Evolution of the APL Campus in Howard County—From Farm to Small City

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ABSTRACT

Driven by sponsor needs, the Johns Hopkins University Applied Physics Laboratory (APL) has responsibly managed employee and campus growth since its beginnings. Having outgrown its original facilities in Silver Spring, Maryland, APL began development of a new campus in rural Howard County in 1952. That farmland is now the equivalent of a small city, with over 6000 people working in 83 buildings comprising more than 2.9 million gross square feet. Enabling the Lab to support timely and critical missions is a system of preventive maintenance, planned replacement, and operational redundancy for APL's numerous specialized computational, fabrication, integration, and test facilities. Evolving facility, employee, and regulatory requirements have been met through innovative, agile, and fiscally responsible means, especially through the reuse and adaptation of older buildings but also through strategic replacement of older or smaller buildings with new or more-capable structures. Effective teamwork across multiple disciplines, organizations, and management groups has been essential to the evolution and operational success of the campus.

GROWTH

Founded in 1942 to aid a country at war, the Johns Hopkins University Applied Physics Laboratory (APL) continues to provide solutions to national security and scientific challenges with systems engineering and integration, research and development, and analysis. APL began in a former automotive dealership in Silver Spring, Maryland, which its staff soon outgrew. In 1952, the Laboratory purchased 290 acres of farmland that was "way out" in rural Howard County, Maryland, for "the new Laboratory." The first building (Building 1's east and south wings), with 63,000 gross square feet (GSF), opened on the Howard County campus in 1954.

By 1962, APL's Howard County campus (Fig. 1) reached its initial configuration, and the northern portion of the campus was no longer contract farmed. The campus was composed of mixed-use office/laboratory, fabrication, integration, small support/trades, and special-purpose test and evaluation buildings. This fully functional and self-contained campus, complete with a post office, barbershop, and credit union, enabled APL to partially vacate the original Silver Spring facility and to fully vacate the Forest Grove facility, which was receiving numerous noise complaints from its neighbors. The campus had approximately 500,000 GSF

Figure 1. December 1962 photo of the APL Howard County campus looking north showing the initial build-out of the fully functional new Laboratory.

for nearly 1,400 employees. By 1975, operations at the Silver Spring sites had fully migrated to the Howard County campus.[1]

The campus continued to grow as needed to meet the nation's needs. As shown in Fig. 2, the campus grew during the Vietnam War, President Ronald Reagan's buildup against the Soviets, and the Afghanistan and Iraq wars, and it continues to grow with the ongoing fight against terrorism. In contrast, employee and campus growth were noticeably absent immediately after the Vietnam War and during the Cold War "peace dividend" period (after the collapse of the Soviet Union).

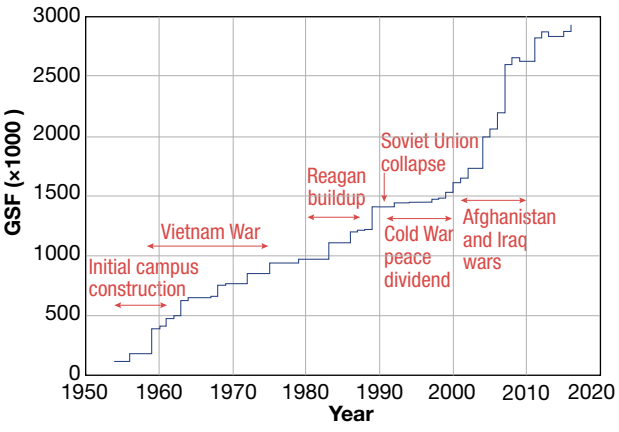

Figure 2. GSF of the APL Howard County campus buildings overlaid with key world events. There was notable employee and campus growth during the Vietnam War, President Reagan's buildup against the Soviets, and the Afghanistan and Iraq wars, and growth continues with the ongoing fight against terrorism. In contrast, employee and campus growth were noticeably absent immediately after the Vietnam War and during the Cold War peace dividend period (after the collapse of the Soviet Union).

