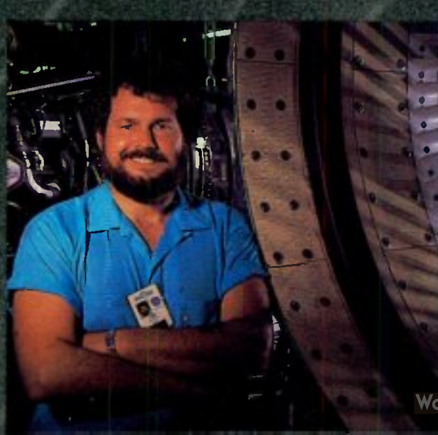
GE People

GE Aircraft Engines–
Employee Annual Report
1989

Making Great Ideas Fly



Sabrina Freeman, bench processor, Rutland

James Byrd, machinist, Evendale

Helen Hurley, inspector, Lynn

Kathy Blum, manager, Quality Control and Advanced Manufacturing Engineering, Hooksett

Steve Blunkall, laser drill operator, Madisonville

Art Gardella, manager, Cost Continuous Improvement, Evendale

Tough Customers

Customer satisfaction—these are the two most important words in an engine maker's vocabulary.

Every six seconds, a commercial aircraft powered by GE engines takes off or lands somewhere in the world. Our engines provide air power for military peacekeepers and drive ships across the sea. They pump oil through pipelines and deliver electric power to factories and cities. It is total commitment to the expectations of those customers that sets GE engine makers apart.

This 1989 Employee Annual Report is written especially for some of GE Aircraft Engines' toughest customers—GE people themselves.

Tough customers like those in engineering who demand the most innovative designs for our engines. Tough customers like those in manufacturing who push the limits of the most advanced production technology. Tough customers in sourcing who search out the finest materials for our products. Tough customers in assembly who insist on top quality precision parts. Tough customers in product support who will settle for nothing less than complete satisfaction for GE's final customers in the field.

Each face you see in our Employee Annual Report represents hundreds more which include a workforce of 37,000-plus "tough customers" worldwide. This report is our story. It is a story of worldwide thrust, flawless flight, tactical advantage, top technologies and winning teams. It's the story of where we are today, how we got here, and where we hope to be tomorrow. But most of all this is the story of our people—people who, by working together to continuously improve our products and services, make great ideas fly.

Harry Weller, engineering designer, Engine Support Operation, Cincinnati

Tommy Lee Finley, A&E technician (foreground from left), and Jeff Smith, supervisor, Edwards/Mojave

Ernie Broughton, test technician, Peebles

Debbie Dustin, quality checker, Hooksett

On the cover. Clockwise starting at one o'clock: Johnny Gibbs, general factory, Albuquerque; Rennie Green, balance mechanic, Ontario; Joe Sayre, mechanic, Strother; Mary Rogers, nondestructive test, Madisonville; Nancy Fitzgerald, sub-assembler, Evendale

Faron Young, machine operator, Wilmington

Worldwide Thrust

What a year 1989 was for GE Aircraft Engines. Commercial orders reached all-time highs. And, while military engine orders leveled off, there were significant milestones, led by the Navy's decision to return 100% of F404 future engine production to GE and successful testing by the U.S. Air Force of the YF120, GE's new generation engine being developed for the USAF Advanced Tactical Fighter.

Commercial—Sales boom

Last year proved to be successful for both GE Aircraft Engines and CFM International (CFMI). The two companies took engine orders, options and commitments for a combined total of nearly 3,700 commercial transport engines with a potential value of nearly $21 billion.

As a leading supplier of high thrust, high bypass turbofan engines, GE Aircraft Engines received commercial orders, options and commitments for the CF6-80C2 and -80E1 engines with a value of nearly $10 billion. A total of 448 engines was placed on firm order and 526 on option order by 17 new and 21 follow-on customers. Nearly 400 GE-powered Airbus Industrie, Boeing and McDonnell Douglas widebody aircraft were placed on firm and option order in 1989.

For CFMI in 1989, 40 customers placed orders, took options or made commitments for a total of more than 2,700 CFM56-3 and CFM56-5 engines, valued at more than $11 billion.

"The success GE and CFMI enjoyed in the 1980s is unequalled in the industry," says Brian H. Rowe, senior vice president of GE Aircraft Engines. "Ten years ago, $1.6 billion worth of orders for CF6 engines were received from 16 customers, a mere fraction of what they are today.

"In addition, CFM56 engines had only just been selected by three customers to re-engine DC-8 Super 70 aircraft—the first engine order in CFMI's then five-year history. We've worked hard to attain this position and have every intention of working equally hard to maintain it well into the next century."

GE and CFMI capped the year with record-breaking fourth quarter orders for their newest, most advanced engines.

The CF6-80E1, designed for the Airbus A330 and other potential widebody applications, was selected by Continental Airlines and Air Inter of France in November to power a combined total of 25 firm, 25 option A330s.

The CFM56-5C2, exclusive powerplant of Airbus' new A340, logged fourth-quarter orders as Air France, Continental Airlines, UTA of France and Iberia of Spain ordered a combined total of 31 firm and 24 option A340 aircraft.

CFM56-3-powered Boeing 737

1989 began with the signing of the largest engine purchase agreement in GE's history when American Airlines agreed to purchase up to 200 CF6-80C2/E1 engines for its future widebody fleet. The agreement marks the first time an airline has designated the engine prior to selecting the aircraft. During the course of

MD-11 powered by CF6-80C2 engines

1989, American Airlines placed 50 of the engines on firm order; if all options are exercised, the airline will exceed the 200-engine agreement.

A similar agreement was reached a few weeks later between CFMI and USAir for the purchase of 250 CFM56-3 engines to power the airline's new 737 fleet.

1989 also saw the launch of two new aircraft types powered by GE and CFMI engines. Air France launched the new Boeing 747-400 freighter with an order for five firm aircraft powered by CF6-80C2 engines. In addition, Alitalia and Iberia launched Airbus' new A321, a stretched version of the A320, powered by the new CFM56-5B engine, with orders for 28 firm, 33 option aircraft. The launch was followed closely by A321 orders from Air Inter and GPA for 13 firm and eight option aircraft.

"The airframers are surprisingly neutral about our engines. They display products from all three makers—GE, Pratt & Whitney and Rolls Royce. From a performance standpoint, the airframer sees engines as basically equal. It is quality, cost and product support that the airlines look at when making a decision. This is the ultimate in head-to-head competition."

John Weickart
instrumentation engineer,
Evendale

More good news

The CFM56-3-powered Boeing 737 has become one of the best-selling aircraft/engine combinations in aviation history since its launch in 1981, and 1989 was another record year. In addition to the USAir agreement, CFMI also received major orders from Delta and United Airlines for -3 engines.

The CF6-80C2 was selected to power a major portion of McDonnell Douglas MD-11 tri-jets ordered in 1989; large orders were placed by GPA, Garuda, VIASA, Federal Express and EVA Airways.

The engine also continued to be a leader in the Airbus A300 and A310 and Boeing 747 and 767 aircraft markets, with significant orders in 1989 from All Nippon, Lufthansa, Britannia, Trans European Airways and CSA.

The CFM56-5A1, which launched the Airbus A320, remains the engine of choice for this aircraft, with firm and option orders for a total of more than 85 aircraft in 1989 from GPA, Air Inter, Iberia, Lufthansa and others.

Among the significant events of 1989 were the first deliveries of CF6-80C2-powered 747-400s to Japan Air Lines and acceptance by Northwest Airlines of its first of 25 A320 aircraft in June. The Northwest event also marked the inaugural for the A320

CF6-80C2-powered Airbus A300

in North America and, as with JAL: it was the first delivery of a CFM International product to a long-standing Pratt & Whitney customer.

Increased engine sales also boost the market for spare parts. Last year, our spare parts business grew by about 15%.

MILITARY—ENGINE COMPETITIONS HEAT UP

GE has more military engines in service than any other company in the world. Here are highlights.

— The year opened with President Bush's Air Force One maintenance crew coming to Evendale for training in line maintenance and basic modular maintenance of CF6-80C2 engines. The CF6-80C2 will power two new specially equipped 747-200s scheduled to replace the aging 707 Air Force One fleet.

The President's plane—Air Force One

— Engine competition between GE and Pratt & Whitney reached to Japan as the two companies vied for contracts to power the Japanese FS-X (based on the F-16C/D). This increased performance engine competition pits our F110-129 against Pratt's F100-229.

— In February, the U.S. Air Force announced simultaneous decisions to conclude the first phase of its "Great Engine War" and to begin a second round of fighter-engine competition. In the final overall tally of the six-year competition, GE received 50.4% of the buy.

— In the first of five yearly increased performance engine (IPE) buys, the Air Force selected 54 GE F110-129s to power new, single-engine F-16s and 68 F100-229s to power twin-engine F-15Es. (In early January 1990, the Air Force announced its buy for 1991: 114 GE F110-129s and 113 PW F100-229s. GE engines will power about 75% of the 150 F-16s in the 1991 order and Pratt engines will power the remaining F-16s and 36 F-15s ordered for 1991.)

— F110-100 engine kits were shipped to the U.S. Air Force to maintain the quality of F-16 Falcons.

— The F110-GE-129 Increased Performance Engine (IPE) successfully completed accelerated mission testing, leading to U.S. Air Force qualification.

— Qualification and first carrier deployment of the U.S. Navy F110-400-powered F-14 was completed.

— The T700 was selected over Rolls-Royce's entry to power the Westland Black Hawk helicopters for Saudi Arabia. This has helped to position the T700 for other markets in the mideast and elsewhere. Also, three new growth models of the T700 entered production last year.

T700-powered Black Hawk

— The GE-produced F404 was selected by Navy for the remaining six years of procurement. Delivery will take place between April 1991 and March 1997. The 16,000-pound thrust class F404 was designed and developed by GE Aircraft Engines. But in 1984, the Navy decreed second sourcing for the engine and Pratt & Whitney began producing the F404. The Navy's 1989 selection brings all of the remaining F404 production back to GE.

— The U.S. Air Force successfully completed taxi tests on the F118-powered B-2 bomber. These tests assessed engine operation, low speed maneuverability and braking systems. Flight testing was begun.

— F120 and YF120 preliminary design review, completed in just 27 days, was well received by the customer. In addition, YF120 hardware was obtained and the engine went to test as scheduled.

— The Joint Turbine Advanced Gas Generator (JTAGG) program was awarded to Lynn for the U.S. Army. It represents the first phase of an ongoing Department of Defense/NASA Integrated High Performance Turbine Engine Technology (IHPTET) initiative designed to double aircraft engine propulsion by the year 2000.

— The Evendale Plant was issued "satisfactory" ratings in all major functions measured by the Air Force during a Contractor Operations Review (COR) from April 17 through 28. It was the first time that any contractor received the USAF's highest rating in all categories since the COR program began in 1984.

Marine and Industrial— Looking to Grow

GE's Marine and Industrial (M&I) business provides power for products ranging from combat cruisers to cruise liners, from off-shore oil rigs to Disney World. M&I is a significant part of Aircraft Engines, representing about 15% of sales.

