A HISTORY OF EASTERN AIRCRAFT DIVISION

EA1432-10M-12-43-LN

AUTHORIZATION FOR PAYROLL DEDUCTION FOR LOST TOOLS

CLOCK NO. _____ NO. _____

NAME _____ DATE _____

CREDIT ACCOUNT _____

_____
Employe's Signature

QUAN.	CODE	DESCRIPTION	PRICE	AMOUNT

COMPT'D

APPROVED:

_____ General Stores

_____ Paymaster

TOTAL

Deduction Made On Week Ended

To a girl the people thought the world about
Good. Luck. R-Bobolewski (31)

John Ruzzo
31#
Doc DelSordo
R.J. Bertolami
Bon Natale.
[illegible] (Supt.)

To one of the most
nicest persons that I've met
Mary [illegible] Dept 31

Send me your address
and I will send you a nice apron.
John L. Lehmann Mgr

Very Best Wishes To You Always
Stella [illegible] Dept #31

Peg Miller (Crib #7)

William Liebhaber Dept 35.
(Foreman)

Paul [illegible] R. [illegible]
a heart of gold
Foreman Dept 31)

Emily Reid
Edward E. Pellerin
Mike Duca
14" Vinson file, Please
Please go to your foreman.

Best of luck to a lovely
person
Rose Hoefling

828

Russ. Klien

828

Jess. Kennard
(CALIF.)

Lots of luck to a
nice person.
Olga Chudoba
(Crib #5)

A HISTORY OF EASTERN AIRCRAFT

A HISTORY

OF

EASTERN AIRCRAFT

DIVISION

GENERAL MOTORS CORPORATION

EASTERN AIRCRAFT DIVISION

LINDEN, N. J. TRENTON, N. J. BLOOMFIELD, N. J.

TARRYTOWN, N. Y. BALTIMORE, MD.

1944

PRINTED BY WILLIAM E. RUDGE'S SONS

TO THE EMPLOYES OF

EASTERN AIRCRAFT

WHOSE HEARTS AND HANDS HAVE

MADE THIS ACHIEVEMENT POSSIBLE

THIS HISTORY IS DEDICATED

WITH THANKS

FOREWORD

THIS is a History of Eastern Aircraft. Like most histories which follow a period and pattern of time, it is unfinished. More dates, facts, and incidents could be added, but it was written when the Division had achieved its first goal – peak production of Avenger torpedo bombers and Wildcat fighter planes – but prior to the completion of one of the U. S. Navy's most vital war jobs.

The employes of Eastern Aircraft made this History. Few who have been with the organization for the past two years have been familiar with the over-all story, for Eastern's vast war production program was spread throughout five plants, each situated many miles away from the others; it was impossible for any one employe to visualize the entire picture. Thus, this History was caused to be written. It is hoped that in these pages each employe will gain a better insight into his contribution to the over-all effort, and will in turn continue to give the same wholehearted cooperation and loyalty to the job in the future.

Too much cannot be said for the help rendered in those early months by the Grumman Aircraft Engineering Corporation, and the United States Navy. In this period of trial and error, Eastern Aircraft leaned heavily on their experience and good advice. Much gratitude goes to the many aircraft companies who have shared their knowledge with this newcomer, and to the thousands of subcontractors and suppliers across the country whose aid was most significant in making it possible for Eastern Aircraft to perform successfully a vital task for the United States Navy.

L. C. GOAD

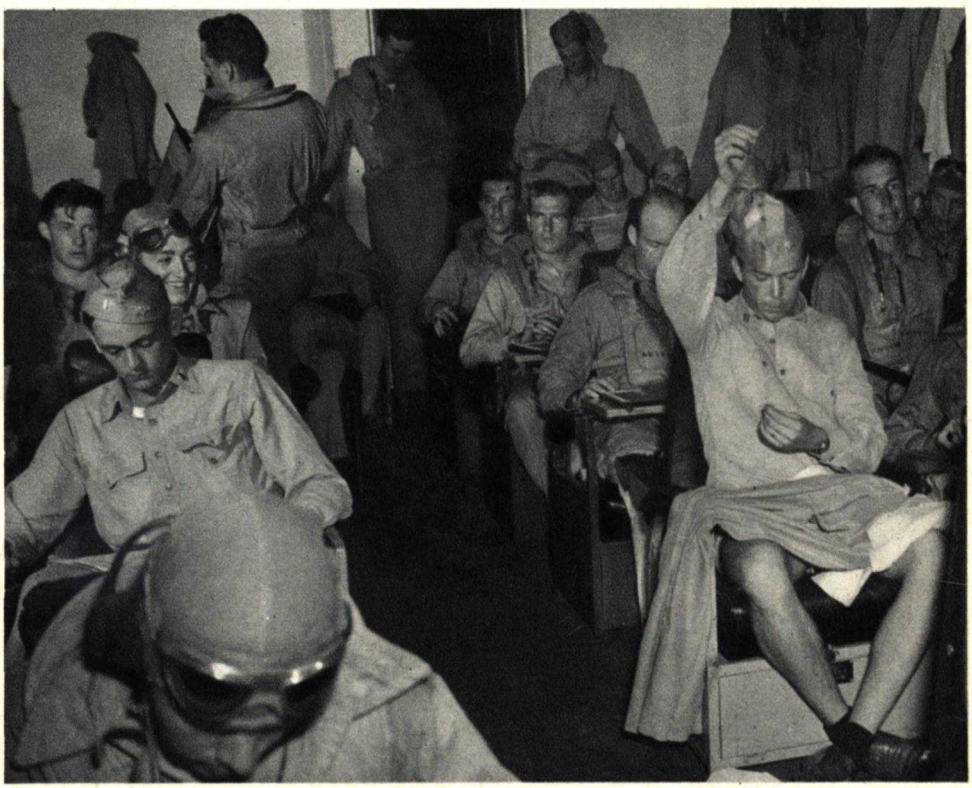
OUR PLANES IN ACTION

EASTERN-built Avenger torpedo bombers and Wildcat fighters, carried by Allied flat-tops the world over, range the enemy sea lanes by the thousands. Axis ships large and small have gone to the bottom of the ocean mortally wounded by an Avenger bomb or torpedo — and enemy fighters have been blasted from the skies by the scrappy Wildcat. Rated as two of the U. S. Navy's best planes, they carry the skill and hard work of Eastern Aircraft employes into every major battle.