By 2016, APL's Howard County campus had grown far beyond the founders' expectations to include almost 460 acres with more than 2.9 million GSF of buildings and structures. (See Box 1 for additional 2017 campus details.) The campus now incorporates a total of four sub-campuses: the original Main Campus (Fig. 3), a South Campus, portions of the Montpelier Office Park, and portions of the Rivers Park industrial park. As the campus has grown, more than 40 significant outdated buildings and structures have been demolished to make way for newer, more technologically advanced buildings—APL's version of urban renewal.

The 89-acre South Campus was acquired through the purchase of the Meade-Westvaco research facility (in 2006) and the adjacent Price Farm (in 2016). Located directly across Johns Hopkins Road from the Main Campus, the South Campus is being developed to provide a more open and collaborative environment. This campus is currently home to one large building, and a second large building is under construction. The farm portion of the property is currently planned to remain undeveloped until 2021.

Figure 3. June 2015 photo of the APL Howard County Main Campus looking north for comparison with the similar December 1962 photo in Fig. 1.

In 2001, APL initiated leases for six buildings in the Montpelier Office Park through 2006. Located immediately east of Main Campus but separated by a forested wetland and stream, the Montpelier Campus was intended to provide close but severable expansion space. Four of the buildings became available in 2016 and were strategically purchased in early 2017. These buildings have recently undergone or are currently undergoing extensive internal customizations to meet evolving occupant-specific mission needs.

Also in 2016, APL initiated a lease for a building in the Rivers Park industrial park. Located approximately 5 miles away in Columbia, Maryland, the Rivers Park building provides space for special or short-term projects for which space is currently unavailable on Main Campus.

With its substantial size and infrastructure, the Howard County campus functions like a small city, with its own distribution systems for potable (drinkable) water, sanitary sewer, storm water, electricity, communications, and natural gas. APL also maintains its own internal security force, fire department, emergency medical services, road system, standby power generation, and heating/cooling utility plants.

For the first 45 years of APL's existence, campus planning was relatively simple and short term: as a new need arose, the new building or structure was located where it was least disruptive. However, by 1999, it became apparent that the available land was a finite resource and longer-term, strategic campus planning was needed. APL established a Long Range Site Development Planning Team in 2001, created its first campus master plan in 2003, and has purposefully updated the master plan approximately every 3–5 years. The campus master plan looks forward 25 years to actively engineer future building placement, utility placement/relocation, pedestrian traffic, vehicular traffic, and parking. To meet ongoing and emerging sponsor needs, the campus is expected to continue its growth in both population and density. The resulting additional buildings, replacement buildings, and infrastructure will be sited according to the master plan.

Overall, APL's Howard County campus has indeed grown into a small city, complete with the challenges of dealing with growth, maintaining continual operations, balancing budgetary constraints, and a mix of old and new buildings and systems.

SPECIALIZED FACILITIES

APL's specialized facilities have been essential to its ability to make critical contributions to critical problems. From the Lab's very beginning, its research and development projects have depended on specialized computational, fabrication, integration, and test facilities.

The Propulsion Research Laboratory (PRL) complex constructed in 1960–1961 is a good example of a large-scale cluster of buildings (Fig. 4) constructed for a spe-

Figure 4. PRL complex of multiple buildings and innovative facilities to support hypersonic testing.

cific purpose: to test jet engines and missile structures under precisely controlled hypersonic conditions. The PRL complex enabled APL staff to use multiple technologies in innovative ways,[2] yet evolving simulation technology and changing sponsor needs resulted in the facility's obsolescence, so it was demolished and its land was repurposed.

A good example of specialized test and integration facilities within one building is the Richard B. Kershner Space Integration and Test Building constructed in 1982.[3] Designed to provide space for the assembly, integration, and testing of spacecraft, the building included extensive low-particle-count cleanrooms for assembly, large vibration test stands that simulated launch stresses,