M&I Highlights

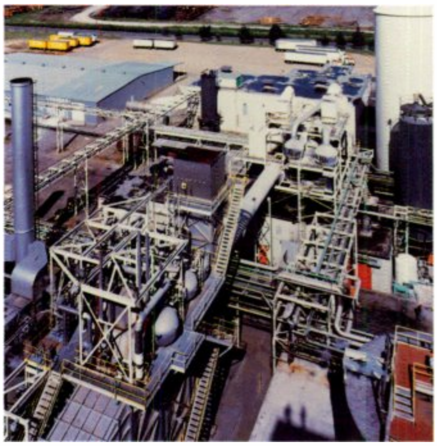
One of the reasons marine and industrial engines have been so successful is that, because they are derivatives of existing GE military and commercial engines, they do not require the heavy investment needed to develop entirely new engines.

LM2500-powered USS Leyte Gulf AEGIS

M&I engines date back 30 years to the LM1500, and more than 1,300 M&I engines are in service throughout the world. Of that number, 700 are marine applications, and 600, industrial applications, operated by more than 135 customers in 33 countries.

The LM2500 leads M&I's current stable of production engines. In production for some two decades and still the biggest seller, the LM5000 has reached an average of about 10 a year. The LM500 is in operation but with limited sales, and the LM1600, M&I's newest engine based on the F404 is achieving growing success in the industrial marketplace.

M&I engines are on all U.S. Navy gas turbine-powered surface combat ships, 85% of similar ships for other



Simpson Paper Company's LM5000-powered cogeneration plant

navies, 85% of the U.S. cogeneration applications and 65% of industrial applications internationally.

Cogeneration refers to a process using gas turbines to generate electricity and heat from the engine's exhaust to create steam. International industrial applications include both cogeneration and mechanical drive systems. The principal competitor for this market share is Rolls-Royce.

Recently, the U.S. Navy accepted its 100th ship, the USS Leyte Gulf, an AEGIS guided missile cruiser powered by LM2500 engines. Each of these cruisers uses four LM2500s. More than 120 U.S. Navy LM2500-powered ships are now in service. The Navy is expected to continue acquiring AEGIS ships for the next 10 to 15 years. A total of 22 navies use LM2500-powered ships.

A new application for the LM1600 is power for a newly designed, high speed, private yacht. Another new application for M&I engines is cruise liners. Among the varied worldwide industrial unit applications is an LM5000 cogeneration unit at the Reedy Creek Energy Services utility plant which powers Walt Disney World.

New M&I products include an LM derivative of the CF6-80C2 engine, a low-cost, competitive product to be ready in a few years. Others are the LM3000 intercooled-regenerative unit (ICR) and the intercooled steam-injected generating unit (ISTIG). And the LM3000 ICR is proposed for development to power the future U.S. Navy surface fleet. Its prime benefit to the Navy is a 30% savings in fuel burned.

Aviation Service

The primary focus of this business is to be there for a customer when needed to support the product, particularly with the increased number of engines entering service. However this is and will continue to be a highly competitive business.

Aircraft Engine Maintenance Center, Strother

In the last 10 years, Aviation Service Department (ASD) people have overhauled thousands of engines and repaired hundreds of thousands of high pressure turbine blades, shrouds, vanes and compressor airfoils.

Flawless Flight

Red sweater day—GE people visit the customer at American Airlines.

According to Federal Aviation Administration forecasts, 820 million Americans will travel by air in the year 2000. That represents an increase of 74% from 1988. In anticipation of that increase, customers purchased Aircraft Engines' commercial engines in record numbers during 1989.

A world of customers

On February 9, 1989, GE Aircraft Engines made company history with its single largest engine purchase arrangement with a commercial airline. In an unprecedented move, American Airlines agreed to purchase up to 200 of GE's highest thrust CF6-80C2/E1 engines to power future orders of various widebody aircraft through the mid-1990s. "This newest arrangement begins an era of enhanced partnerships with our customers, suppliers and employees to achieve total product excellence," said Frank Byrd, general manager of North American Sales for GE Aircraft Engines.

Robert Crandall, chairman and president of American Airlines, put it this way: "We already have 100 of GE's big CF6-80C2 engines in our fleet...adding 200 more is a very natural thing to do as long as GE maintains the same high standards American has been accustomed to getting from it. American wins two ways...reliability and commonality."

The American Airlines order is a sign that customers are moving toward long-term relationships with suppliers, in the realization that the customer's success is tied to that of its suppliers. These long-term relationships are characterized by such strategies as including suppliers in the design phase, and creating customer/supplier teams for improving supplier processes. These strategies have been shown to lead to higher value products over the long term.

> "When American receives a part, we want to install it on an airplane here or install it in the field and go! We're counting on GE to provide that level of quality."
>
> *James Martin*
> *senior manager,*
> *Quality Assurance Department,*
> *American Airlines Maintenance and Engineering Center*

Best value

No longer are customers buying products from GE Aircraft Engines on the basis of "first cost" alone. Commercial airlines are looking harder at direct maintenance cost in deciding whose engine to buy. And, in 1989, the U.S. Air Force's senior logistician sent letters to 3,864 companies, including GE Aircraft Engines, telling them that contractors who consistently deliver the best value will be those who get future contracts. General Alfred G. Hansen, commander of the Air Force Logistics Command (AFLC), explained that Logistics Command is "...rapidly transitioning from a 'lowest bidder' contract award approach to a 'best value to the U.S. Air Force' approach." General Hansen also indicated that AFLC was in the process of identifying "those suppliers with whom we intend to establish long-term business relationships."

For GE Aircraft Engines, "best value" means that obtaining future military business in an environment of shrinking defense spending will depend on being the top performer in providing product quality, on-time delivery, fair price and strong customer service.

Visiting the customer at McDonnell Douglas

Great expectations

Over the years, both military and commercial customers have come to expect a lot from Aircraft Engines products. That's the result of some hard work on Aircraft Engines' part.

"We have set some tough goals and objectives about how long engines stay on wing," says Bob Gerardi, general manager of Continuous Improvement and Customer Support. "The standards used to be that an engine would stay on wing six months to a year before removal for maintenance. Now our objective is one, two, three years, depending on whether the engine is used for long or short flights.

"We at GE and CFMI are providing products that are much more reliable, stay on wing longer, have less and less disruption in service. We know that the customer's customers, including ourselves when we travel, want to have that airplane leave the gate within 15 minutes of when it's supposed to."

And when there is a disruption in service, Aircraft Engines' Product Support and Field Service people move quickly to solve the problem.

The problem could be a work stoppage in the maintenance facility —for example, a set of bolts might be needed, or there might be a question about a procedure. In such cases, Aircraft Engines must respond within 24 hours to resolve the problem.

The most critical events occur when an airplane is on the ground. It may be scheduled for dispatch the next morning, but the customer needs a pump or a valve, or simply some advice. In these cases, Aircraft Engines people must resolve the problem within four hours.

"Our customers expect us to respond," says Bob Gerardi. "Not just to respond quickly, but respond in a way that they can trust us if there is a problem. Our integrity's at stake

GE employees with pilot at MacDill Air Force Base

GE people at Cecil Field Naval Air Station

every day. So the people of Product Support and Field Service depend upon their internal suppliers, whether they be in design engineering, quality, manufacturing, human resources or the training schools, to provide the best information, to make the promises to our customers count."

MAKING PROMISES COUNT

In 1989, GE Aircraft Engines' customer support continued to be the best in the industry. The following are some major accomplishments that help explain that reputation:

— The Product Support Distribution Center maintained its excellent performance levels in quality and accuracy of parts shipments at a rate of more than 99.9%.

— Aircraft Engines initiated a system of electronic invoicing and electronic payment, which simplifies customers' accounts payable processes and makes it much more efficient for the customer to process invoices.

— Aircraft Engines' Lease Equipment Operation maintained a fleet of CF6 and CFM56 engines ready to support customers in every corner of the globe, 24 hours a day, seven days a week.

— Upgrades of configuration data traditionally took days to reach Aircraft Engines' U.S. Navy customer, and the magnetic tapes used for data storage and transmittal were easily damaged, creating a lot of work for both supplier and customer. Thanks to computer technology, Lynn Contractor Provisioning can now send upgrades within minutes over telephone lines.

— Aircraft Engines' Lynn and Evendale technical training schools provided engine maintenance and repair training to more than 2,600 people, representing military and commercial customers all over the world.

— Improvements to the technical status of the F110 augmented turbofan resulted in 50,000 hours of flight for the F110 without a single in-flight shutdown.

— Repair Engineering developed procedures that saved 30 sets of LM1500 LPT nozzles which would otherwise have been scrapped.

— Hundreds of support equipment items were delivered ahead of schedule to support successful F404 Depot activation at Jacksonville (Florida) Naval Air Station.

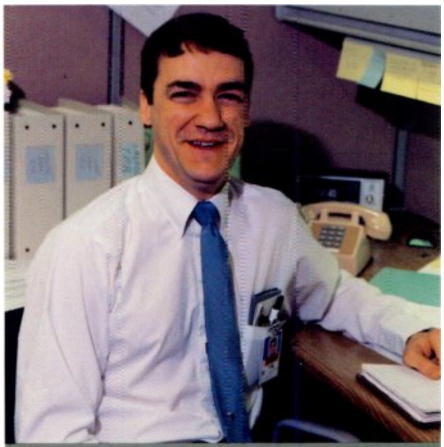
— GE field representatives were positioned at strategic locations to ensure the success of the world's first 180-minute extended twin operations (ETOPS). The CF6-80A and the CF6-80C2 are the only engines in history to receive this level of ETOPS approval. In locations as diverse as Charlotte, North Carolina; the Seychelles, Mauritius; and Santiago, Chile, as well as in the major cities of Los Angeles, New York, Dallas, Chicago, Paris, Frankfurt, London, Zurich, Bangkok, Bombay and Hong Kong, and in Eastern European locations like Warsaw and East Berlin—Field Service representatives were there to ensure a successful program.

— Twelve full-time field reps and five technicians at Seattle helped ensure that every Boeing aircraft equipped with GE's CF6-50, CF6-80A, CF6-80C2 or CFM56-3 engines was delivered on time.

— In June 1989, Northwest Airlines began accepting the first of its 25 A320 aircraft powered by CFM56-5 engines. Field Service people began preparations for this event a year in advance.

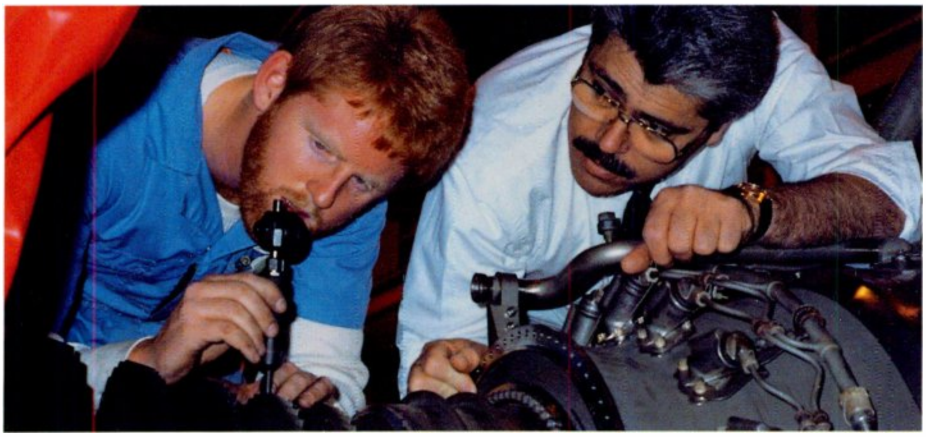
— Field Service placed F110-100 maintenance teams at Ramstein and Spangdahlem, Germany; Torrejon, Spain; Kunsan, Korea; and Misawa, Japan, to assist the U.S. Air Force in accomplishing F110 engine modifications and upgrades.