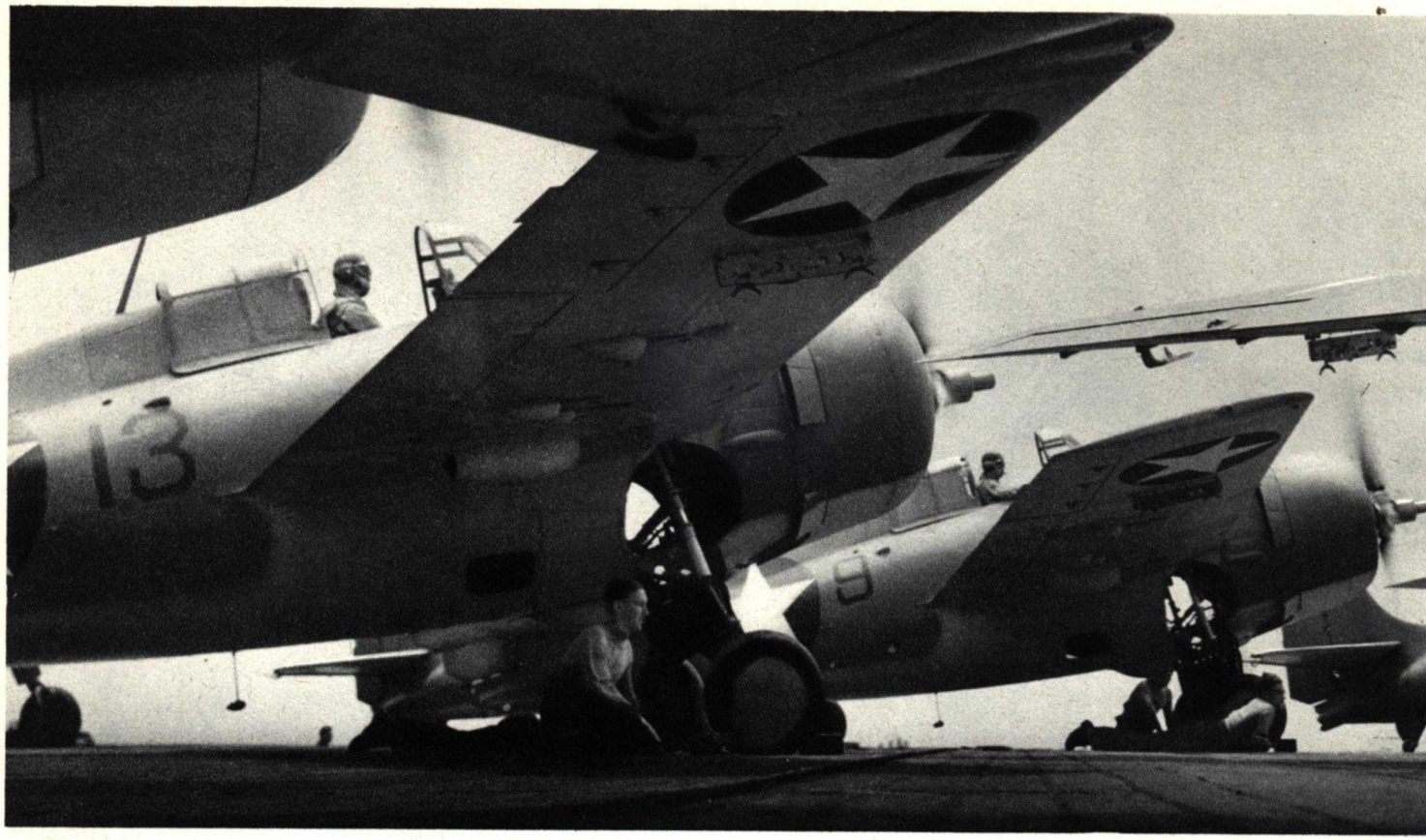
UP AND OVER . . . Seamen and officers aboard a flat-top at an American port watch intently as an AVENGER torpedo bomber is swung aboard ship. This mighty carrier-based ship is the product of many skilled hands.

UNDERWAY . . . The mighty flat-top depicted on previous page receiving an AVENGER, sets sail through a calm sea with a full complement of torpedo bombers and WILDCAT fighters. Their goal is a distant battleground.

ACTIVITY BELOW . . . A deadly bomb load is prepared amidst WILDCATS. There's a fight coming up.



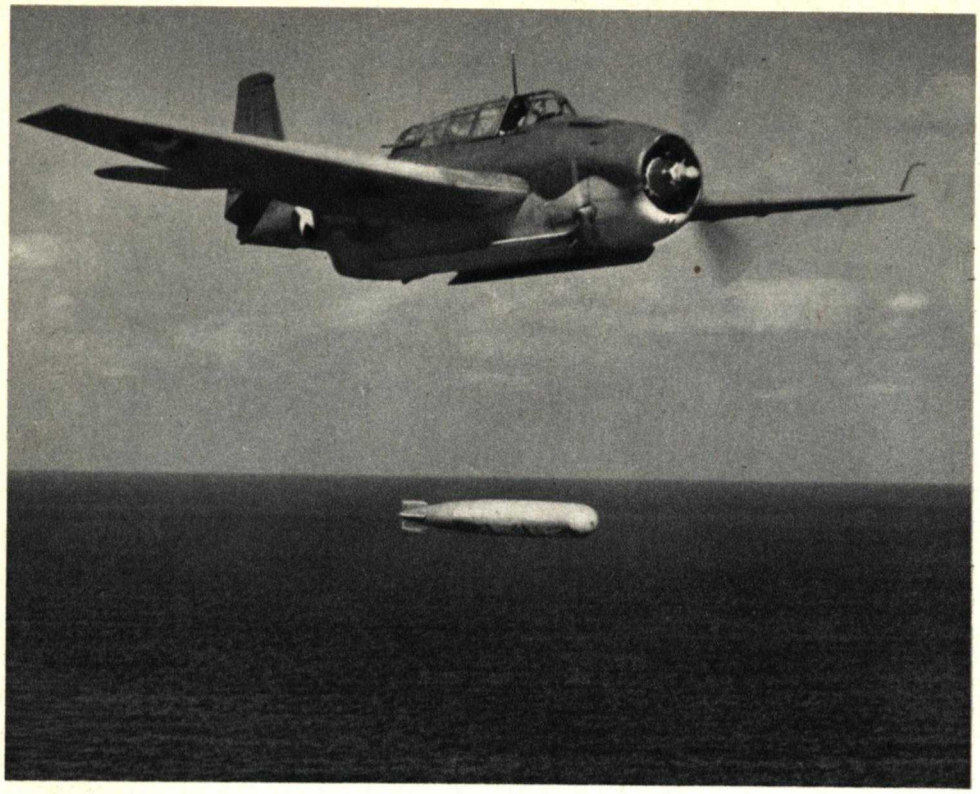
READY ROOM ABOARD A CARRIER . . . Pilots of AVENGERS and WILDCATS await the call to battle.



