# ORGANIC MANUFACTURING — THE PROGRAM MANAGER'S SAFETY NET

## *A Means to Respond Quickly to Contractor Defaults on Programs Critical to Defense Readiness*

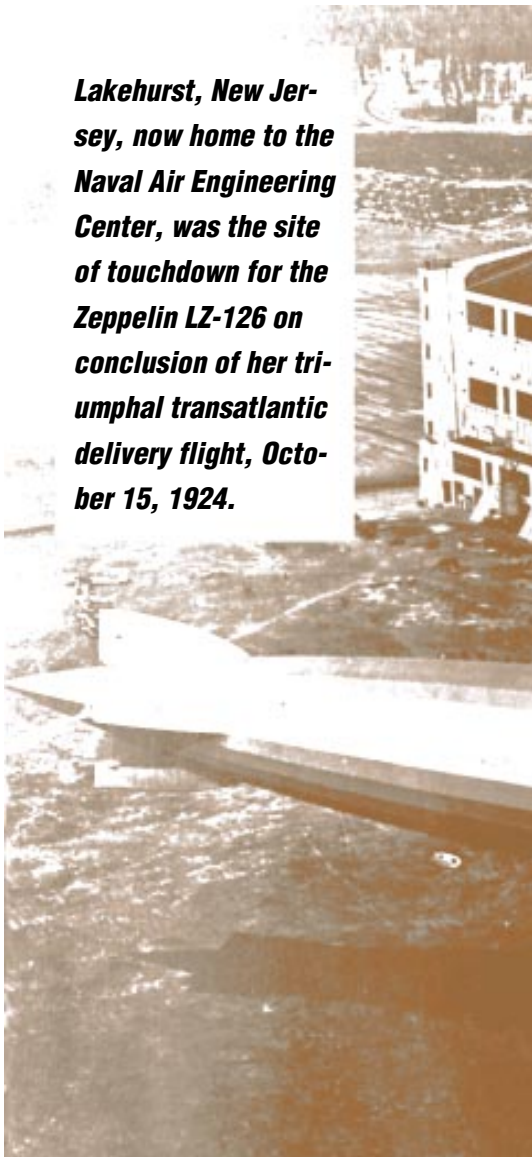
*Mark E. Gindele*

As the program manager, you evaluate all the programmatic factors that can affect your program. Issues addressing schedule, cost, environmental impact, and delivery are reviewed and alternatives considered. With the fleet's requirements driving the need, you draft your acquisition plan to merge procurement laws governing defense contracts and an acceptable delivery strategy. The plan is universally accepted and all the parties sign up. Just when you gain a modicum of confidence that you have a truly executable plan, trouble starts.

The acquisition program includes contracting with a small business. Although the contractor never produced this type of item prior to this, the pre-award survey's results supported a recommendation that this contractor could produce the item you need. You try to stay current on the progress of the contractor, but 6 months into the contract you begin to realize the finely crafted acquisition plan is in serious need of an overhaul. After considerable discussions and negotiations between the contractor and the government's contracting office, you accept the fact that this contractor will not deliver. The final issue of the default notice to the contractor only confirms your worst fear.

Swiftly you consider career changes, thinking this would be the perfect time to take a detail in another department or the 14-week Advanced Program Manager's Course at Defense Systems Management College. As reality sets in (and professionalism takes command) you become cognizant that turning over the program to someone else will not help satisfy the needs of the fleet. You meet with your contracting office and discuss plans to terminate the existing contract, collect all work in process, and re-solicit the industry. Calculations indicate the default cost you 12 to 18 months of schedule time, and your delay will impact fleet readiness.

You need to somehow overcome your schedule impact and devise a way to deliver the needed items. You review the steps that put you in the



***Lakehurst, New Jersey, now home to the Naval Air Engineering Center, was the site of touchdown for the Zeppelin LZ-126 on conclusion of her triumphal transatlantic delivery flight, October 15, 1924.***

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predicament you are presently in, and accept that you cannot afford another possible default. You need an entity that can work with you on schedule, can conform to strict levels of quality assurance, and, above all, cannot stop work. You turn to organic manufacturing for solutions.