— For the first flight of the F118-powered B-2 Stealth Bomber, the GE Aircraft Engines field team at Northrop spent many long days preparing the engines for their eventual flawless flight.



"Repeat business depends on good product support. Our customers count on us to stand behind our engines."
Tom Merk
methods engineer,
Evendale

Troopers



Jake Or-Bach (right) diagnoses engine in the field.

Jake Or-Bach keeps doctor's hours. He's "on call" 24 hours a day. If he receives a call in the middle of the night, Or-Bach is up and on his way to work within minutes.

Or-Bach is an Aircraft Engines senior field representative in Norfolk, Virginia, supporting Lynn and Evendale product lines at Norfolk Naval Air Station, AIRLANT headquarters, Oceana Naval Air Station and Norfolk Depot. AIRLANT is the command that oversees all aviation activities for the Atlantic fleet, including aircraft and aircraft carriers. Oceana is a fighter base that houses F-14s powered by F110 engines. At Norfolk, F110 engines undergo overhaul, and T64 and T58 engines undergo repair.

At AIRLANT, Or-Bach provides headquarters coverage for all Lynn and Evendale engines in the Navy inventory.

As a senior field representative, Or-Bach can expect to move, on average, every two to three years. Wherever his expertise and "can-do" attitude are needed, Or-Bach is willing to go.

"We're troopers," says Or-Bach. "We do what is necessary to make sure we take good care of the customer."

"I tell all the new troops that we're hiring, loud and clear: 'You're the customer in our eyes,'" says Walt VanDuyne, program general manager of Aircraft Engines' Field Service Operation.

"'You're the one who has to push the button when the customer has asked you a question and is looking for an answer. You must take it as high as you can to get a response. Our customers pay good money for our product, and we want to make sure they get value for their dollar. The only way you do that is to be there when the customer needs you.'"

— A Field Service team of 12 people was launched to Oceana Naval Air Station in Virginia in early July to accomplish modifications and updates of F110-400 engines installed in the Navy's F-14A Plus aircraft. The team upgraded 87 engines by October, enabling the Navy to meet its planned schedules. Squadrons on the USS Eisenhower getting ready for a cruise in early 1990 will be accompanied by two GE Field Service reps.

— GE's military and commercial field investigation teams dedicated themselves to resolving safety issues for Aircraft Engines customers. Their efforts in 1989, as always, focused on identifying potential safety factors, isolating causes, developing corrective actions and standardizing improvements to maintain and enhance product reliability.


Engine makers get close-up view of their product

QUALITY AMBASSADORS MEET THEIR CUSTOMERS

Aircraft Engines' quality ambassadors carried their search for excellence from Tokyo, Japan to Yazoo City, Mississippi last year. Some 1,000 Aircraft Engines people participated in more than a dozen trips to customers around the world. Employees chosen were those who might not ordinarily have the chance to meet Aircraft Engines' customers face-to-face.

The goal of the quality awareness trips is to help employees understand how their work impacts Aircraft Engines customers. During their visits, employees listen and learn about customer needs and expectations and then share those messages with their co-workers.

Here's a look at some of their experiences.

MacDill Air Force Base, Tampa, Florida. In this "flying classroom," young Air Force pilots learn to fly the F-16 Flying Falcon, whose C and D models are powered by GE's F110 engines. During their April visit to MacDill, 220 Aircraft Engines employees toured the base, talked to pilots and maintenance personnel, and watched the F-16 fly.


Ron Richardson (left) at MacDill

"The trip to MacDill is a day I'll cherish forever. At MacDill I could physically touch what I've done. It made me feel very good about my accomplishments and it made me proud to be a part of the GE team."

Ron Richardson
production welder,
Evendale

"From suppliers, specifically GE Aircraft Engines, we expect a very high quality product that's delivered on time. Those are fundamentals...If you concentrate right down to the shop floor on doing the job in a quality manner, cost and schedule will follow."

Joel Smith
vice president of Quality,
Douglas Aircraft

McDonnell Douglas, Long Beach, California. In June, some 160 Aircraft Engines employees visited this commercial airframer and saw the last of the widebody DC-10s, powered by GE's CF6-50 engines, ready for delivery. At Douglas employees also saw the first of the new generation widebodies, the MD-11, powered by GE's CF6-80C2 engines, in final assembly.

American Airlines Maintenance and Engineering Center, Tulsa, Oklahoma. More than 200 GE engines undergo maintenance and repair at the Tulsa facility each year. Add to that the large order GE received from American in 1989, and it's easy to understand why Aircraft Engines sponsored six employee trips to the Tulsa facility last year. During this largest trip of the year, more than 300 GE Aircraft Engines visitors toured the center, watched a DC-10 receiving a scheduled heavy maintenance check and saw GE engines in various stages of maintenance and repair activity in the engine shops.

Five more customer visits involved sending small groups of employees to American to focus on specific improvement tasks.

Cecil Field Naval Air Station, Jacksonville, Florida. Some 200 Aircraft Engines people toured the Navy master jet base, which houses the GE F404-powered F/A-18 Hornets.

Boeing Commercial Airplanes, Seattle, Washington. A group of 27 engineering, management and production employees from CFM56 Final Assembly spent two days touring their facilities and talking to the people who prepare GE engines for installation on Boeing aircraft.

Japan Air Lines, Tokyo, Japan. Four Aircraft Engines employees spent a week touring JAL's overhaul facility and participating in ceremonies to celebrate the delivery of the first GE engine to JAL.

"During my visit to JAL, it became more clear to me that people's lives are depending on every one of us. We've got to ship no less than 100% quality. So far JAL loves our engines, but we've got to keep working hard to continue to earn their confidence."

Tyrone O'Neal
assembler,
Evendale

"Quality is more than just making parts to spec. It is very comprehensive. It means shipping on time, answering customer questions promptly, resolving logistical problems, correcting and clarifying technical manuals, providing for ease of maintenance, satisfying life requirements and thrust requirements, and always striving to improve on past performance."

Steve Burnham
manager,
Quality and Technical Planning,
Lynn

Mississippi Chemical Corporation, Yazoo City, Mississippi. Fifteen Aircraft Engines employees, most from LM2500 Assembly in Evendale, saw a GE Aircraft Engines Industrial LM2500 generating electrical power for the manufacture of chemical fertilizers.

Ingalls Shipbuilding, Pascagoula, Mississippi. Sixteen employees from Evendale's Marine and Industrial assembly area visited the Chancellorsville, the new AEGIS cruiser powered by four LM2500 engines.

Tactical Advantage

GE F404-powered U.S. Navy F/A-18 Hornets

It's 6 a.m. Altitude 15,000 feet. Speed 600 m.p.h.

Capt. Greg Minks strategically maneuvers his F/A-18 Hornet to intercept an F-16 "adversary." The last thing this 32-year-old marine needs to worry about are his F404 engines.

"It's a great tactical advantage knowing that you can depend on your engines," says Minks, one of a handful of marine instructors who, along with about 20 navy instructors, trains the pilots at Naval Air Station Cecil Field in Jacksonville, Florida.

Knowing his engines won't let him down allows Capt. Minks to concentrate on the business at hand, which consists of practice missions including bombing runs and air-to-air dog fighting. Minks, who has flown more than 1,000 hours in F/A-18s, has come to rely on F404 engines to give him the power he needs when he needs it.

The F/A-18 pilot's reliance on the F404 underscores the importance of GE's commitment to pushing its technology one step further, finding a better way every day to get the job done to create the competitive edge. And none of this is possible without GE's No. 1 resource—its people.

There are the engineering teams who continually research ways to improve the F404, the men and women from eight different GE Aircraft Engines plants who fabricate F404 parts, and the GE people who assemble, test and ship the finished product. They may live in different parts of the country, but they share a common purpose: absolute quality in the engines they produce.

Aircraft Engines U.S.A.

From engineering offices to the manufacturing and assembly floor, GE people are dedicated to delivering the best:

—In Hooksett, New Hampshire, craftspeople produce compressor vane sectors and 58 different tube assemblies that connect accessory to accessory, line to line for Greg Minks' F404 engines.

—Across the country, in Seattle, GE people make check and drain valves, high pressure variable geometry actuators and actuator rings which control the F404's variable compressor geometry.

—From Madisonville, Kentucky, come the F404 low pressure nozzles, and the low and high pressure turbine blades.

—Out west in Albuquerque, New Mexico, our people produce the F404's composite duct, turbine shrouds and compressor shroud supports.

—GE people in Rutland, Vermont, use an advanced technology to produce the engine's fan and compressor blades and vanes.

Al Bennett, inspector, Lynn

— From team members in Wilmington, North Carolina, come the fan and front compressor casings, cooling plates and 12 other unique pieces for the F404.

— In Evendale, Ohio, employees manufacture the rear compressor case and high pressure turbine nozzles, which direct the flow of hot gas out of the turbine.

— In Lynn, Massachusetts, engineers work on the design of the F404, while manufacturing employees are busy producing a number of components, including the afterburner liner, afterburner fuel control, the combustion liner, the flame holder and rotating parts. It is in Lynn that all the pieces come together and the F404 is assembled, tested and shipped.

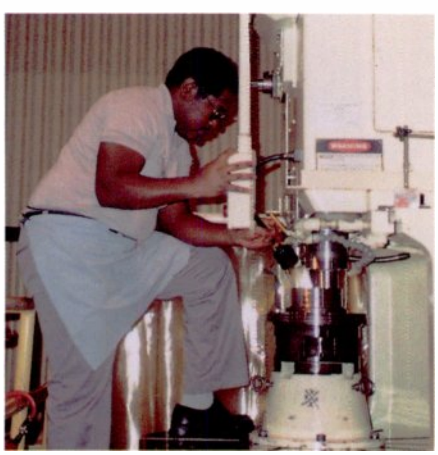
THE ENGINE TEAMWORK BUILT

While some plants are more involved than others in the making of the F404, each plant's contribution is integral to the engine's success. Former Shop Manager Bruce Blomberg, now staff engineer at Lynn, knows well the importance of GE people's contributions across the country.

"Whether we're missing a main engine component or a nut and bolt, the impact on us is the same," says Blomberg. "Whether a part costs $25,000 or $25, the engine comes to a halt and is rolled to the side if a piece isn't there."

Technology, and GE people's commitment to the continuous improvement of that technology, keep the F404 and GE Aircraft Engines flying high. At each plant, engineering teams are always looking for new, innovative ways to constantly improve design, while manufacturing teams look for new and better ways to produce the product.

Dick Querze, inspector, Hooksett



Vern Messick, machine operator, Wilmington

Minh Nguyen, project/design engineer (standing), and Dave Curulla, electrical repair & test, Seattle

Rutland, for example, has developed techniques for precision forging, a technology that makes possible the production of the blades and vanes for the F404's compressor section. Precision forging "allows us to maintain close tolerances and keep costs down," says Steve Smith, manager of Process Engineering for the forge area.

Wilmington uses a state-of-the-art Flexible Manufacturing System (FMS) to produce the fan and front compressor casings for the F404.

"We employ closed-loop machining to check hardware characteristics while the part is being machined," says Jack Smith, who manages shop operations for the Casings FMS. "Because of the quality built into the system, little inspection is needed after the part is complete."

Albuquerque's production of the non-metallic composite outer bypass duct is a prime example of GE technology at work.

Following 10 years of development, GE began producing the composite ducts. While lighter weight, the new duct is as durable as metal and is the first structural composite hardware to be installed on the F404 engine.