ONE TO GET READY — Props whirling, deck crew ready to remove wheel blocks, WILDCATS prepare for a takeoff.

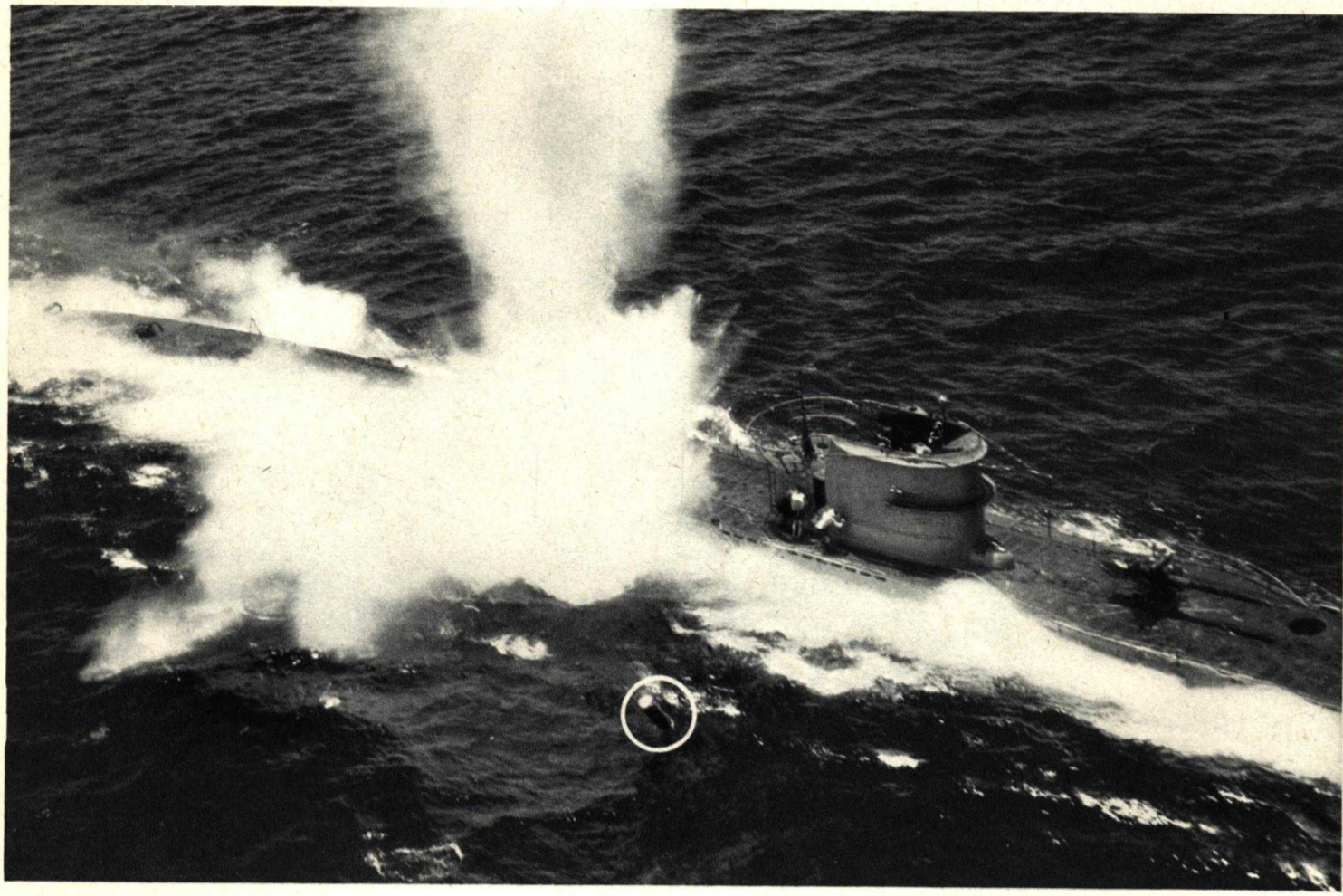
TWO TO GET SET — Deck officer, wearing unique helmet, waves an AVENGER into position on the flight deck.

THREE TO GO – A WILDCAT leaves the carrier deck to provide a fighter screen for AVENGER operations.



TARGET AHEAD . . . A 2,000 pound torpedo drops from bomb bay of an AVENGER. The attack gets underway!

HELPLESS . . . The sub hit amidship lies helpless on surface as fighters rake her decks with hot lead.



AVENGERS LEAVE THEIR MARK . . . Smoke climbs into a cloud-filled sky from Japanese installations on heart-shaped Marcus Island after a carrier raid by battle-toughened AVENGERS and WILDCATS from a task force.

"BOY! DID WE DO A JOB!" Back safely on the carrier, AVENGER and WILDCAT crewmen enjoy an enthusiastic description of action pilot in foreground is giving. Comrades grin at an amusing incident.

A HISTORY OF EASTERN AIRCRAFT DIVISION

IN 1941, key-pointed along the Eastern Seaboard from Tarrytown, New York, to Baltimore, Maryland, were numerous plants, all members of the General Motors family, but not of the same Division. Early in 1942, the destinies of five plants suddenly became the destiny of one, for they were welded into a new Division which in the course of months became one of the largest in General Motors, and the U. S. Navy's largest source of combat planes.

In August of 1941, the *United States News,* with an ear cocked to the Washington ground, predicted complete stoppage of automobile production for private use sometime early in 1942. Already a great many materials were on the critical list and cars were coming off the assembly line without their traditional "bright finish."

On a memorable Sunday morning, December 7, 1941, the armed forces of the Japanese Empire completed a devastating attack on the great Naval Base at Pearl Harbor. Throughout the day, sporadic radio accounts of the assault circled the country, blending into a death knell for all peacetime production. Surprised and bewildered employes, like millions of other Americans, remained close to their radios throughout that day — every one of them knew it meant a change, for there was a long fight ahead.

Monday, December 8, Congress declared war on Japan.

Thursday, December 11, Germany and Italy declared war on the United States, and the United States Congress, in joint session, declared that a state of war existed between America and the Axis —

The same day the Office of Production Management issued a curtailment order on automobile production.

* * *

Three hundred and forty-three thousand automobiles left the super-assembly plant in Linden, New Jersey, from 1937 through December 23, 1941. Throughout these years of peace, Buicks, Pontiacs, and Oldsmobiles flowed in an endless procession from this as-

sembly unit into dealers' showrooms from Maine to Virginia — then production stopped just twelve days after the government slowdown order had been issued.

