to remain the same. As director Dr. Ralph Semmel notes in a book celebrating APL's 75th anniversary, "Although we are a much more complex and diverse organization today, we continue to nurture the spirit of innovation and culture of experimentation that characterized the Lab's early years. We also continue to create systems engineering solutions that repeatedly deliver new capabilities to the nation's warfighters. Perhaps most important, we remain guided by our founders' deep commitment to trusted service to our sponsors and the nation."[12]

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