Albuquerque also uses sophisticated inspection technologies including one that was developed for the medical field.

F404 Design Engineer Karen Ogulewicz-Anderson, Lynn

Rena Little Axe, CAT Scan technician, Albuquerque

"We have a GE Medical Systems CAT scanner we use for diagnostic purposes when we have a problem with a part," says Lou Boczek, manager of Quality at Albuquerque. "We use the same machine to examine engine components that hospitals use to examine patients."

Albuquerque also ensures quality with an image analyzer developed specifically for the composites business. Purchased in 1989, it is the first system of its kind to be used by GE, and only the second such system that exists in the world.

Albuquerque uses the image analyzer to examine parts. If a part is found to be defective, the image analyzer is used to find that defect.

"Based on this data, we can understand what happened in the process and institute improvements," says Boczek.

Meanwhile at Lynn, employees use an advanced technology called multihole electro discharge machining to drill thousands of cooling holes on the combustion liner where gases and air are mixed in a controlled explosion, propelling the engine's turbine, while Evendale's laser drilling operation produces the cooling-hole patterns on the turbine airfoils and the bands.

"Being able to see our engines in the field, the enthusiasm of the pilots who depend on those engines and meeting the people who service and maintain the aircraft and engines brought the importance of our work into perspective."

Ann Quinn
forge tollgate,
Rutland

Dave Scott, (left), supervisor, F404 Fabricated Nozzles, and Del Carroll, precision grinder, Evendale

Bringing technology to life

What makes this state-of-the-art technology work? It's people.

Former Madisonville Plant Manager Sonny Pierce, who now manages Aircraft Engines' Manufacturing and Quality Technology Department, tells this story about Madisonville's first work on the F404:

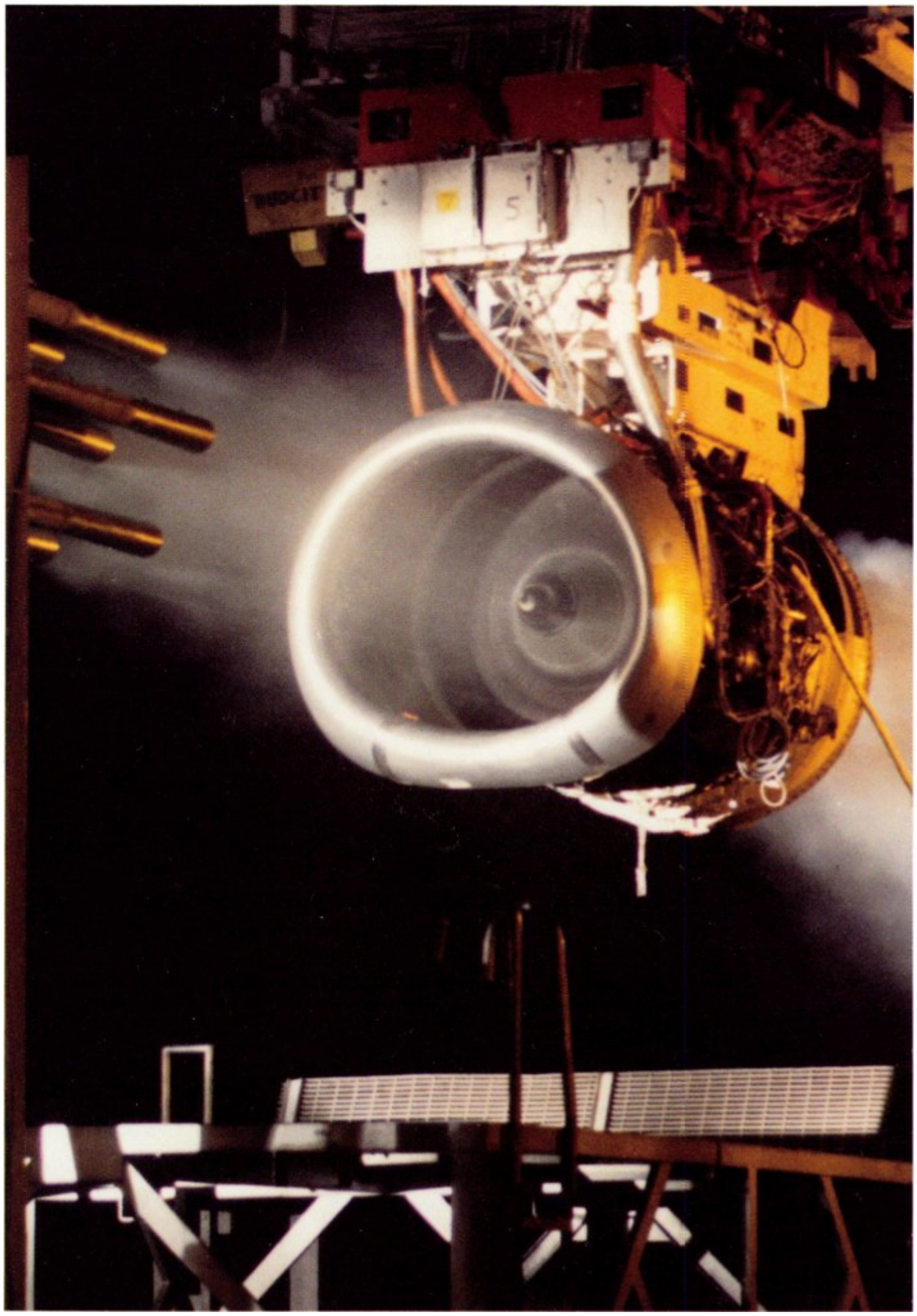
Designated in 1981 as the charter source for F404 high-pressure turbine blades, Madisonville employees were so proud of their first production parts that they couldn't merely ship them to Lynn for assembly. Instead, they decided that Pierce should deliver the product in person.

"We took Polaroid pictures of people throughout the plant so that the people in Lynn could see who made the blades," Pierce says. "We put the pictures in a box with the blades, and put an inscription on the box that read: 'F404 HPT blades: Made in Madisonville, Kentucky, by people who care.'"

Messages like that are just the tactical advantage Capt. Minks is looking for.

Carrie Cook, laser operator, Madisonville

10 Top Technologies



Hail simulator system

HAIL SIMULATOR SYSTEM

Operational problems with CFM56 engines during low power descents in extreme weather conditions, including heavy rain and hail, resulted in the need to better define the tolerance of this family of engines to ingestion of ice during engine operation at near idle power settings.

A seven-gun hail simulator system, capable of generating a uniform cloud of high velocity ice pellets at the inlet of a test engine, was conceived, developed, fabricated and subsequently used during ground test at our GE outdoor test facility at Peebles, Ohio. Testing with the new hail simulator—which complements tests completed with our rain simulator system—simulates in-flight encounters with heavy concentrations of hail at velocity levels of over 600 ft./sec.

Testing to date has identified configuration and power setting changes to improve engine operation margins during even the most extreme weather conditions.

Source: Richard Keller
*8-332-0776,
Evendale

Casings flexible manufacturing system

Casings flexible manufacturing system

Wilmington, North Carolina employees can be very proud of their accomplishments in the design, development and production implementation of the Casings Flexible Manufacturing System (FMS). This program, sponsored by the U.S. Air Force Industrial Modernization Incentive Program, was truly a team effort supported by people throughout GE Aircraft Engines. The major focus of the Casings FMS was its transition from traditional process centers to a flexible product-oriented flow. The Casings FMS was designed to accommodate any part that requires turning, milling and drilling which fits inside a 42″ cube.

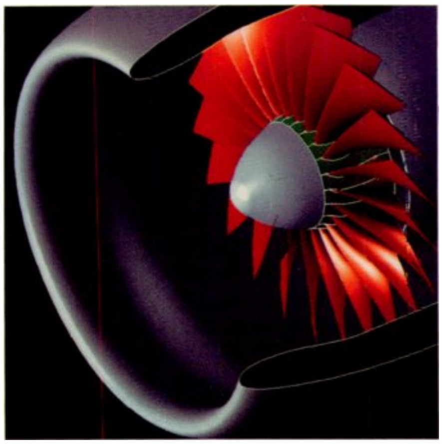
Specific features include an automated storage and retrieval system, automated part movement, tool delivery and chip handling, automated tool management systems, closed loop machining and inspection, tool wear and break sensing, automated part and fixture wash, an event manager and real time quality control for the entire manufacturing process. All of the systems in the Casings FMS are fully integrated to work together for optimum high quality output and total control of the product. The key success factor of this program is people working together to improve the quality of their working life.

Source: Bill Rouse
*8-332-0161,
Evendale

CATIA (Computer-Aided Three-Dimensional Interactive Application)

Since the stone age, man has had to communicate the shape of objects using two-dimensional pictures. Over time, these pictures have moved from the walls of caves on to paper documents, but the task of defining and communicating exact geometric shapes has remained relatively unchanged until recently. During 1989, a team from Engineering Technical Support and Aircraft Engines Systems implemented a new computer-aided design system called CATIA.

This system has allowed engineering designers to complete engine component designs by generating three-dimensional solid models. These electronic solid models are then quickly telecommunicated to similar systems at Boeing, Rohr and other airframers that have CATIA. As a result, the designs are easily validated for compatibility with the airframe systems. By using CATIA as an integrated systems design approach between Aircraft Engines and airframers, design errors and component interferences will virtually be eliminated.



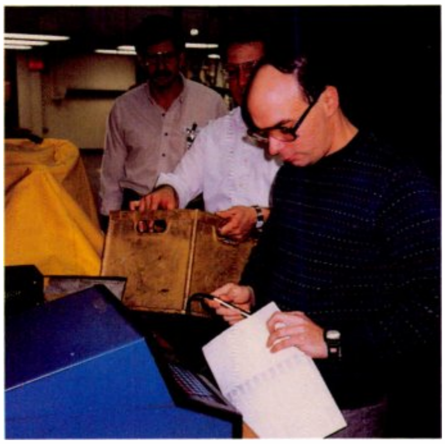
CATIA

Source: Mike Bleill
*8-332-0453,
Evendale

Electronic physical inventory system

Physical Inventory is a day in which every part manufactured is physically counted and recorded by teams of employees. Rutland's new Electronic Physical Inventory Software uses existing Welch-Allyn data collection devices to allow for the quick and easy taking of inventory. In the past, tremendous effort was expended to collect, keypunch and correct the data entered. Now, by simply scanning the parts' identifying code bar, the data is collected and verified. This built-in on-line audit capability reduced Rutland's errors to near zero of more than two million pieces counted. In addition, summarized reports and data are available the same day. In 1989, Aircraft Engines Hooksett used the new software and had similar outstanding benefits.

Source: Bill Montross
*8-560-1334,
Rutland



Electronic physical inventory system

Flexible Electronic Gaging

Complex airfoil geometry, high production and process control requirements promoted the design and purchase of the Sigma Flexible Electronic Gage. This airfoil gage is a custom five-axes DCC machine where all axes are under simultaneous control. The gaging system provides many unique features that promote the advancement in airfoil measurement and analysis, such as real-time, fully integrated statistical process control and multiple part numbers inspection. The system is operator friendly, and offers selective characteristic menu (full range of characteristics, i.e., all thickness and chords), and is capable of best fitting airfoil contour for all sections. Prior to the implementation of the gaging system on the CF6-80C2 Outer Guide Vane, verification of the airfoil contour was performed on a Coordinate Measuring Machine (CMM) which took several hours to run and analyze. Now, the gaging systems perform the same measurements in a matter of minutes. The Sigma Flexible Electronic Gage has provided Albuquerque Composites with a system that assists in identifying product variation early in the production line.