## Organic Manufacturing Defined

Organic manufacturing is an in-house capability to produce quality products for the fleet. It provides a safety net for responding quickly to contractor defaults on programs critical to defense readiness. And organic manufacturing provides much more. In the recently formed Competency Aligned Organization at the Naval Air Warfare Center, Aircraft Division, organic manufacturing capability resides in the Industrial Department, which has facilities both at Indianapolis, Indiana, and Lakehurst, New Jersey. Although this article specifically addresses the industrial department, often referred to as "Prototyping and Manufacturing" Department, Naval Air Warfare Center, Aircraft Division, Lakehurst, New Jersey, similar issues pertain to most organic facilities.

Many benefits emerge from having an in-house manufacturing department that has all the capabilities necessary to produce new and modified equipment. Primarily, the capability to handle surge production is an available, distinct advantage. This allows the military to provide one-of-a-kind products or short-term volume increases for specific operations. Implementing mobilization plans is faster when you can control the process. For example, during operations Desert Storm and Desert Shield, the prototyping department designed and manufactured 560 special gas mask fittings within a 2-week time frame.

U.S. Navy photos

Organic manufacturing provides the flexibility needed to support many material situations that may arise as a result of maintaining a military readiness. In addition to fast responses and surge capacities, workforce skill levels, enabling government procurement personnel to be smart buyers, can be cultivated and maintained. With the hands-on experience gained by producing products, personnel can perform accurate product evaluations, emergency repairs, and field installations and modifications of specialized equipment. Personnel are also an outstanding resource for source selection support and manufacturing consultants.

## The History of In-house Manufacturing

Eight short years after the Wright brothers' auspicious flight of the Kitty Hawk in 1903, a stunt flyer from the Glenn Curtis flying team, Mr. Eugene Ely, successfully landed an aircraft on a make-shift landing deck aboard the cruiser ship Pennsylvania. With the aid of wires and sandbags, the airplane's velocity was adequately arrested and the plane safely landed. In the following year, Lt. Theodore G. Ellyson used an inclined wire across the beach in Hammondsport, New York, to help launch his aircraft into flight. With the basic concepts for aircraft launch and arrest on a ship proven, naval aviation would soon become a preoccupation with the Navy.

After many experimental flights the Navy purchased its first two Curtiss seaplanes with a 1911 appropriation