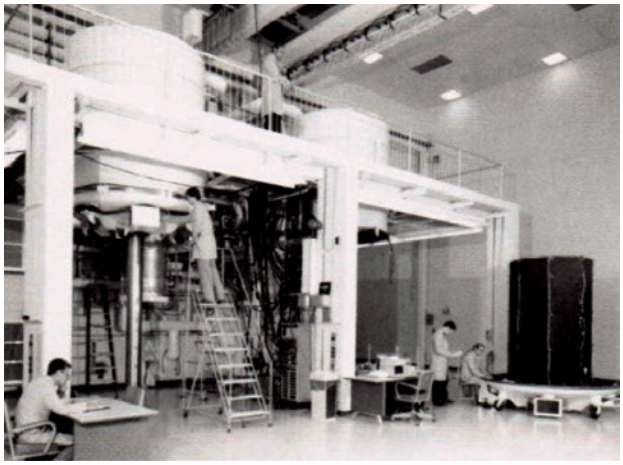

Figure 5. Kershner Space Integration and Test Facility. Two vertical Mt. Vernon thermal vacuum chambers are used to simulate the space environment. Space hardware is mounted on a "door" (unit on rollers, far right). Instrumentation wiring is added, and the assembly is lifted hydraulically into the chamber for testing under programmed computer control. (Image and caption from Ref. 3.)

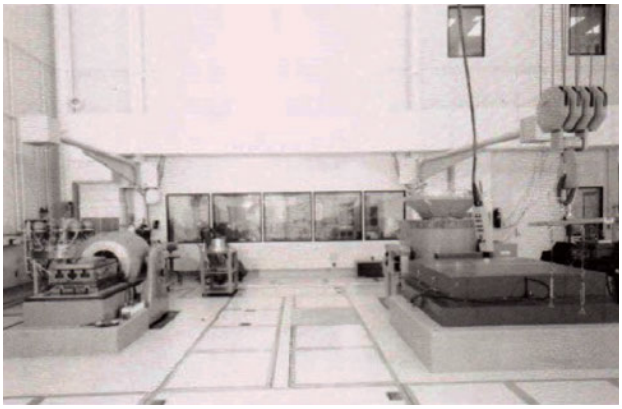

Figure 6. Kershner Space Integration and Test Facility. The Vibration Test Laboratory contains two shakers mounted on reaction masses to isolate vibrations from other parts of the building. The shakers are rated at force capacities of 18,000 pounds (left unit) and 40,000 pounds (right unit). They are used to subject the space hardware to simulated launch conditions. (Image and caption from Ref. 3.)

and large thermal vacuum chambers that simulated operation in deep space (Figs. 5 and 6).

The Steven Muller Center for Advanced Technology (Building 13), which opened in 1989, was APL's initial step in replacing the 1950s-era Butler buildings with new, flexible, state-of-the-art buildings that could efficiently support evolving needs for specialized facilities. Its glass exterior (see Fig. 7) and six-story height were notable changes from the Lab's typical low-rise brick or concrete buildings. At over 185,000 GSF, it was more than twice the size of all but one existing building on campus. Its support infrastructure, which largely came from the new adjacent Central Mechanical Plant, pro-

Figure 7. The glass and metal exterior of the Steven Muller Center for Advanced Technology (Building 13), which opened in 1989, illustrated a shift toward more modern architecture while supporting large numbers of specialized facilities and offices.

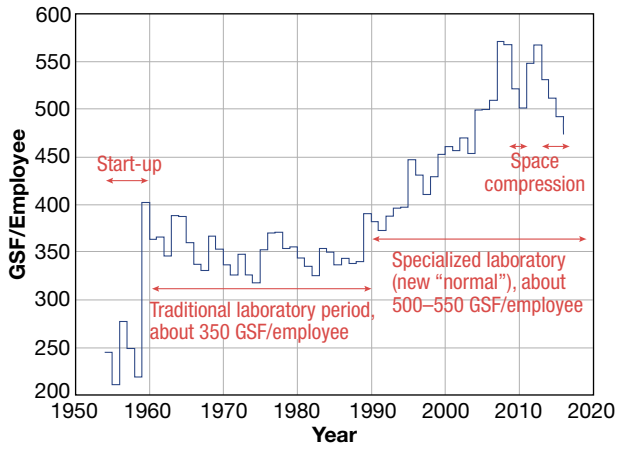

Figure 8. Trends in office, laboratory, public, and infrastructure space on average per employee. Between 1960 and 1990, APL's campus provided approximately 350 GSF per employee. Since 1990, there has been a steady increase to approximately 500–550 GSF per employee. The increase is attributed to an increase in the space dedicated to technical facilities, laboratories, and collaboration areas. Notable recent dips illustrate brief periods of space compression when new building construction and/or leasing has not kept pace with employee growth.

vided large amounts of power, cooling, and ventilation to its multitude of laboratories and facilities as well as hundreds of two-person offices.