The system assists real-time analysis, flexible part measurement definition and cycle time. Each of these areas has saved many thousands of dollars while providing our customer with an improved quality product.

Source: Lonnie Ross
*8-455-2474,
Albuquerque

Pressure Welder

Test cell upgrades

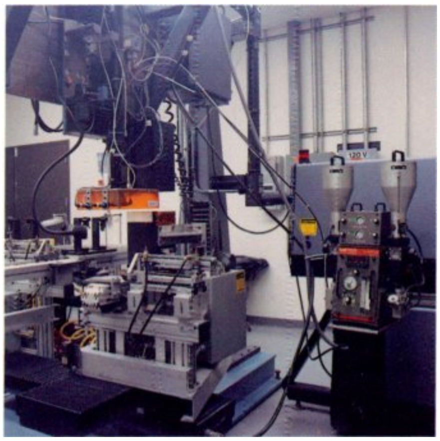
Major modifications to Lynn test cells 114 and 115 for development testing of advanced fighter engines were completed last year. Cell 114 now has the unique capability of multi-axis thrust measurement which enables performance testing of engines capable of thrust vectoring. The micro-computer-based thrust measurement system measures forces in all six degrees of freedom and displays the resulting thrust, its location and vector angle. Cell 114 is also equipped with a new heated inlet system capable of raising inlet air temperature from 0°F to 120°F. This unique binary system uses steam as the heat source and ethylene glycol as the medium for transferring heat to the cell inlet heat exchangers. This eliminates winter freeze-up problems which can cause expensive damage to the system.

Both cells are equipped with a newly developed 3,000 channel, high speed data system which has enabled data logging time to be reduced from up to 10 minutes to a matter of seconds. Cell 115 is supplied with ram air from a steam turbine driven F101 fan. The ram-air flow capability was increased by eliminating an overboard air bypass and using the full air flow capability of the F101 fan for ram air. In spite of the magnitude and complexity of the modifications required in these two facilities, both cells went through extremely successful checkouts and operated trouble-free once productive testing was initiated.

Source: Ken Moser
*8-263-4664,
Lynn

Laser welder

At the Tennessee Avenue facility, GE people repair high pressure turbine blades by extending the tip to replace material worn or corroded in engine use. Previously, manual TIG welding was used to perform this operation. Now, a vision-assisted, powder-fed laser welder is used to build up the blade tips. The vision system digitizes each blade individually, then writes a unique numerical-



Laser welder

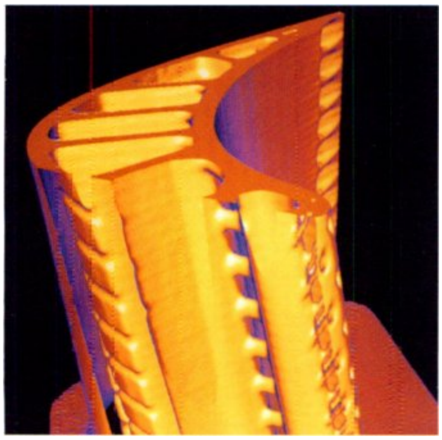
control program for operating the welder. The weld build-up is near-net shape which reduces the amount of benching work to return the blade to proper dimensions.

GE was unable to find such a unique machine tool anywhere. To accomplish the task, a collaborative team consisting of service shop engineers, welding engineers and engineers from the Quality Technology Center, the Manufacturing Technology Laser Lab and the Factory Automation group put this do-it-yourself project together. The result is a leading-edge technology process that has received several patents for innovative design solutions. The automatic welding of blade tips using the laser welder has resulted in annual savings of more than $250,000.

Source: Gary Richter
*8-335-3583,
Cincinnati Service Center

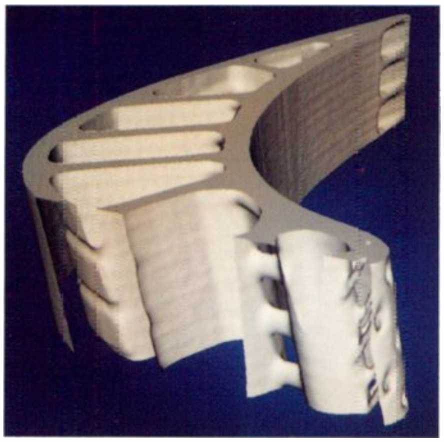
Digital Replication™

Modern jet engine designs are resulting in increasingly complex turbine blade shapes which operate in a high temperature, high stress environment. In order to assure proper blade performance and life, parts must be manufactured to very close tolerances. The traditional method of inspecting blades is to cut them up and compare the cut sections to engineering drawings.



Digital Replication™

Digital Replication™ is a new method of making highly detailed and accurate three-dimensional electronic models (Digital Replicas) of complex components such as blades which are being developed by GE Aircraft Engines and GE Corporate R&D. To make a Digital Replica, a part is scanned over its full volume with one of GE Aircraft Engines' industrial CT scanners, and the digital data is processed to build the electronic model.



Digital Replication™

The Digital Replication can be "cut up" electronically to check blade dimensions and view internal structure without damage to the physical blade. The Digital Replication process is faster and provides more information than the traditional cut and measure process. Digital Replication also facilitates rapid structural and thermal analysis of actual parts by providing the geometrical data needed for the engineering analysis.

Digital Replication is in daily use at Aircraft Engines' Quality Technology Center and is being implemented in its Evendale and Madisonville airfoils manufacturing plants.

Source: Joe Ross
*8-758-4716,
Quality Technology Center,
Cincinnati

F404 Engine flight test

F404-400 high pressure compressor stage 1 and stage 3 blades have been redesigned to correct a fatigue-failure problem. The U.S. Navy was preparing to spend $35 to $40 million to retrofit the redesigned blades into engines in the F/A-18 Hornet aircraft. It was necessary to measure the vibratory stresses of the redesigned blades throughout the F/A-18 flight envelope to demonstrate the adequacy of the redesign.

Two methods to measure rotating blade stresses were used in this flight test.

1) Strain gages are attached to the rotating blades, and the signals generated are transmitted by radio telemetry from a transmitter mounted in the rotor to an antenna mounted in the engine stator and then to electronic signal processing and recording equipment.

2) Light probes are mounted on the high pressure compressor casing over the blade stage to be measured. Blade tip vibrations are sensed optically by means of light signals transmitted through fiber-optic bundles. The signals are processed and recorded electronically.

Previous flight tests using telemetry were conducted on passenger-carrying aircraft where telemetry conditioning and recording equipment were located in environmentally conditioned cabins and the aircraft was not subject to the high-G maneuver loads of a fighter aircraft. Light probes have never before been used in a flight test. GE Aircraft Engines people, working with the U.S. Navy, designed and fabricated environmentally conditioned capsules for the telemetry and light probe signal-processing equipment. GE people rebuilt the signal-processing equipment to withstand the harsh vibration and G-loading encountered in a fighter aircraft flight test.

The flight test successfully demonstrated the adequacy of the redesigned blades.

Source: Jim McGuinness
*8-263-2097,
Lynn

Hybrid exhaust emissions measurement system

Fuel combustion efficiency is of particular importance to customers, environmentalists and to those of us who manufacture jet aircraft engines. Combustion efficiency is determined by the analysis of exhaust gas constituents. Test criteria dictate one of two systems for these measurements: pollutant or combustion performance, and their respective efficiency calculations. A more cost-effective approach was needed.

Instrumentation Engineering people "hybridized" these two measurement systems into a single system capable of either measurement. A PC-based computer system controls the hardware and provides real-time data acquisition/reduction, permitting the test engineer "in process" test optimization. The system, on board a mobile van, readily provides for remote-site testing capability. Projections indicate a 50% cost savings in combustion performance measurements.

Source: Russell Arey
*8-730-2107,
Evendale

Winning Teams

In the history of Aircraft Engines, 1989 may go down as the year when more than ever we realized the benefits accruing from teams: teams that are breaking down old hierarchies and inventing better ways to communicate—working across functions and plants and business components—proving that the synergy of employees working together not only improves work life, but product quality as well. And teams are proving that those products can be made faster and more efficiently.

Picture this. At a remote camp site in southern Indiana, six groups of men and women are huddled over tables pushing and pulling at tinkertoy spools and rods. Everybody's in on the act—with an opinion and plan in hand. Just one hand, mind you. The other is behind their backs.

Their goal? To build a bridge that spans 24″ and holds a four-pound weight. They also simulate all the functions in a paper airplane factory. They go back-to-back with a partner trying to guess what that person has changed about his or her appearance.

Not exactly the typical day in the life of an Aircraft Engines employee. But then there's nothing about the camp that's business as usual.

Take Bob Huff. He's an IAM carpenter at Evendale who designed the tinkertoy exercise above. A former professional rodeo circuit rider, Huff and several other production employees had spent their week not in maintenance or retooling machines —their regular jobs back at Evendale —but in facilitating a week-long training session called Winning Together, which teaches employees how to work better as a team.

The training brings together natural work groups from across Evendale—a diagonal slice of an organization that includes managers, supervisors, specialists and hourly workers. The groups learn how to create a shared vision for how they can improve their work. They then write short and long range plans for carrying out their vision.

By doing exercises like building the bridge, they learn to begin to trust each other more. To listen to each other's ideas. And to share a sense of power by making decisions together.

Need for change

Why so much emphasis on teamwork and training? "Because people all over the business could see that the way we were doing things wasn't working," says Evendale's Organizational Effectiveness Manager Tim Hutzel.

"Traditional organizational structure says that the people on the top tell people in the middle what to do to the people on the bottom. Everybody was competing to please the boss and had forgotten about the customer—who often came last," noted Hutzel.

Add to that global competitors who threaten to take away business and a changing customer base from military to commercial, says Hutzel, and it became clear "we had to think about improving our quality and service if we were to stay number one."

So three years ago Hutzel started the Winning Together training, which is based on the principle that if a factory system is to change, the people who work there have to be involved in designing the new environment—not management experts.

And what began as a quiet grassroots effort has become a popular and important team-building process for Evendale. With a base of 900 employees who have gone through the Winning Together training over the last three years, in 1990 alone Hutzel and facilitators plan to train 1,500—accelerating from 13 sessions in 1989 to 34 this year.

"Winning Together" at Evendale

Outward Bound

While admittedly a few leave the session feeling unsure of how to put their new team experience to work, the majority are enthusiastic about the training.

Forging new ground

After a year or two, there have been some impressive results from the training. Bob Hastings, manager in Equipment Maintenance, and a number of people in the area have first-hand experience.

A few years ago, efforts to look at how the group could improve the service to their production customers led to several hourly and salaried employees coming up with a plan to totally recondition an old lathe instead of constantly repairing breakdowns during production.

In the process the team forged some new ground—mostly in the way they worked together.