## *FIGURE 1. Aircraft Manufactured by the Naval Aircraft Factory*

| YEAR | PLANE | NO. MADE | ENGINES | HP | MAX. MPH SPEED | WEIGHT (LBS.) |
|---|---|---|---|---|---|---|
| 1918 | N-1, Pusher | 4 | 1 | 360 | 94 | 5,900 |
| 1918-19 | H-16, Flying Boat | 150 | 2 | 720 | 87 | 10,900 |
| 1918-19 | F5L, Flying Boat | 138 | 2 | 720 | 89 | 13,000 |
| 1919 | SA-1, -2 Light Recon. | 4 | 1 | 55 | 70 | 810 |
| 1920-21 | NC5 (to NC10) Flying Boat | 6 | 4 | 600 | 85 | 28,000 |
| 1920 | HS-3, Patrol Bomber | 2 | 1 | 360 | 89 | 6,432 |
| 1920 | MF, Flying Boat | 80 | 1 | 100 | 73 | 2,488 |
| 1921 | VE-7, Trainer | 140 | 1 | 180 | 115 | 2,100 |
| 1921 | M-80, High Wing Monoplane | 36 | 1 | 300 | 145 | 2,068 |
| 1922 | PT-1, Seaplane | 15 | 1 | 400 | 96 | 6,789 |
| 1923 | TS-1, -2, -3 Fighter | 10 | 1 | 200 | 131 | 1,913 |
| 1922-23 | TR-1, -2 Racer | 2 | 1 | 200 | 127 | 1,720 |
| 1923 | ZR-1, Airship, Shenandoah* | 1 | 6 | 1,800 | 60 | |
| 1920-23 | TF, Tractor-Pusher Seaplane | 4 | 2 | 600 | 107 | 8,846 |
| 1923 | PT-2, Seaplane | 18 | 1 | 400 | 100 | 7,055 |
| 1923 | DT-2, Torpedo Plane | 24 | 1 | 450 | 104 | 6,502 |
| 1924 | DT-4, Tractor Biplane | 5 | 1 | 520 | 107 | 6,833 |
| 1924-28 | PN-7, -8, -9, -10, -11, -12, Patrol Flying Boats | 10 | 2 | 1050 | 128 | 16,870 |
| 1924 | TG-1, -2, -3, -4, -5 Series (Trainer) | 5 | 1 | 200 | 97 | 2,953 |
| 1924 | NO-1, Observation | 3 | 1 | 350 | 104 | 4,842 |
| 1924 | N2N-1, Trainer | 3 | 1 | 200 | 106 | 2,640 |
| 1925 | NM-1, Land or Sea Biplane | 1 | 1 | 325 | 108 | 4,440 |
| 1927 | XTN-1, Observation Scout, Torpedo | 1 | 2 | 880 | 123 | 10,535 |
| 1929 | Mercury Racer | 1 | 1 | 1,300 | 5,000 | |
| 1929 | XT2N-1, Dive Bomber | 1 | 1 | 525 | 144 | 5,282 |
| 1931 | XP4N-1, -2 Patrol | 3 | 2 | 1,150 | 115 | 17,595 |
| 1937-38 | N3N-1, Trainer | 185 | 1 | 220 | 116 | 2,770 |
| 1939 | XOSN-1, Observation Scout | 1 | 1 | 550 | 160 | 5,412 |
| 1939 | SON-1, Scout Observation | 44 | 1 | 550 | 165 | 5,287 |
| 1940-42 | N3N-3, Trainer | 817 | 1 | 235 | 121 | 2,940 |
| 1941 | XN5N-1, Trainer | 1 | 1 | 320 | 135 | 3,370 |
| 1942 | SBN-1, Scout Bomber | 30 | 1 | 850 | 237 | 5,972 |
| 1942 | OS2N-1, Scout Observation | 300 | 1 | 400 | 165 | 5,600 |
| 1942 | TDN-1, Radio-Controlled Assault Plane | 70 | 2 | 440 Towing | 145 | 6,800 |
| 1942 | XLRN-1, Transport Glider | 1 | | Speed | 180 | 37,764 |
| 1943-44 | PBN-1, Patrol Bomber | 156 | 2 | 2,100 | 175 | 36,353 |
| 1945 | KU2N-1, Gorgon Missile | 1 | Radio Controlled | Rocket Power 500+ | | |

*Gas Capacity: 2,115,000 cubic feet.

of $25 thousand. But early airplanes had many problems, and their operational effectiveness yet remained to be solidified. While the airplane captured the imagination of young men and military strategists, specific military benefits needed to be demonstrated. Despite the establishment of the first naval air station at Pensacola and the endorsement by the Secretary of the Navy, Josephus Daniels, in 1914 naval aviation had not shown much improvement over earlier years.

As the United States entered World War I, the aircraft being used were still very primitive. Assistant Secretary of the Navy Franklin Roosevelt reported that none of the 55 aircraft in the naval aviation inventory could be used as offensive weapons, and only 8 were capable of flying at all. According to Peter Andrews and the editors of *American Heritage* in their 1986 "Navy Air — 75 Years of U.S. Naval Aviation," Justice Charles Evans Hughes led an investigation into American preparedness in aviation and said that is was unfortunate that the provisions of the criminal statutes do not reach inefficiency. With the mood changing toward supporting the military, naval aviation was about to receive a big lift.

The Naval Aircraft Factory (NAF) was established at League Island, Philadelphia, in 1917. Collocated with the Philadelphia Naval Shipyard, this was the first and only aircraft factory ever owned and operated by the U.S. Government. This new facility was responsible for producing the majority of naval aircraft and for designing structures supporting launch and recovery of aircraft on board ships. As the role of aviation grew in importance for the Department of Defense, the NAF, together with Naval Air Station (Mustin Field), increased in size and mission.