A beautiful building stood idle with no manufacturing facilities, no toolroom, nor foundry, nor wood shop, nor presses, nor any of the other types of machinery that could be adapted quickly to war production. The plant was a maze of specialized fixtures, with forests of monorail hanging jungle-thick from the ceiling. Railroad docks accommodating long freight trains extended on either side of the building, from which tons of material were unloaded each day.

Forty-two miles away, nestled in the fertile Delaware valley at West Trenton, New Jersey, another modern General Motors plant had ceased production. This unit, known as the Trenton-Ternstedt Division, had made one of those amazing contributions to industry, turning out at peak production as many as 750,000 automobile hardware items each day. Production here stopped on December 12, one day following the government curtailment order.

The Tarrytown, N. Y., and Baltimore, Md., Fisher Body plants were still in production, and the Delco-Remy Battery plant at Bloomfield, N. J., was actually enjoying a production spurt, but they were to play a big part in a new production program although they had no knowledge of it at the time.

* * *

As early as 1940, the Trenton-Ternstedt plant had forecasted and anticipated work stoppage. Many attempts were made to secure new contracts in an effort to keep approximately 3,000 employes busy, once automobile hardware production had tapered off. Other industries in the plant area had also felt the changing economy. Production in the entire section was slackening. Trenton was successful in obtaining small contracts — work which brought little or no profit, but which did keep some employes busy until a major contract of some sort could be negotiated.

Studies were made, and bids submitted on the manufacturing of such things as 20 mm. cartridge cases, mine and depth charges, magazine feeds for the 20 mm. machine gun, the M-103 bomb nose, the incendiary bomb, and the parachute flare. The tempo of this search-for-work program increased from November, 1940, until May, 1941, when the project became a major function for a group of personnel in the plant. Every day found men writing letters — telephoning the country over — and entraining at all hours of the day and night for far-off places. The circuit of Washington, New York, and Detroit became a race track, and vacations were no longer considered. Somehow, real work had to be found to keep the employes working — working. Negotiations were in progress on three or four items at one time. In the accounting department employes worked far into the night to prepare estimates and bids, but in each case the results were disheartening — something went wrong — until a telegram arrived on January 20, 1942, advising Trenton that the parachute flare bid had been accepted by the U. S. Army. But it came too late.

* * *

The general manager of the Linden Division appeared in Detroit prior to the Linden shutdown. He and his staff had also worked frantically to stay the inevitable shutdown — to keep the plant in operation — to keep 4,000 employes on the job. As a last resort, he was appealing to the General Motors home office for help.

After analyzing the problem, it was suggested that Linden try for a job on subcontracting aircraft wings. This type of work

seemed closest to Linden's capabilities. With metalworking experience, plant layout, GM's know-how, the suggestion seemed logical.

From Linden went letters and telegrams to most of the aircraft producers across the country, as far off as California. Would they be interested in having Linden make wings for them? Back from each came the same answer — not interested. Various government agencies in New York were solicited. Still the same answer.

The situation looked discouraging, but the search continued. About that time a new Army fighter, about which much was to be heard later, had just come off the drawing boards. When the company making the fighter was contacted, immediate interest was shown. Visits were exchanged; everything pointed toward the possibility of a contract. The plane was a deep secret, designated the P-47. It was to achieve fame as the "Thunderbolt."

In the meantime, to be sure that no stone was left unturned in the search for a job for the Linden plant, a representative was dispatched to Washington, armed with floor plans and statistics. That was Sunday of Christmas week.

The next morning found him in the Navy Department where groups of officers studied the material he had brought with him. Yes, they were looking for plants which could turn out fighting equipment for the Navy, but what did the GM representative have to offer? They figured Linden had nothing more than four walls filled with a mass of highly specialized equipment, good for only one thing — assembling shiny new automobiles. And from that point of view they were right.

Noon came, and the Linden representative, discouraged, was ready to pack up and go home, save for a date scheduled that afternoon with the Office of Production Management.

There he arrived expecting the same answer — not interested. Instead he was greeted with a barrage of questions. How had he happened to come to OPM at that particular time? Had he received a tip on something?

Then it developed that only a matter of hours before his visit, the Navy decided to go all out on a brand-new plane — a torpedo bomber — in which they had great faith. At that very moment they were planning the facilities necessary to expand greatly the production of this torpedo plane — facilities just about the size of the Linden automobile plant.

Yes, the Linden representative had stumbled on something — something far bigger than he or anybody else realized at the time.

The Linden representative, in talking with the Linden general manager by telephone, urged him to leave immediately for Washington, but the latter was reticent, for he felt that his negotiations on the "Thunderbolt" subcontract were in the final stages, and he couldn't justify his jeopardizing it for a long gamble on government business. Discussions continued over the telephone, and as a result, the Linden manager telephoned Detroit where General Motors had been eagerly following the "Thunderbolt" negotiations, and told of the new development in Washington. As the final upshot, it was decided to meet in Washington the next day.

To the GM group which met in Washington the next day, the name of Grumman was an unknown quantity. They had not heard of the firm, which had been established in an abandoned garage in Baldwin, Long Island, some 13 years before. Appropriations for Naval Aircraft were small almost to the point of insignificance during the first eight years of operation, and as a result the contracts for Grumman planes were slim. Later, as the war in Europe gathered force, orders began to flood in, and Grumman found it necessary to expand its organization and facilities many fold.

The Navy Department throughout these years had the highest regard for the Grumman firm and assured the GM group that it considered Grumman aircraft among the finest in the world. It was already buying quantities of the Grumman F4F-4 fighter, known as the Wildcat; and it was pushing for production of the new TBF-1 torpedo bomber, named the Avenger. The folding wing and other improved features of the two Grumman planes made them particularly desirable for Pacific warfare, where every cubic foot of stowage counts aboard an aircraft carrier.

The Grumman officials, advised of the Navy's urgent need for an expanded torpedo-bomber program, and already greatly expanded themselves, were willing to transfer some of their production to any firm recommended by the Navy Department. They were quite willing, therefore, to meet with General Motors officials, though it is conceivable that they, like other old-line aircraft firms, could not help but question the ability of the automotive industry to produce combat planes in quantity — and in a hurry.

The Navy called the meeting to order and presented its problem to the representatives of the two firms. To the surprise of the GM members present, the problem was not just wings — it was entire planes.