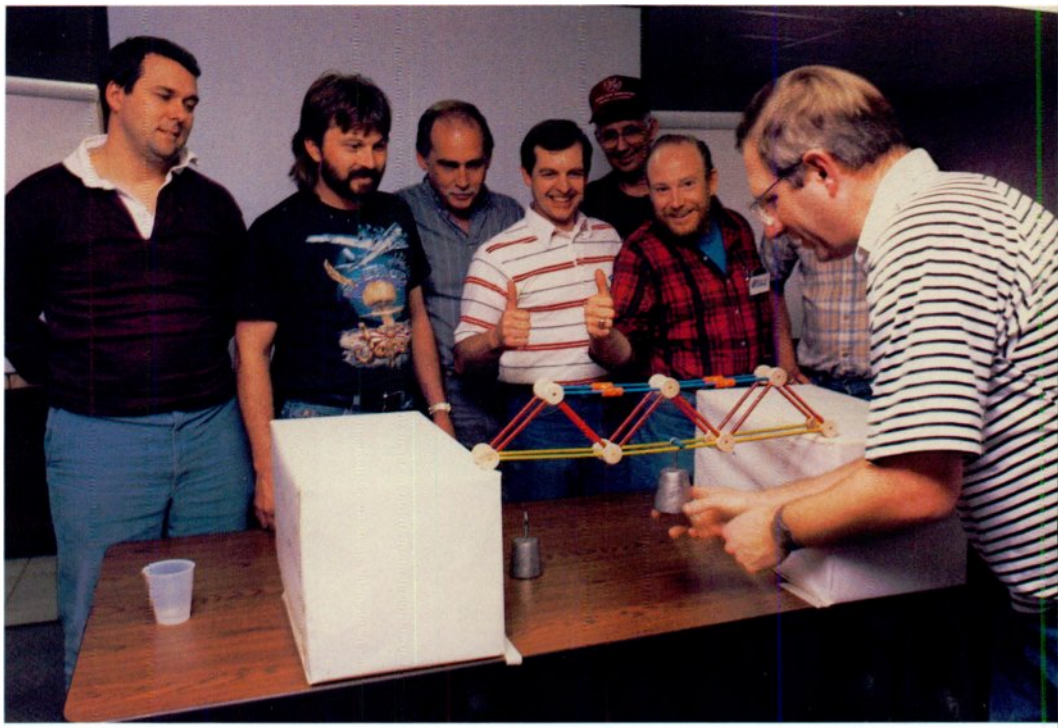
— Hastings began to serve as a facilitator and coach rather than as a person who gave orders.

— The team was empowered to plan and schedule their own work. They later helped select their new supervisor.

— When the process was complete, the 30-year-old lathe was returned to production good as new.

— As a direct result, a new business, the Equipment Re-condition Group, has been started in Equipment Maintenance.

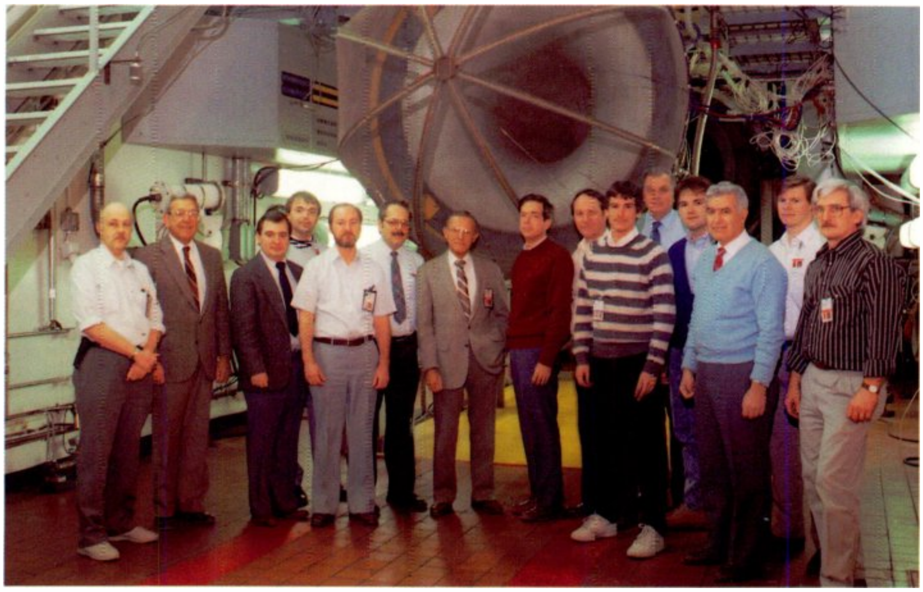
"What we're doing has a big impact on production," says Machine Repairman Ed Dempsey who is part of the team. "There's less downtime and more quality parts because of the job our team is doing." In the future, Dempsey even predicts such team efforts can lead to zero scrap and zero downtime.



Bridge to the future at "Winning Together"

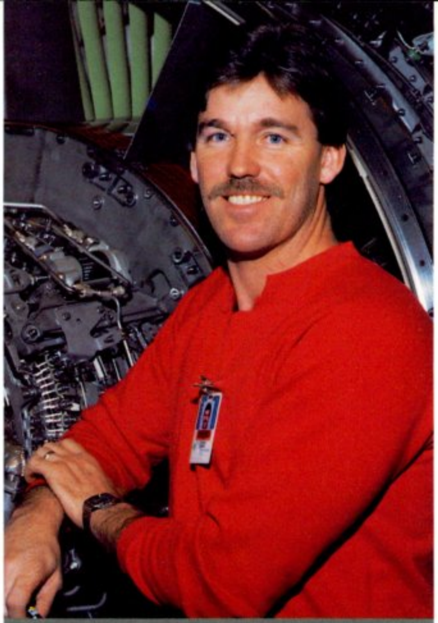
To make their team even more cohesive, Hastings and some members of his crew also participated in Venture Out—a series of physical exercises designed to show teams how they are—or aren't—working together, says Evendale's Manager of Experiential Education Bill Kuhn.

Exercises such as tightrope walking between trees and jumping from platforms 20 feet high to catch a trapeze may sound dangerous. But the environment is really safe, Kuhn says. "The only risks are mental ones —because the only way *one* person can get over a wall, or climb a rope, is if the whole team plans a strategy so they *all* get through the course."



Test cell modification team, Lynn

On the factory floor at Bromont



"When airplanes leave the airframers' assembly, they take off for a test flight. Once the engine is on the plane, it just has to be right. You can't fix it when it's in the air."
Eddie Edwards
assembler,
Evendale

Sharing the Knowledge

"It's the same in the factory," says Hastings. Nobody has all the answers there either. But everybody has a piece of the answer. In a team everybody shares their knowledge.

If any business component has learned the importance of team members sharing power, it's GE Canada's Bromont facility. From its start-up eight years ago, the facility has based its superior performance on participative management philosophy, based on the comprehensive integration of human and technological systems.

At Bromont everybody is trained to participate in the team process and is expected to be on several teams. Employees learn and do several jobs. Communication is considered the determining factor in Bromont's success, and "listening—not talking—is what is important," says Luk Pellerin, Human Resources Manager. "When you really listen, you assume that what employees tell you is intelligent and creative."

Teamwork— a Way to Be

Pellerin is also quick to point out that teamwork is a long term process—a way to be—not a quick recipe for success. And that it takes managers who are willing to "walk the talk" with their employees—by serving *with* them as team members and giving up some of their control.

As a result of its skill in marrying teamwork with the best technology, Bromont has achieved impressive bottom-line results: The facility's first full year of production in 1984 netted 142 sets of blades with 405 employees on board. Last year 620 employees produced 1,400 sets. And the shop cost to produce a set was cut 60%.

At Aircraft Engines' Rutland plant, employees are systematically implementing a technical and social change effort. The process has involved an extensive analysis of how processes are performed, where bottlenecks and variance points are, and how work can best be structured to maximize quality at every step in the airfoil manufacturing process.

Not surprisingly, heavy emphasis is being placed on teamwork, multiskilling and communication, says John Sollazzo, manager of Employee and Community Relations.

Their goal? "To be the most competitive we can be, and through this overall plant transformation to put wheels on Continuous Improvement," says Sollazzo.

As at Evendale, production employees who are the closest to manufacturing operations are being used as trainers. And their teams are being given the authority not just to raise problems in the factory, but more importantly, to make fixes as well, says Sollazzo.

Again the business is reaping the benefits.

- Two teams in Lynn's Dovetail Machining Unit cut manufacturing losses per blade by 30% from 1988.
- The teams saw a 10% to 20% improvement in output while dropping from three shifts to two.
- And they reduced their production cycle from six to five weeks.

NOT WITHOUT HEARTBURN

Sollazzo and others involved in changing from traditional organizations to new team-based systems say that the change is not without its heartburn. Some supervisors feel more anxiety than others. And as the teams develop, different cultures and ways of operating may exist in different parts of the same plant.

AMR Eagle team, Lynn

But team-building exercises are aimed at helping employees understand that change takes patience and that newly trained, enthusiastic teams pouring their skill and knowledge back into the factory may not be accepted or appreciated—at first. But it's not long before results take hold.

Here are other success stories from around the business proving that teamwork pays off in a variety of ways:

— In Lynn, the development of a new Material Review Board (MRB) system involved multifunctional teams and employees from across eight Lynn, Hooksett and Rutland plants. The results? More than 700 users internally, as well as their customer, the Department of Defense, now have access to the same computerized information for handling non-conforming engine parts.

"As a result," says Donna Sieckert, manager of Quality Technology Programs, "the new computer system allows for the elimination of the paper hold ticket, speeds the MRB process, helps eliminate recurring problems and also adds to the reduction of product losses.

"Most important, however, is that the project's success came as a result of the involvement and ownership of users at all levels for the initial design and continuing improvement of the new system.

"Many inspectors who initially were reluctant to enter hold ticket data into a computer terminal now would never think of writing another paper ticket," says Sieckert.

— Hooksett finished 1989 with its best quality performance ever. Manufacturing losses were down from 5.4% in 1988 to 4.3%. Lynn Production Division selected Hooksett as the recipient of the fourth quarter quality award and the 1989 yearly award for quality excellence.

— At Strother, Wally Del Core, manager of Materials and Traffic, and a team of reps from the other satellite shops, helped design a new material support network using a software package called Axiom. With the new system put in place in December, all the shops now have the same information on distribution, parts inventory for their customers, and will be able to improve ordering, shipping and distribution throughout the system.