With its start at producing one F5L flying boat per day toward the end of World War I, NAF would eventually make 2,272 aircraft. Figure 1 lists the aircraft produced at NAF. The NAF

Catapult and Arresting Gear school would train over 3,000 Canadian, British, French, and American soldiers during World War II. In addition to aircraft, the NAF's product line included the first U.S. airship, ZR-1 Shenandoah, support and launching devices, and full-pressure space suits for the National Aeronautics and Space Administration. Employment reached 3,600 employees during World War I, and 12,000 during World War II.

As the aviation industry grew exponentially in size after World War I, numerous corporations stepped up to the challenge of designing and building airplanes. The NAF's role of building aircraft during wartime changed during peacetime to designing and building prototypes and support equipment. As the industry evolved over the years to more complex and demanding products, the NAF changed too. First it became the major cornerstone of the Naval Air Material Center; then in 1962 the name was officially changed to the Naval Air Engineering Center (NAEC), a name that more closely reflected the function of the matured NAF.

As technology advanced and procurement laws changed, the need for a stand-alone, government-owned manufacturing facility diminished. Although the desire to maintain an overall flexibility to permit the undertaking of a broad variety of industrial work still remained in the hearts of naval leaders, the available budget for such a large facility was decreasing. The naval air manufacturing capability was moved from Philadelphia in the early 1970 period, and settled in as part of the NAEC located at Lakehurst, New Jersey. With the number of employees at this time approximately 300, the role of the manufacturing department concentrated on fabricating specialized hardware for catapults, arresting gear, visual landing aids, and aircraft support equipment.

## Present Manufacturing Situation

What started as the Naval Air Factory in 1917 currently resides at the Naval Air Warfare Center, Aircraft Division, Lakehurst, New Jersey, in the Prototyping and Manufacturing Department. This department has evolved into a multi-functional capability for the support of the Department of Defense. Its ability to quickly develop, design, and manufacture items to meet fleet emergencies continues to substantiate the need for an in-house manufacturing base. With a workforce of just over 200 employees, the role of organic manufacturing has greatly changed from the days of delivering seaplanes for the Navy.

The current purpose of the department is to provide cradle-to-grave manufacturing technology support for the Aircraft Platform Interface products. Having moved away from maintenance and production-oriented work, the prevailing role of the department is multi-purpose. Key functions are concurrent engineering support to development programs, producibility studies, emergency manufacturing, drawing validation support, prototyping, and catapult and arresting gear support. Figure 2 provides a detailed look at the engineering development process and the prototype department's role.

With its primary focus the delivery of high-quality, cost-effective products and services to the fleet, the track record for the department is unsurpassed by any other similar entity. Its output-oriented, organizational structure complements the integrated program teams that are a critical part of the competency-aligned NAWC. Through the use of an automated manufacturing planning and control system, quality is stressed and implemented before a task is initiated. By continually reviewing the process, improvements and cost savings are