Obviously the accidental Monday afternoon lead of December 29 had snowballed into a far bigger proposition than the Linden plant alone could handle. There was talk of Linden and Goodyear supporting Grumman on an expanded program. The Linden general manager, realizing his lack of a toolroom — and the cost of putting one in — had already considered the possibility of using GM's Delco-Remy Battery plant in Bloomfield, N. J., as a possible support for Linden in any large endeavor, and so the Bloomfield plant was brought into these conversations. But the Grumman bomber was a big ship, and the schedule the Navy was proposing was far greater than Linden's narrow bays and automobile assembly experience could easily accommodate — even with Bloomfield's support.

It was then arranged that the GM and Grumman representatives would visit each other's plants at an early date, and that conversations would then be resumed in Washington.

In line with the mutual agreement, Grumman officials came to Linden and looked over the plant, but it was not easy for them to visualize a transformation then.

To them the auto assembly plant was a huge place comprising four walls jammed with equipment, fixtures and machinery, which were entirely useless to aircraft manufacture. Auto production was still being cleaned up. Overhead and underfoot was a type of equipment representing the highest refinement of specialized mass production technique — a plant geared to eject one finished automobile every 60 seconds.

The Grumman plants, on the other hand, visited on New Year's Day by the Linden representative, presented an entirely different aspect. Accustomed to the General Motors sense of flow — the essence of his own Linden plant — the GM man saw at Grumman a great deal of activity but an apparent dispersal of effort. Grumman's tools and methods of manufacture seemed to him primitive; while Linden's methods seemed to the Grumman visitors equally impossible—an over-specialization that could never, never work in the airplane business.

And thereby both caught a first glimpse of a great dilemma that confronted them.

In the meantime, work was going on at a feverish pace on a formal presentation of how General Motors would produce the Avenger

torpedo bomber, when the Navy dropped another bombshell. It announced, out of a clear sky, that it would like General Motors to take on another Grumman plane – a plane which already had won laurels for its heroic work with the Marines in defending Wake Island – it was the F4F-4, the Wildcat fighter.

Worried enough about the bomber program, with which GM had already agreed to go along, the General Motors representative was in no way prepared for this surprise. "It practically floored me," he related, "because I didn't know how we were going to make the first plane."

So he left Washington for Detroit with two planes in his hat, and no facilities with which to build them – beyond the doubtful adaptability of the Linden assembly plant, which obviously was too small for this staggering program. What was needed was a full-fledged divisional set-up, complete with engineering, manufacturing and assembling facilities.

General Motors said, in effect, "We will organize a new Division, put somebody in charge of it, and let that individual draw from the other Divisions' pool of experience, and create a complete manufacturing organization – as though we were starting a new company."

And so, on the next day, January 21, 1942, Eastern Aircraft was born.

The following day, thousands of GM employes directly affected by the decision first learned of it in their local newspapers. Among them was the wife of the newly appointed general manager, who noted with surprise that her husband was to head a new Division formed "to build fighter planes for the Navy." Until that moment, her husband had always been "an automobile man."

The press notice was brief and merely added which of the plants were to be taken over by the new Division. They were five East Coast plants: the Linden Division assembly plant at Linden, N. J., the Delco-Remy Battery plant in Bloomfield, N. J., the Trenton-Ternstedt hardware plant in Trenton, N. J., and the Fisher Body plants in Tarrytown, N. Y., and Baltimore, Md.

The Navy presented its problem to GM.

IN THE BEGINNING

WITH NEGOTIATIONS in Washington past history, and contracts practically a reality, those who worked tirelessly night and day on them returned home to something new and bigger – something almost too big to comprehend. One of the momentous decisions in the history of General Motors had been made, and it had come with the swiftness and surprise of an exploding bomb amid the affected plants.

America was at war, and time was of the essence. In effect, General Motors men had said to the Navy: "We'll get set up to build these planes and we'll meet your schedules." It was an agreement to take over one of the Navy's biggest assignments after days of tireless figuring and study had convinced them they could handle the job.

There was a vast difference between the automotive and aircraft industries at this time. The auto industry, larger of the two, had just finished a decade of amazing production. On the other hand, under the impetus of war, the aircraft industry was emerging like an awakening giant. The big question in everyone's mind the country over was – can the automotive industry produce aircraft on a mass production basis?

Prior to the war, most aircraft companies had advanced and faltered over a period of years. Each was a progressive pioneering group, struggling along under tremendous handicaps. In contrast to automobile manufacturing, the volume was very small. For example, in the year 1940, the total production of planes in the country was only 5600 units. Even before the United States entered the war, a few companies had received British and French orders which served to brace them financially for the immediate future. But even so, with the small production, it would have been pointless and impractical for even the largest airplane manufacturer to use the so-called quantity production methods that had been used in the automotive industry, for millions of cars were turned out each year. The problem was further complicated by the constant flow of engineering changes in the original specifications affecting every section of the plane being requested. Thus when the aircraft industry was called upon to produce hundreds of planes for the arsenal of democracy, their procedures and tooling were in great contrast to those of the automobile industry. The limited quantity of planes, plus the necessity for frequent changes in design, made it out of the question for them to employ expensive and highly specialized tools which were commonly used in the manufacture of motor cars, where the designs are

changed only after a complete model run.

By the very nature of things the design of an airplane is a very different proposition from the design of an automobile. And for these reasons:

1. The car designer has more latitude than the plane designer. His product operates on the surface of the ground, and while he is naturally concerned with weight, it is in no sense the overwhelming consideration that it must be in the design of an airplane.

   Thus the component parts of an automobile can, to a considerable degree, be designed from a standpoint of facilitating manufacturing operations, thereby reducing costs to the customer — and without impairing the quality.

   In the case of the airplane, however, weight is so important that it is frequently necessary to go to very elaborate manufacturing operations to meet weight requirements.

2. The motor car is relatively slow-moving, so the over-all shape of the finished product is governed primarily by considerations of appearance and comfort.

   The airplane, however, must operate at very high speeds. Not only is scientific streamlining of utmost importance, but the maneuverability is greatly affected by the over-all design.

3. Furthermore, while the body, hood, fenders, etc., on an automobile serve primarily as a protection against weather, the covering or "skin" of an airplane serves a definite *structural* purpose.

   In other words the airplane designer must depend to a great degree on the "skin" of his product to provide the necessary strength.

   This skin must be designed to withstand stresses and strains in flight operations far beyond anything that would ever be encountered by a ground vehicle.

One of the biggest problems confronting the executives and engineers of the Eastern Aircraft organization was to adjust their thinking to these fundamental differences.

The maximum success of the program called for an open-minded attitude.