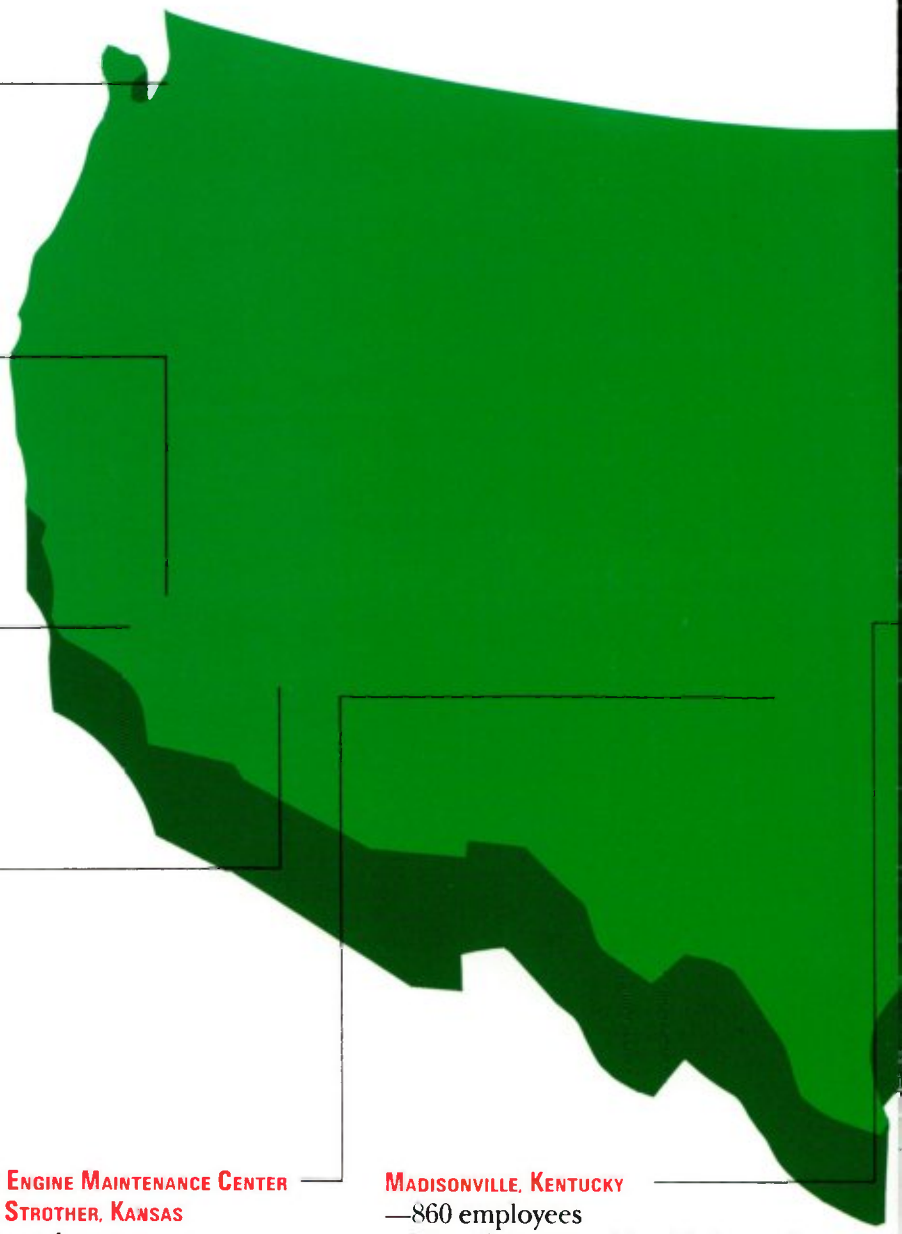
— At Evendale, a team effort that helped break down communication barriers between design and assembly resulted in a net savings of $3,050 per engine on the F110-GE-100 program. Keith Alexander, team leader, and Tom Bode, a producibility engineer, helped lead the effort that reduced engine assembly cost and cycle time.

"Employees separated by function and building got to meet for the first time," says Alexander. "And the team who designed the product got feedback from the production people on the floor as to how they could improve the design. Involvement and communication were the keys to the project's success."

F110 Cost-Continuous Improvement team, Evendale

Geography Lesson

GE Aircraft Engines Facility Locations.



Aviation Component Service Center (ACSC), Cincinnati, Ohio; Seattle, Washington; Singapore
—2,000 employees
—Performs component overhaul and repair work for commercial airlines, general aviation customers and the military. Also manufactures test equipment and other products used to support GE engine programs. (Singapore not shown on map.)

Flight Test Operation (FTO), Edwards/Mojave, California
—300 employees
—Carries out flight test, design and fabrication of commercial lines.
—Performs jet engine field maintenance and provides engineering support for military engines.

GE Engine Maintenance Center (EMC), Ontario, California
—900 employees
—Performs engine overhaul and repair for CF6-6, CF6-50, CF6-80A and CF6-80C2 engine lines, as well as LM2500, LM5000, F404, CT58, T58 and J79 engines.

Albuquerque, New Mexico
—1,600 employees
—Manufactures turbine shrouds and seals, thin-wall aluminum cases and composites—a global leader in the manufacture of lightweight, high temperature composite hardware.

Bromont, Canada
—600 employees
—Manufactures compressor airfoils. Bromont has been a leader in implementing participative management, based on socio-tech principles. (Bromont not shown on map.)

Aircraft Engine Maintenance Center (AEMC), Strother, Kansas
—1,000 employees
—Performs repair and overhaul for CFM56, F110, CJ610/CF700, CF34, CT7, J85 and T700 engines, with more than 3,000 commercial, military and government customers worldwide.

Madisonville, Kentucky
—860 employees
—Manufactures turbine blades and vanes for aircraft engines, as well as marine and industrial applications.

Rutland, Vermont
- —2,300 employees
- —Manufactures precision airfoils (blades and vanes) for all GE's commercial and military engines.

Hooksett, New Hampshire
- —850 employees
- —Performs engineering, manufacturing and quality control for vane sectors, tubes, blisks, impellers and bellcrank components for aircraft engines assembled in Evendale and Lynn.

Lynn, Massachusetts
- —7,750 employees
- —Designs and produces aircraft engine parts, small aircraft engines for a wide range of military and commercial applications, and marine and industrial engines.
- —Also designing propulsion system for future tracked combat vehicles.

Peebles Test Operation (PTO), Peebles, Ohio
- —230 employees
- —Outdoor test facility: Tests development aircraft engines. Develops technical parameters and requirements for simulated icing, hail ingestion and bird ingestion tests.

Commercial Product Support Center, Cincinnati
- —1,000 employees
- —Provides worldwide customer satisfaction for GE Aircraft Engines commercial and military customers. Support services include technical manuals, spare parts, product support engineering and warranties for all large commercial engines.
- —Works with Group Field Service and GE technical reps stationed around the world.

Product Support Distribution Center, Erlanger, Kentucky at Greater Cincinnati International Airport
- —40 employees
- —Distributes commercial and marine and industrial spare parts to locations around the world.

Greater Cincinnati, Evendale, Ohio
- —18,000 employees
- —GE Aircraft Engines headquarters and advanced technology center.
- —Designs and produces aircraft engine parts, large commercial engines (CF6, CFM56), military engines (F110, F108) and marine and industrial engines (LM2500, LM5000).

Wilmington, North Carolina
- —1,200 employees
- —Produces 130 different rotating parts and engine casings in a highly automated facility to support CFM56, F404, CF6-80C2 and F110 engine programs.

Durham, North Carolina
- —Will employ more than 500 people when plant becomes fully operational in 1993 or 1994.
- —Will manufacture compressor vanes and blades for GE engines.

Engine Support Operation (ESO), Cincinnati, Ohio
- —550 employees
- —Provides ground support equipment and expertise for all military and commercial engine programs.
- —Also markets its engine facilities, test, repair and overhaul skills worldwide through the International Engine Support Operation.

Our Sales Dollars

—And How We Used Them

GE Aircraft Engines business-wide 1989 sales dollars.

Sales from our customers were in excess of $6.8 billion. 100%

In 1989 we produced 902 commercial engines and 1,394 military engines group-wide. In 1988 we produced 789 commercial and 1,624 military engines.

Cost of materials to make our products 41.6%

During the last year our operations required the purchase of outside goods and services which included material, tooling, rental costs, services, office and shop supplies.

Cost of human energy 27.0%

Our next largest expenditure in 1989 was for wages, salaries, pensions, medical and other benefits for our employees. This includes company payments of social security and unemployment benefits.

Cost of buildings and machinery wearing out 3.2%

These are dollars spent for the depreciation and wear of buildings and machines. The cost of each year's purchases is spread out over its useful life in this way.

Cost of utilities, maintenance, property taxes and insurance 3.6%

This amount includes gas, electric, water, maintenance, property taxes and insurance.

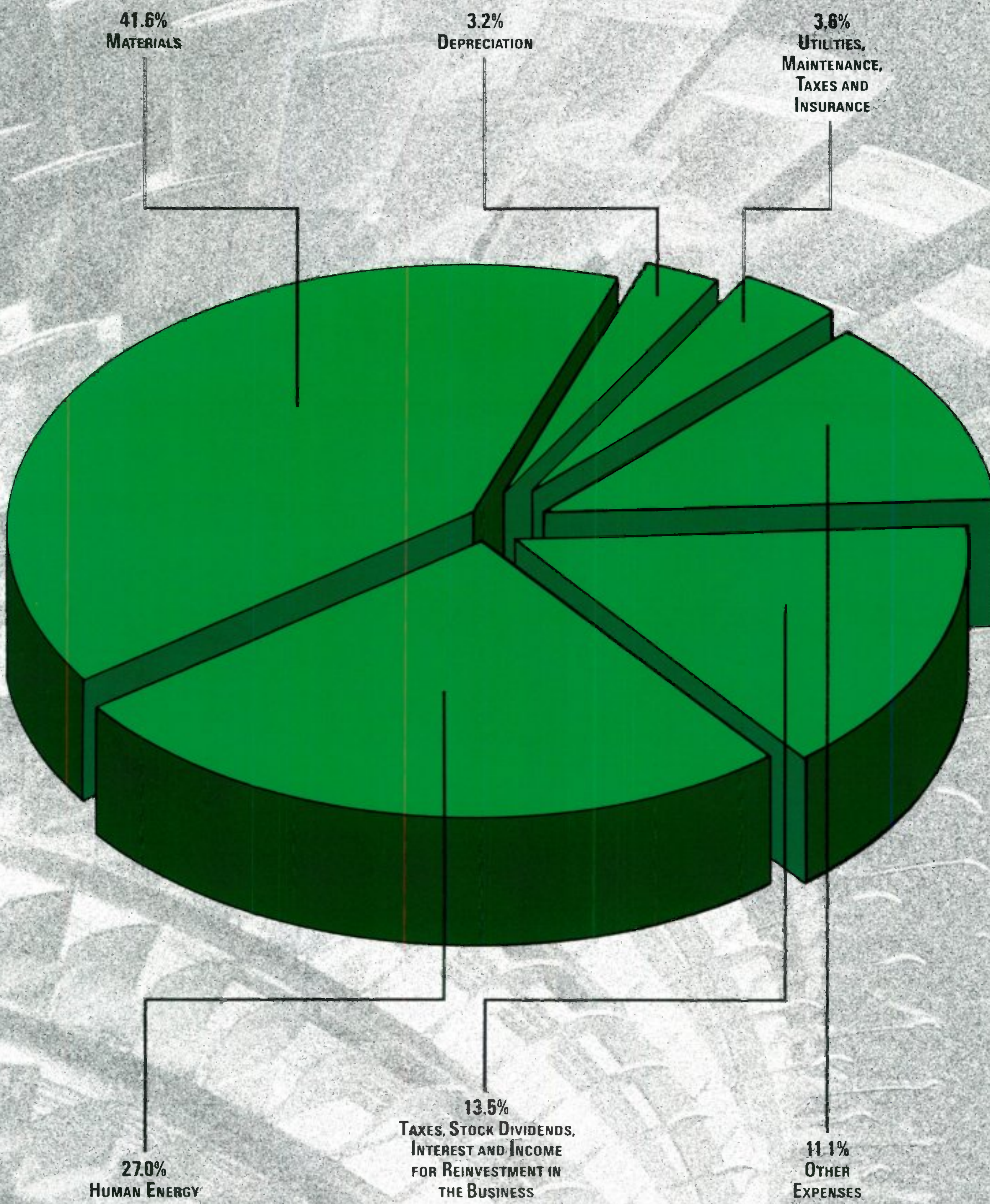
Other expenses 11.1%

This amount includes all other costs to run the business, including product and customer support.

Operating income 13.5%

These dollars are spent for taxes, return to stockholders, interest and income for reinvestment back into the business.

GE's Corporate Annual Report, which was distributed in March, gives a detailed look at the company as a whole and how Aircraft Engines fits into the total company strategy.