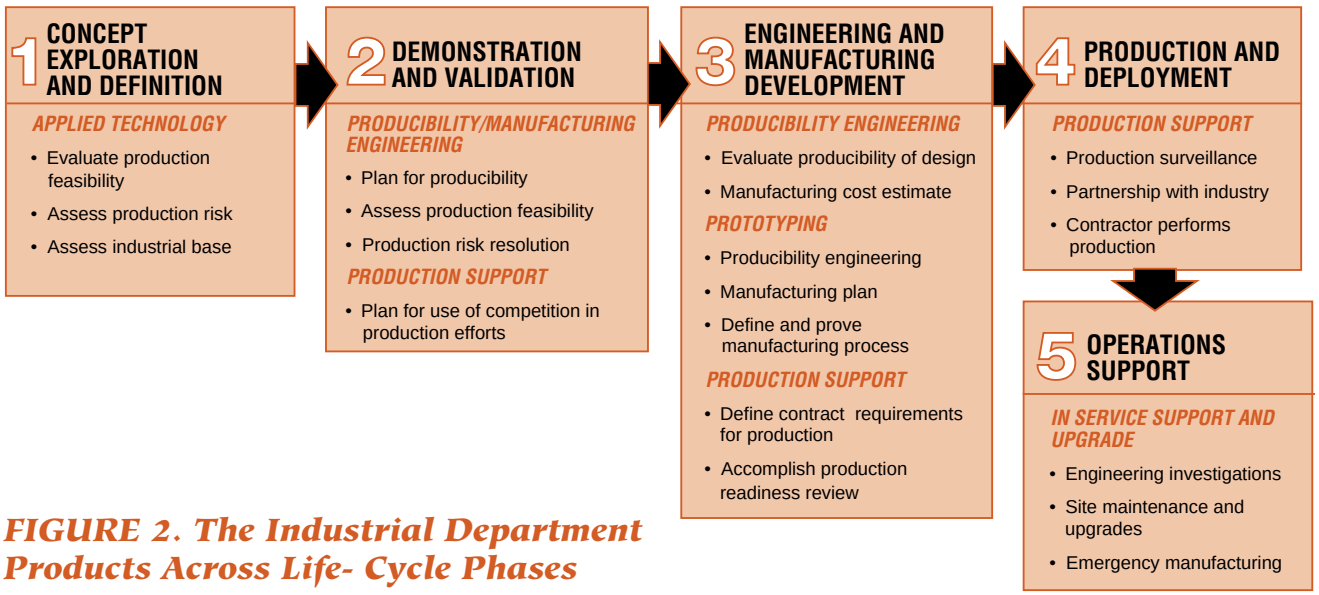
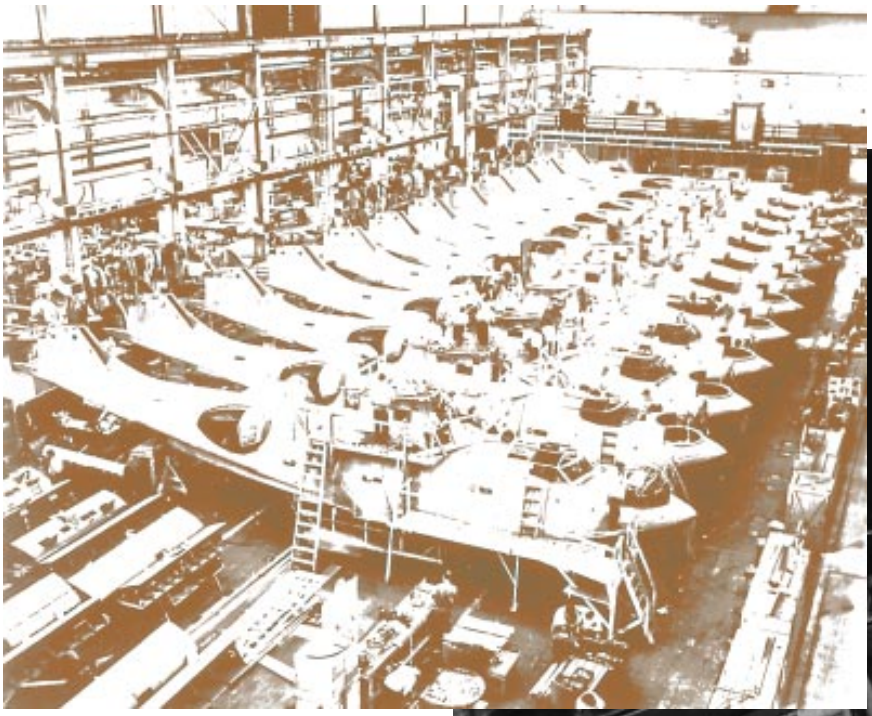



***FIGURE 2. The Industrial Department Products Across Life- Cycle Phases***



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*Interior view of Naval Aircraft Factory, Philadelphia, 1944.*

often the by-products to comprehensive planning.