It was not a matter of merely applying their automobile production technique to the manufacture of airplanes, but a matter of carefully analyzing each and every phase of the problem with a view to evolving techniques that would take into account the experiences and problems of both industries.

These things are doubly true on military planes, for it has been said they must be built to withstand the unpredictable.

The two new planes had to be studied, and engineering information obtained. There were plenty of major problems to think about and plan for now. Great masses of automobile equipment had to be cleared from the five plants and stored. Material and equipment had to be ordered, and employes had to be trained. Each represented a giant task in itself, and all planning went on a 24-hour basis.

Out of these first few stormy weeks plans took form rapidly, and one of the initial requirements was more than acute. Men with knowledge were required to take over and administer the many newly planned departments hitherto unknown to automobile men. Where could they be found? Aircraft companies already in production for several years were jealously holding on to their engineers and skilled workers. Few, if any, men of the type were available anywhere in the country, and what few there were held vital jobs. As

Admiral DeWitt C. Ramsey, speaking as Chief of the Navy's Bureau of Aeronautics, said two years later:

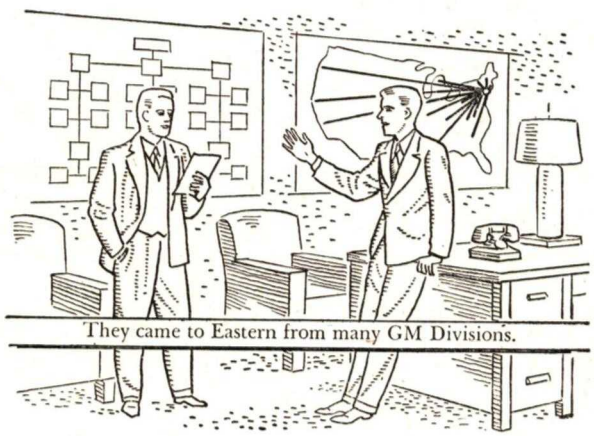
> "A further handicap imposed upon Eastern Aircraft by the demands of the situation was the agreement that no trained personnel was to be begged, borrowed or stolen from established aircraft plants. All that was not done just to make the job more difficult. The reason was obvious. We did not want to rob Peter to pay Paul."

Eastern Aircraft had no other alternative but to turn to the parent corporation for aid.

And so, Eastern Aircraft looked to General Motors and its Divisions across the country. For that matter, the various GM Divisions did not have any experienced people to spare either, because they were loaded down with war contracts for production, which even at that time, totaled better than a million dollars a day.

But they came through. Each Division gave a little — an engineer from Michigan, a toolmaker from Indiana, a foreman from Ohio — but in the aggregate they formed a great pool of skills which could not have been hired at any price at that time. Today there is hardly one of the thirty-seven operating Divisions of General Motors which is not represented in Eastern Aircraft.

These men tore up their established roots, left their home communities, and came to Eastern Aircraft from GM Divisions all over this country — some from as far off as California. Why? Because there was a big job to be done and they wanted to be in on it.



They came to Eastern from many GM Divisions.

CHANGING OVER

THE NAVY LETTERS of Intent arrived February 5 for the bomber, and February 9 for the fighter. Preparations for plant change-overs had not been delayed awaiting these letters. Although the matter of final assembly was already settled, with Trenton building the Avenger torpedo bomber, and Linden the Wildcat fighter, it was still undecided just which parts of the respective planes each plant would make. Yet whatever parts they built, it would first be necessary to empty them of all the old automotive equipment and ready them for the new layouts and machinery.

This demolition or dismantling program, as it became known in the plants, progressed at varying speeds. Like other Division-wide programs that were to follow, it seemed in the eyes of many, like a race. First one plant would be way ahead on its program, then at the next leg in the race, another plant would move out in front.

Linden, lacking any large plant engineering force, subcontracted its entire demolition and physical conversion to outside contractors. The program extended from February 21 to the end of April, 1942. On the former date a host of outside workmen came into the plant and began a wholesale stripping of the interior — demolishing equipment that could not be saved, dismantling and storing all that could be saved. Work was also begun on a 64,000-square foot one-story storage building across the street, on property newly acquired from the Standard Oil Company for the Linden airport.

Everything was ripped from the huge Linden plant. Five miles of monorail and conveyor equipment were torn down; 14,000 square feet of boiler plate steel came out; enough industrial piping to reach from New York halfway to Philadelphia; hundreds of tanks, ovens, welding jigs, heater units, glue-pots, balancers, motors and other equipment were all given a protective coating of grease and carefully stored in the hastily erected storage building, under a prearranged plan of indexing so that the exact whereabouts, within a few feet, of every single item could always be known. Care was also taken to see that storage was arranged so that any piece in any part of the building could be quickly taken out of storage for possible later use or sale.

Dozens of huge trailer-trucks formerly used to distribute Linden's finished automobiles were converted into moving vans, and after hundreds of trips across the highway and over a short stretch of muddy morass, hundreds of thousands of dollars worth of equipment was

tucked away in the Linden storage building.

Not all of Linden's tons of manufacturing and structural equipment was stored, since a large part of it which was permanently or semi-permanently attached to the plant was necessarily damaged or demolished in removal. As material was torn from the walls and floors and cut by torches from the ceiling, it was earmarked for either storage or scrap. The latter, made up largely of the 250 tons of structural members stripped from overhead, was piled in an area behind the plant where it eventually stacked up six feet high over a full acre of ground. This scrap was gradually routed back to the steel mills as fast as arrangements could be made with scrap dealers.

Two aisles of vertical columns in the plant were removed, the roof above then raised 26 feet, and huge steel crossbeams were installed to carry the widened span and to provide an overhead crane bay. These changes went on long after the completion of the demolition on May 15.

New lighting, elaborate plant protection, and heating systems were installed.

Nearby the Trenton plant and across the highway at Linden, bulldozers went to work leveling the sticky Jersey clay and making runways for airports to be used in testing Avengers at Trenton and Wildcats at Linden. Other construction workers began the job of building the huge hangars at each airport.

Trenton's removal and structural program began February 27, and extended through mid-July. Millions of pounds of equipment rolled out of the plant, across the highway and into a hastily erected 182,000-square foot storage building. In contrast to Linden, which had practically no machinery that could be adapted to aircraft use, Trenton salvaged 243 out of its total of 1,104 peacetime machines. Of the remainder, 617 were stored; 36 were sold; 106 transferred to other GM Divisions, and 41 returned to original lessors.

Trenton's moving program was accomplished, as at Linden, with the use of automobile trailer-trucks. More than 120,000 man-hours were expended in the stripping of the plant and removing and storing equipment.