41.6%
Materials
3.2%
Depreciation
3.6%
Utilities,
Maintenance,
Taxes and
Insurance
27.0%
Human Energy
13.5%
Taxes, Stock Dividends,
Interest and Income
for Reinvestment in
the Business
11.1%
Other
Expenses

Looking Back

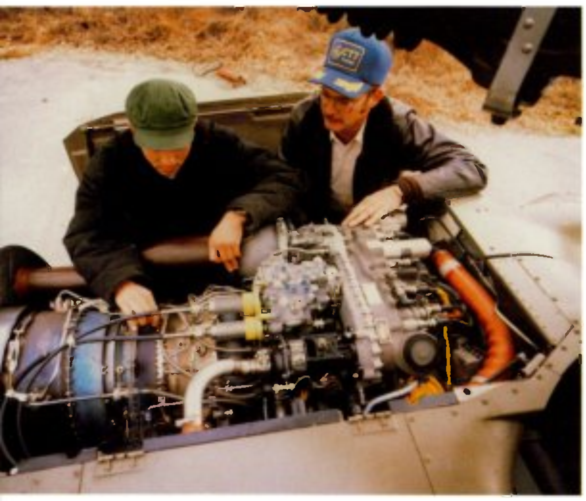
GE Aircraft Engines entered the 1980s with a goal—world leadership.

It was an ambitious goal in view of the fact that the decade had begun in tough economic times, which included high fuel prices and airline deregulation. Then came the military build-up of the middle years, and the surge of commercial business in the later years.

By the end of the '80s, GE Aircraft Engines had achieved its goal for the decade. How was that accomplished and how will we maintain that position in the years ahead? Brian Rowe, senior vice president for GE Aircraft Engines, put it this way: "Others don't always understand what makes GE Aircraft Engines so good. I do. Our people have world-class talents and skills, and something else—the spark that makes things happen."

Here are highlights from a decade of successes.

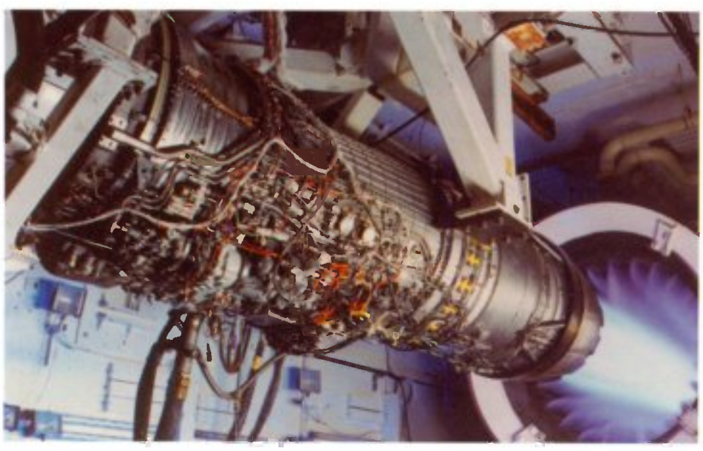
The CFM56 engine family took off in the '80s to become the single most popular commercial engine family in the world.



CT7, a commercial version of the T700, was developed in 1980 as an advanced turboprop. It was certified in 1983 and by the end of the decade 150 were in service.

The TF39 returned for another military production tour.

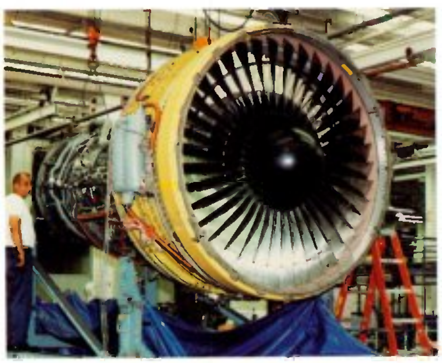
The LM2500, a marine derivative of the TF39/CF6-6 engines, provided power for modernization of the U.S. Navy surface fleet.



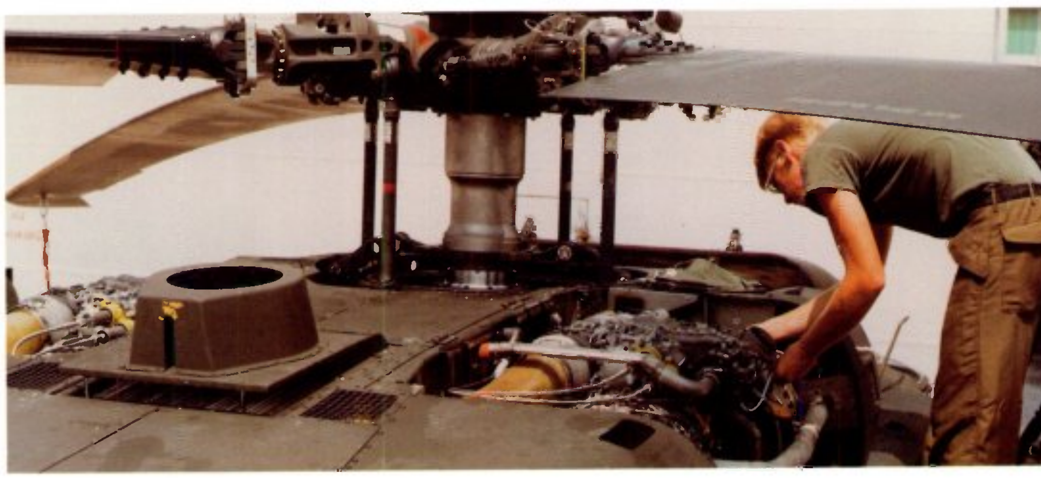
The F110 pushed competition aside to keep GE in the thick of the military fighter business; the Increased Performance Engine (F110-IPE) entered production.

The F101 took its place aboard the B-1B at the forefront of America's strategic bomber fleet, and the F118 followed aboard the B-2.

F404 total production for the F/A-18 was awarded to GE in 1989, after the U.S. Navy had the engine co-produced by Pratt & Whitney in 1984.



The CF6-80 engine family helped usher in the '80s commercial business and became the CF6 'bread 'n butter' engine, with the -80C2 the premier large engine of the decade.



By the end of the '80s more than 5000 T700/CT7 engines had been shipped. Production continues into the 1990s.

Community service and employee contributions to charitable organizations grew substantially in the 1980s. One standout event was the award of $1 million from the GE Foundation to GE Aircraft Engines' "Partner In Education," Aiken High School in Cincinnati.

Commercial development engines include the recently announced GE90, a new-generation high thrust engine, and the UDF* engine. Military development engines include the YF120, T407 and LV100. Development of the CF6-80 engine family, marine and industrial engines and other products also continues.

In 1989, GE Aircraft Engines was indeed the leading producer of aircraft engines worldwide, with a backlog of firm orders that reached some $13 billion, and another $22 billion in options. Now the challenge is to continuously improve upon those accomplishments as we move toward the year 2000.

Looking Ahead

1989 was a very successful year for GE Aircraft Engines. I want to thank each of you for your contributions to that success.

Since this report signals not only the beginning of a new year, but also the beginning of a new decade, I've given a great deal of thought to how far we've come in 10 years and also to where we're going in the 1990s.

In 1980, our sales were just over $2.6 billion. Our 1989 sales were almost $7 billion. In the '80s, we moved from number two in the marketplace, behind Pratt & Whitney, to number one. Many things went into that success—our superior technology, outstanding product support and service to our customers, solid business planning and, most of all, the great efforts of our people.

I am very proud of what we've accomplished. And I feel optimistic as I look down the road to the opportunities before us. Our dedication and excellence paved the way, and can continue to do so.

We have more development work going on today than ever before. This work is essential to our future because to maintain and grow our sales, we must fill the needs of our customers. The sales we made in 1989, for example, would not have been possible without our significant investments in development over the years.

In the 1990s, we will continue such investment in our products, plants and equipment, at a rate of better than $1.6 billion a year. We will also continue the share-to-gain partnerships that have helped make us so successful around the world. We pioneered this share-to-gain concept in the jet engine industry, and it has been proven that sharing the development and production of new engines with other countries is beneficial to all.

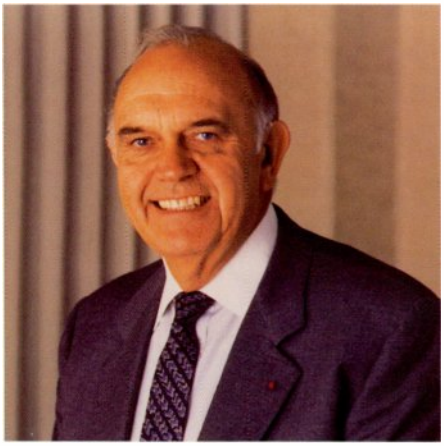
A prime example is CFM International, a joint company of GE and SNECMA of France, which produced the best-selling CFM56 engine and gained entry to markets which might otherwise have been closed to us. In 1989, GE Aircraft Engines and CFM International took orders, options and commitments for a combined total of 3,700 commercial transport engines. The success GE and CFMI enjoyed in the 1980s is unequalled in the industry.

Now we, along with our partners, will offer the GE90, a new high-thrust, high-bypass engine, to airlines as a powerplant for the Boeing 767-X and other potential widebody applications.

So, while the word "globalization" entered our vocabularies in the 1980s, the 1990s will bring even more interactions with companies and customers throughout the world. Our competitors recognize this and are developing their own share-to-gain partnerships.

There's no question that the great changes we're seeing around the globe signal a very different world, politically, socially and economically, in the 1990s and beyond. These changes will impact the global marketplace in ways we have only begun to calculate. The economic revitalization of western Europe is well on its way. Japan is strengthening its already strong position in the world economy. And Pacific Rim nations like Korea are working hard to become serious international forces.

All this means both greater opportunities and greater competitive pressures as the stakes get higher in search of emerging markets. To meet these pressures, we must continue to find ways to make work simpler and to produce better and better products more quickly—products of both higher quality and higher value.



As I have said repeatedly this past year, I believe Work-Out and Continuous Improvement will provide the focus and the means for us to attain our objectives. My staff and I devoted a great deal of time in 1989—almost a working calendar month—to the study of the new ways of operating a business that are emerging in the world. As we dug deeper and deeper into these ideas, it was clear to us that these new ways must become a way of life for all of us at Aircraft Engines. Continuous Improvement and Work-Out will help us continue doing the things we do well and improve the things we can do better.

I am encouraged by the involvement of Aircraft Engines people in Continuous Improvement and Work-Out education and process application in 1989. The new ways involve continuous, lifelong training and education—for all of us. Remember, it is up to all of us to continuously improve and to "Find a Better Way Every Day."

Thank you for your efforts in 1989. I look forward to our team efforts focused on our customers in 1990 and the years ahead.

Brian H. Rowe

Brian H. Rowe

Acknowledgements

It takes teamwork to build a quality, state-of-the-art jet engine. It also takes teamwork to tell the story of the people who make that happen. We extend sincerest thanks to the following people who contributed ideas, assistance, insights and support for our 1989 Employee Annual Report.

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Precious Cargo

GE People—Aiming High, Earning Their Wings Everyday

The customer's customer. GE Aircraft Engines Vertical Turret Lathe Operator Dan Sheppard, with his wife Dianna, daughter Carrie and son Ryan at Greater Cincinnati International Airport.

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Editor
Paula Kollstedt

Contributing Writers
Susan Eckert-Hume
Judy Gillis
Al Stevenson

Design
Lamson Design, Cincinnati, Ohio

Production
Bill Roush

GE Aircraft Engines

One Neumann Way
Cincinnati, Ohio 45215-6301