**Product Lines**

The Competition in Contracting Act of 1976, which defined areas of work the government could and could not contract out, served to greatly define the type of work permitted by the prototyping department. Since production-type work, i.e., work requiring repetitive manufacturing of the same identical item, is contracted out to the private sector, the product lines of the department vary widely. While defense depots enjoy legislation that protects their core business from private industry competition, i.e., the '60/40' rule, the prototype department's work consists mostly of work that industry tried, but failed to do correctly, or, for other reasons, cannot be performed by the private sector. The following paragraphs define four of the current key work areas.

• **Contractor Defaults**. A significant area of work arrives in the prototype department as a direct result of contractors defaulting on defense contracts. This work is identified by the

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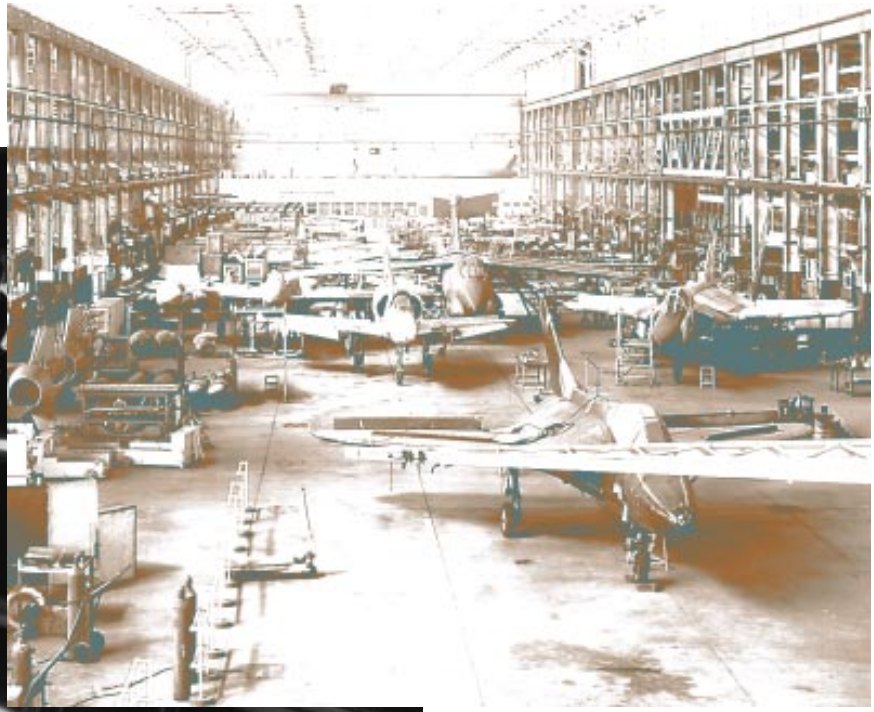


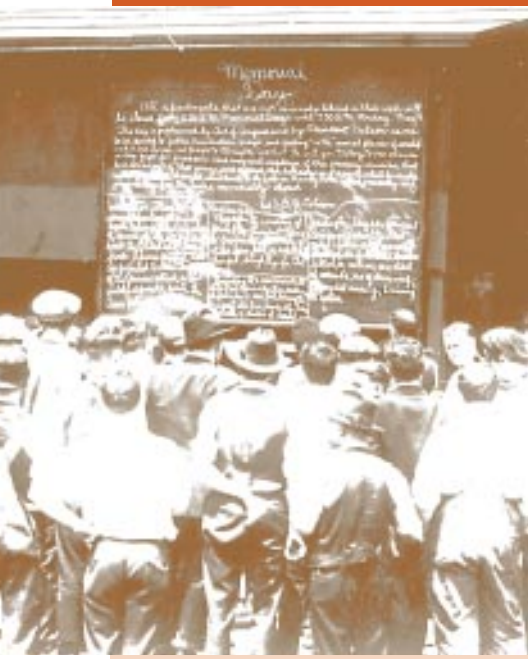
*View of aircraft used in barricade testing at the Naval Aircraft Factory, Philadelphia, 1955.*

products that were contracted to private industry, but for one reason or another, the contractor cannot deliver within the prescribed schedule. Oftentimes the department goes to the contractor's plant, collects all work in process, and tries to complete a partial delivery to the fleet to avoid or mitigate a fleet-readiness problem. This category also includes contractors that deliver inferior or unreliable parts.