One of the many structural changes at Trenton involved breaking through a brick wall at the northwest corner of the building, and installing an 8-ton, 25′ x 70′ door to allow an exit for finished planes to move out of the final assembly bay and across the road to the airport.

At both Trenton and Linden, and perhaps more conspicuously at the Baltimore, Tarrytown and Bloomfield plants, a great deal of ingenuity went into the physical conversion of the plants. Baltimore, for example, used the welding and railroad pits in the plant as storage areas, filled them with unusable automobile equipment and covered them over with portable flooring that allowed access to the stored material. Baltimore also adapted automobile materials storage racks to serve as aircraft workbenches. More than a million pounds of equipment was removed from the Baltimore plant, including 795 body trucks, 20 welding units and the usual long footage of conveyor and monorail equipment, jigs, ovens, etc. In dollar value, less than 10% of the Fisher Body equipment in Baltimore was scrapped; of the remainder, half was stored and half was adapted to the new job.

The Tarrytown plant began its dismantling program on February 10, and completed the removal of material July 1, while structural changes in the plant were made between March 3 and August 31. They leased a storage warehouse from the Westchester Lighting Company; subcontracted with Anchor Motor Freight for the removal of the Fisher Body

equipment; and subcontracted with various outside firms for a number of structural changes. These included removal of walls and partitions, covering railroad well, enlarging hospital, cafeteria, and other employes' services.

The Bloomfield conversion was accomplished entirely by Bloomfield's own production and maintenance employes. Because of the nature of Bloomfield's aircraft assignments the plant continued operation as Delco-Remy until the end of May, 1942. Actually, removal of equipment, however, began as early as February and continued through mid-June. Interior alterations began in March and extended into July, as former battery assembly line workers became carpenters, cement mixers, and construction men. The plant during this period was referred to jokingly as the "Bloomfield Construction Company."

Trenton utilized the framework of its overhead ovens to form a balcony and thus gain badly needed floor space.

Even before these various conversions were planned, each of the plant staffs journeyed to the Grumman plants on Long Island to determine just which parts of the two planes they would build. The final decisions were made at a meeting in Trenton during the first week in February, attended by the Trenton, Baltimore, Tarrytown, and Divisional staffs. A complete blueprint of the bomber was spread before the group, and major assemblies were broken down. It was decided that Tarrytown would build the two wings, the center section, trailing edges, the motor mount, the cabin, windshield, and upholstery. Baltimore, though it would have liked to have taken the wings, was limited already by a Navy ruling against its taking on an assignment that would require a great amount of manpower, because the city of Baltimore was already a critical area. So it was determined that the Baltimore plant would build the rear fuselage, the tail assembly, and all control surfaces.

A Bloomfield group visited the Grumman plants a short while later, on February 21, with two possibilities in mind: to handle machining of parts for the fighter, or to take over the electrical controls. Noting that the electrical tubing and cable assemblies for both ships included considerable duplication as well as similar raw material purchases, they suggested that these three groups be manufactured at Bloomfield for both planes. Although this would mean that Linden would have to install a complete production machine shop, the Bloomfield proposal seemed a sound idea and was accepted.

By the end of February each of the five plants knew specifically which parts they would build, and knew the two production dates to be met — the first fighter by October, 1942, the first bomber by November of that same year. With their conversions underway, it was now up to each plant to get going.

Two contracts superseded the original Letters of Intent, and were dated March 23 and March 25 for the bomber and fighter, respectively. In the months to follow, one addition after another to the original contracts built up the number of planes Eastern was to produce.

Navy fliers needed more planes — and needed them badly.

Linden's fighter contract was scheduled so that a portion of the required planes were earmarked for the British Navy under the provisions of the Lend-Lease Act. The chief difference between the two planes lay only in the type of insignia and camouflage, specified "Caribbean Blue" for the U. S. ships, and "Sea-green-dark-earth" for the British ships.

FIRST VISITS TO GRUMMAN

THREE MEN from the Baltimore plant stepped off a train arriving at 7:30 in New York one morning less than a month after Eastern Aircraft Division was born. They proceeded to the main information booth, where, according to a prearrangement, they awaited a group from Trenton. Conversation idly wandered around such subjects as the war, the late automobile business and airplanes. It kept coming back to airplanes.

"I understand the whole job has to be kept down to a thousandth tolerance even on the sheet metal parts."

"Closer than that. Down there at the Martin plant I hear they had trouble with the jigs every time a material truck went by the aisle. Threw the jigs off just a hair, but enough to give 'em trouble."

"Wonder why they don't spot-weld those skins instead of all that riveting. I don't see the reason for this anodizing they do either."

"W-ell, from what I hear, it's just the same as plating, except that it isn't quite. Actually . . ."

By 10:30 the group had already put away several cups of coffee and had decided that something must have happened to the Trenton group, so they proceeded to the Long Island side and entrained for Bethpage — to the Grumman plants. Arriving at the station they found there were no taxis, so they hired a local saloonkeeper to drive them out to Grumman. There they found the Trenton crowd, who, it developed, had waited for them a couple of hours in New York — at a different information booth.

Grumman was just completing its ninth Avenger at Plant No. 2, and Wildcats were rolling out fairly fast from Plant No. 1. Business with the firm had already expanded tremendously. Grumman was mighty busy.

Viewed for the first time by the GM group, the two planes were beauties. The Avenger, largest single-engine bomber in the country, was a handsome mid-wing monoplane with a barrel chest and belly, topped by a cabin and revolving turret, and with wings that folded back and up like a grasshopper's. She looked like a big fighter, but within her belly was a bomb bay that concealed a full-size marine torpedo or its equivalent weight in deadly bombs.

The Wildcat was the Navy's top fighter. It had a speed of better than 300 miles an hour, and an amazing maneuverability, which made it beloved by Navy pilots. Even as these GM men were viewing it for the first time, the Wildcat was well on its way to fame. It had

made the Japs pay a terrific price for Wake Island, and "Butch" O'Hare had just flown his way to aerial immortality in a Wildcat the day before by shooting down five Jap bombers singlehanded.

Both planes were equipped with retractable landing gear, with arresting hooks in the rear, and with the same ingenious folding arrangement of the wings. With Pearl Harbor fresh in the memories of all, there was no doubt of the Navy's urgent need for hundreds of these modern craft as quickly as possible for the war in the Pacific.

In the beginning, some of the Grumman personnel seemed to resent the entrance of General Motors into the manufacture of its two proud planes. This very human reaction was aggravated, too, by certain loose statements that had been made early in the defense program by automobile men who had never got down to analyzing the fundamental differences between building planes and building cars. One manufacturer, as will be recalled, was quoted as saying that we could turn out a thousand planes a day if given the go-ahead. The older employes in more plants than just Grumman were fed up with this kind of talk.