As shown in Fig. 8, from 1960 to 1990, APL's campus provided approximately 350 GSF of office, laboratory, public, and infrastructure space on average per employee. However, the last 25 years have seen a steady increase to approximately 500–550 GSF of office, laboratory, public, and infrastructure space on average per employee. The typical office space assigned to an employee has remained fairly constant at approximately 75 usable square feet. The space assigned per employee for infrastructure (such as HVAC, generators) and public space (such as corridors, restrooms, etc.) has also remained fairly constant.

The substantial increase in average GSF per employee since 1990 is directly attributed to a dramatic increase in the space used by technical facilities, laboratories, and collaborative areas. This increase is driven by two factors. First, government security requirements drove an increase in dedicated classified facilities such as closed areas and special secure areas. Second, APL's purposeful effort to diversify its sponsor base during and after the Cold War peace dividend required additional specialized computing, fabrication, assembly, integration, and test facilities. With their focus on large, specialized, and high-bay facilities (Fig. 9), APL's two-system integration buildings, which opened in 2007, illustrate the Lab's response to this growing trend in facilities.

The two notable recent dips in average GSF per employee in Fig. 8 illustrate brief periods of space compression when new building construction and/or leasing has not kept pace with employee growth. APL's current new building and lease initiatives (including a new building presently under construction to house the Research and Exploratory Development Department on the South Campus) aim to put GSF and the employee count back into balance.

Overall, specialized facilities are essential to APL's capabilities, are constantly evolving, and are constantly increasing in technological complexity.

AGILITY AND INNOVATION

As APL has made innovative critical contributions to meet the nation's critical challenges, its facility management team has provided innovative and creative facility-related solutions to enable those contributions.

APL's 1942 wartime "do whatever is needed" philosophy continues today. This philosophy is evident not only in how APL's facility management team maintains the campus but also in how it has planned and evolved the campus even when funds have been limited.

APL's facility team provides in-depth support to keep the APL campus and its technical facilities fully functional 24 hours a day, 7 days a week, 365 days a year. Being fully operational around the clock is even more important in today's environment of multiday software simulations, worldwide field operations support, and spacecraft mission operations control.

Figure 9. Example systems integration effort in a high-bay facility.

Keeping facilities up and running at all times requires not just quick reaction in the event of equipment failure but also redundant infrastructure designs, a preventive maintenance program, and a strategic capital facilities renewal program. APL's redundant infrastructure designs improve reliability while allowing for maintenance and repair of equipment without disrupting critical operations. Through the Lab's extensive and adaptive preventive maintenance program, the team usually catches equipment issues before they lead to unplanned outages, thus providing timely scheduled repairs or replacements. With periodic facility condition assessments (detailed building and equipment inspections and service-life evaluations) and an annual capital facilities renewal program, the Lab proactively replaces equipment as it approaches its end of life, typically with systems that have improved energy efficiency and performance.

As a cost-conscious nonprofit organization, APL continually strives to provide the best value to its government sponsors by minimizing its overhead and maximizing its infrastructure investments. The Lab has adapted and renovated its original "legacy" buildings (those constructed before 1980) many times to support technologies and laboratories that those facilities were not originally designed to support. For example, it has been challenging to adapt buildings that were constructed when computers were just a novelty to now house, power, and cool computer-intensive facilities. Similarly, APL frequently converts general-purpose laboratories and office space into specialized chemical laboratories with extensive plumbing, ventilation, and safety features.

APL has used its capital facilities renewal program and project-driven facility renovation projects to continually respond to changing building codes, energy-efficiency goals, greenhouse gas-reduction goals, and improvements in building automation systems. Planning and incorporating these efficiency improvements have resulted not only in cost savings but also in improved operational reliability.