An example of this kind of work is the swivel torque couplings needed to keep arresting cables from unraveling under the stress imposed from stopping 60,000-pound planes landing on aircraft carriers. One F-14 aircraft was lost after Operation Desert Storm because of a contractor-made arresting engine swivel coupling failure. A Lakehurst team of engineers and manufacturing artisans assessed the failed part; designed, prototyped, and tested new parts; examined fleet

*Main building of the Naval Air Engineering Center, Prototype and Manufacturing Department, Lakehurst, New Jersey, 1995. The naval air manufacturing capability was moved from Philadelphia in the early 1970s.*

## MEMORIAL DAY OBSERVED



Memorial Day at the Naval Aircraft Factory, May 28, 1918. The board reads, in part:

"All departments that are not seriously behind in their work will be closed from 6:30 a.m. Memorial Day until 7:30 a.m., Friday, May 31. This day is proclaimed by Act of Congress and by President Wilson as one to be devoted to public humiliation, prayer, and fasting in the several places of worship and in our homes, and prayer to almighty God that He will give victory to our armies as they fight for freedom. And may each employee of this factory remember that he or she is part of that army and regard this holiday as a day in which he or she will by rest and thought come back to the job on Friday better fixed mentally and physically for the tasks immediately ahead."

Signed by Comdr. F. G. Coburn

inventory for similar defects in equipment; and manufactured a limited number of new parts to maintain carrier readiness.

• **Sole-source Items**. Due to extremely high-quality standards, low quantities needed, and unstable production demands, several unique products are made in the prototype department. At various times these items were contracted from private industry, but the products that were delivered failed inspection and testing, or the items were not open to private-industry bidding.

An example of such an item is the cross deck pendant. Part of the aircraft arresting system, the pendant is the cable system that can withstand a 169,000-pound pull force, which is the calculated strength required to stop an aircraft within 300 feet on a carrier deck. In the 40 years that the prototype department manufactured these pendants, no failures were attributable to a manufacturing defect. Given that in the last 5 years, over 2,000,000 launches and arrests were safely executed, this is quite a testimony of the exacting standards used to manufacture navy flight critical equipment.

The cable manufacturing process, which includes purchasing the cable from private industry and testing for required strength and compliance with specifications, includes preserving, packaging, and shipping to U.S. Naval vessels around the globe.

• **Equipment Overhaul**. Since many of the items manufactured by private industry for military use are expensive, design considerations involve the potential for overhaul at some cycle point. Some of these items are overhauled in the industrial department. An example of this type of item is the Low Loss Launch Valve (LLLV).

The LLLV is utilized on CV and CVN class vessels. Its primary function is to provide direction of steam to the catapults for launching aircraft. The valve admits and shuts off the flow of steam to the launching engine cylinders during catapult operations. A total of 96 valves exists; 57 are actively in service. The remaining 39 valves are either waiting to be overhauled or are no longer usable.

This valve is required to be overhauled every 10 years or 50,000

*Left: Assistant Secretary of the Navy Franklin Delano Roosevelt and escorting party at the Naval Aircraft Factory, May 2, 1918.*

*Take off now…*
*Aircraft lining up behind two Jet Blast Deflectors aboard the U.S.S. Constellation.*

launches. When the valve body is shipped from the fleet and received by the prototype department, each of the components of the valve is examined and reworked, as necessary, to match original specifications. Welding processes are used to build up the valve seats that were eroded by sea water and super-heated steam. It takes 9 months to rebuild one valve — a rather lengthy and time-consuming business. The department overhauls four valves per year.

## Prototyping

Concern for safety is of paramount importance to the Navy. This premise is unquestioned. But the implementation of the axiom starts early in the equipment life cycle. When you take into consideration the complexity, environmental issues, and durability required of military systems, juxtaposed with flight critical parts, you have the opportunity for minor details to transform into major disasters. To minimize the potential for catastrophic loss, prototyping is the best direction to take.