At times the demolition of a building or group of buildings and the reuse of their land for a new building is the best option. As noted previously, over 40 significant older buildings and structures have been removed from the campus as a selective urban renewal. Significant examples include the PRL complex, multiple fabrication buildings, multiple maintenance buildings, two radar test buildings, and the purchased Meade-Westvaco buildings on the South Campus. These past and future selective building demolitions have enabled and will continue to enable significant campus modernization efforts.

Overall, APL's facility needs have been met in many innovative ways, providing its sponsors with the best research and development and its employees with a pleasant work environment by ensuring the highly reliable operations of its facilities.

2017 HOWARD COUNTY CAMPUS BY THE NUMBERS

- 459 acres owned
- 27 acres leased
- 2,568,176 GSF owned
- 54,856 GSF leased to others
- 361,645 GSF leased from others
- 80 owned buildings/structures
- 44 owned buildings more than 5,000 GSF
- 3 leased buildings more than 5,000 GSF
- 36 parking lots
- 6,682 parking spaces
- 74 acres of parking and roadways[a]
- 4 acres of sidewalks[a]
- 91 acres of maintained turf[a]
- 3.5 acres of planting beds[a]
- 3,500 trees and shrubs[a]
- 900 outdoor lights[a]
- 24 cooling towers[a]
- 25,000 building automation monitor points[a]
- 28 elevators and lifts[a]
- 282 drinking fountains[a]
- 174 restrooms[a]
- 25,500 doors[a]
- 202,000 interior lights[a]
- 27 standby generators[a]

[a] Only those owned and maintained by APL; excludes leased properties.

TEAMWORK

It takes a diverse team and multiple partnerships across multiple internal and external organizations to fulfill APL's numerous and evolving facility needs. The team, which includes approximately 200 employees, contributes planning, project management, design, construction, preventive maintenance, 24/7 operational oversight, failure response, grounds maintenance, fleet maintenance, and housekeeping services.

The team's internal partners provide security, fire protection, safety, industrial hygiene, audiovisual, IT network, contract, and legal specialty services. Facility managers and facility coordinators throughout APL provide local coordination, communications, and collaboration services for both projects and daily requests.

As needed, subcontracted partners provide specialized repair, preventive maintenance, design, construction, utility, and master planning services.

Notable is APL's building permit partnership with Howard County since 1982.[4] Guided by a master building permit and a *Building Code Compliance Assurance Manual*, the partnership allows many of APL's daily

Figure 10. The flexible, open, and collaborative design of the Intelligent Systems Center.

facility modifications to proceed without the need for separate building permits and inspections. The agreement contains specific limitations, design criteria, a design review process, verification of code compliance in construction documents, in-house inspections, and occasional county inspections and audits. The partnership has proven to be hugely beneficial to APL and Howard County.

Also very notable is the support and involvement of APL's upper management in strategic facility/building investments, master planning, and funding of daily operations.

It takes a large team working together to keep this small city operating well. Everyone brings not just their skills but also their dedication to helping APL make critical contributions to critical challenges.

THE FUTURE

Based on past business trends, we believe that the combined Howard County campus will continue to support growing sponsor needs with additional offices, laboratories, facilities, and infrastructure. The campus is expected to grow in density and use if not in physical size. Significant growth can be supported by using the undeveloped land on the South Campus. However, over the long term, we expect to replace more of the pre-1980 buildings with newer and larger buildings that provide greater technical capabilities, improved energy efficiency, lower maintenance costs, higher density, improved collaboration spaces, and improved abilities to be reconfigured for future needs.

The Intelligent Systems Center, which opened in 2016, is designed to be a good model for flexible and easily reconfigurable spaces that facilitate collaboration between project teams. Its open office design (Fig. 10) is very different from APL's traditional two-person offices. Building 201, currently being designed for the South Campus, is adapting and extending these open, flexible, and collaborative space concepts to its extensive research laboratories and work areas.

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Jay R. Dettmer retired from APL at the end of June 2017. He was a member of the Principal Professional Staff and a program manager within the Facilities Management Department. He was responsible for planning and overseeing the capital facilities renewal projects for the Howard County campus. His background includes systems engineering; personnel management; security procedures; import/export procedures; the production of high-reliability/prototype volume electronics; and the organization, planning, and execution of construction projects as well as hardware/software development projects. He holds four U.S. patents.