After engineering groups design new aircraft launch, recovery, and support equipment, the technical teams in the prototype department take over. At this stage of the product design cycle, the engineers work hand-in-hand with artisans and technicians to make full-scale prototypes of new items. By providing rapid turnaround of preproduction samples, the final design can be refined and critical tests conducted on sample parts, prior to committing to extensive production contracts with private industry. By using this operation, it is not unusual to make multiple iterative revisions to what was previously thought to be the final design using computer-aided design software. Experience has proven that cybernating the design has not been completely reliable for flight-critical items. Clearly, the prototype process stabilizes the design before entering production.

One condition that facilitates this prototyping cycle is that NAWC, Lakehurst, also has an engineering department and test facilities located at the same site. Ultimately, all three disciplines working together lead to robustness in design configurations and clearer understanding of each other's needs. Interim paperwork is replaced by face-to-face meetings between the builders, designers, and testers. Each group gets feedback immediately, thus reducing lead times, cutting costs, and increasing efficiency.

This collocation of the multi-discipline team provides a dynamic feedback mechanism to the design engineers. Artisans and technicians are in a position to identify design problems in the prototypes, and, together with suggested improvements, these data are rapidly absorbed into the revised equipment designs. This design and engineering evolution allows the Navy to mature the design of a product over a short period of time rather than the life of a product in the fleet. As a consequence, product recalls such as those in the automotive industry are almost non existent in the Department of Navy.

*…Take off then*
*Catapulting from the U.S.S. North Carolina in 1916.*

Seeing this process work is a splendid example of engineering application. Feedback is provided quickly to engineers on designs, which, in turn, can alter drawings and then have a prototype produced to the revised

*Launch valve then...*
*Launch valve at the Naval Aircraft Factory, Philadelphia, 1965.*

drawings. Material can be changed on different prototypes and the results measured in terms of weight, strength, and durability. Various configurations can be made, producibility can be determined, drawing packages can be validated, leading to a well-engineered, well-researched item for the military. Teamwork such as this can resolve many problems early in a most economical fashion.

*...Launch valve now*
*Launch valve at the Prototype and Manufacturing Department, Naval Air Engineering Center, Lakehurst, New Jersey, 1995.*

**Future**

Due to downsizing initiatives throughout the government, organic manufacturing facilities are being reviewed for realignment or closure. Concurrently, those facilities that can't be closed due to military importance, such as the prototyping department at Lakehurst, are seeking ways to maximize the value of every dollar spent. To achieve this goal, new and innovative ways of doing business will have to be considered.

The prototype department at Lakehurst, for example, is entering into partnership arrangements with academia, public, and private entities. With the current staff representing a minimum core capability necessary to provide prototyping development and similar support, the department must concentrate the remaining staff on its core function. Work that is not critical to performing its basic chartered services will be obtained from other sources that are experts in those fields. This allows the Navy to take advantage of national and state assets and still maintain a manufacturing facility to support its mission. This public and private partnership also supports the Secretary of Defense initiative to facilitate a healthy industrial base to produce Navy as well as private-sector products.

**Summary**

Procurement laws dictate that program managers purchase items from the private industry. But when contractors default, industry chooses to forego bidding on items, or military readiness needs dictate schedules that cannot be met by the procurement process, organic manufacturing may be a viable alternative. Possessing a controllable facility permits a safety net for the few programs that cannot be satisfied by the present industry/government arrangement.

Maintaining and supporting an organic manufacturing facility requires a commitment of tremendous resources. To be able to support such a diversified product line requires a state-of-the-art facility, including computer numerical control machines, welding, heat treating, grit blasting, and fabrication centers. To efficiently function as a manufacturing and prototyping department, a well-trained, experienced workforce is necessary.

Organic manufacturing provides the necessary asset to maintain fleet readiness at all times. When fleet users identify a product as made by the organic manufacturing department at Lakehurst, such identification implies a "Guaranteed Correct" stamp on every part. A quality philosophy is endemic in every employee in the department. This commitment takes a long time to develop and nurture, but the return on investment is measurable in lives saved.