To the credit of both the GM and Grumman personnel, this feeling never flared into anything more than occasional and quick-passing moments of friction.

The big difficulty, as explained in preceding pages, was a fundamental difference in the manner in which the two industries, aircraft and automotive, had operated. As a consequence, the planes were hand-tailored to order by expert, highly skilled craftsmen, comparable to toolmakers, who needed little more than sketches to carry out their work. Because of small orders, tooling, except for the simplest kind, had been out of the question.

The automotive industry, on the other hand, was used to turning out hundreds of thousands and in some cases millions of cars, using some skilled and many semi-skilled and unskilled employes. The sources of component parts were many and varied, but when they arrived at assembly plants they had to go together easily with no hand fitting. As a result, they felt it was absolutely imperative to have engineering drawings accurate down to the last detail.

This difference between the two industries was first brought home to Eastern Aircraft when it was drawing up, with Navy approval, a detailed agreement with Grumman, wherein they had listed what was specifically required by GM in the way of engineering and purchasing information. Grumman was reluctant to sign these agreements.

"We don't have that kind of information," said Grumman. "In fact, we never had need for it under our method of operation, and you'll admit we know how to make planes.

"We don't have a set of drawings that are detailed. We can't even guarantee they are right. All we know is that they have sufficient information for us to work with."

"Can't you arrange to correct a set of drawings for us? We'll need them."

"We can try it. But we won't be able to give you details because we don't have the organization to make that many drawings. We can't give you any process sheets because we never needed process sheets. And we don't have any time studies or routing sheets."

The Eastern Aircraft general manager paused at this. To an automobile man who had grown up in a mass production, such data was the essential starting point — the very foundation of a production program.

"Maybe," he said, "we can get along without these if you let us put our men into your plant for a while. But what about a Parts List?"

"We have what we call a Parts List, but it's not like the one you specify, and we don't have a Bill of Materials like the one you want either."

"How do you go about buying material without a Parts List?"

"Well, our stock rooms will know about how much material goes into each plane. As far as knowing exactly what amount of material is in each part, we don't know."

Plainly, GM resourcefulness was due to face a rare test.

Selected groups of supervisors were sent from the five Eastern Aircraft plants and put on their own responsibility for getting their respective sets of information. This was done in every possible way — through hunch, observation, guesswork, inspecting files, asking questions, peering over shoulders, interpolating, measuring parts, sketching parts, photographing parts, examining bins, taking notes — and perhaps a dozen other fact-finding methods never before required of a group of General Motors men.

For a Bill of Materials, the Linden group made an exhaustive study of Grumman's card file and reviewed every single part, including raw material, that was charged to the Grumman F4F-4 plane. Unfortunately, this file contained not only the parts for the F4F-4, but also those for the British plane JRF, for the F3F, and other Grumman planes.

The information was phoned back to the Linden plant as quickly as it was compiled in order that purchase requisitions could be written at once. It was a gamble at best, but time was short and the subcontracting and purchasing load was heavy on a product such as the Wildcat fighter, which, it was later determined, comprised 10,963 different parts.

The Trenton purchasing group had begun as early as 13 days before receipt of the Letters of Intent to assemble as much information as possible on the bomber. On February 21, the group first visited Grumman to get this information firsthand — and encountered the same difficulty the Linden group was experiencing. Grumman had agreed earlier to supply both Linden and Trenton with lists of their subcontractors on the two planes, but when the bomber list was submitted, on February 28, a restriction was attached. A large portion of these subcontractors were marked by Grumman "Hands Off." Good aircraft subcontractors were precious in 1942.

Trenton used the same means as Linden in getting together at Grumman what it could for a Parts List and a Bill of Materials. On March 13, Grumman supplied Trenton with a partial Bill of Materials that included forgings and castings, but left out 800 bar stock parts. As fast as possible purchase orders were placed all over the country.

Engineering information had to be assembled at Grumman in the same hit-or-miss fashion. The first prints arrived at Trenton on February 13, and the complete Grumman file did not arrive until August 5. Linden's first set arrived in March. Both plants sent engineers to the Grumman plants as soon as the Letters of Intent were signed, and these men were joined later by engineers and supervisors from the other three plants.

Although it was first hoped that Parts Lists on the two planes could be established from the information that appeared on what few blueprints Grumman could supply, these were eventually found to be so incomplete that both the GM bomber and fighter engineering groups were forced to go right out on the production floor to get their needed information. On the whole, the Grumman foremen were particularly patient and helpful in answering questions — often foolish questions —

from their long-experienced aircraft point of view.

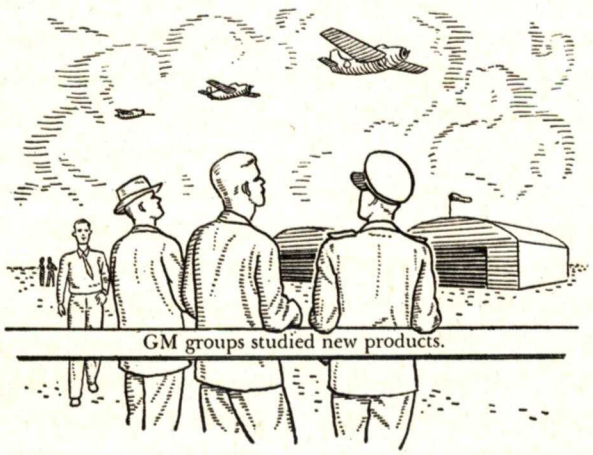
Engineers were herded into a tiny office – the only space Grumman could spare – and they had actually to sit or lie on the floor to examine the sprawling prints that were given to them. They constantly shuttled from this office out to the production floor to verify and correct the prints, to make processing notes and specifications memos. From this kind of information and under these conditions, the first engineering releases were written.

A GM photographer was kept busy taking hundreds of pictures of various parts, tools and fixtures. Notes were then made hastily on the photographs, which had to serve in many cases in the absence of a print. Grumman had no prints of its tooling set-up, and so dozens of sketch artists were supplementing the work of the photographer, and dozens of engineers were filling voluminous notebooks.

There was an awareness even this early of the cleavage in basic manufacturing methods between the aircraft and the automobile industries. In view of this difference, a definite philosophy was laid down of investigating and learning all of the standard methods of the older aircraft companies – learning first how *and why* these methods were used – and then, wherever feasible, applying the more modern automotive methods later.

It was decided, too, that the quickest way to get into production would be to copy Grumman processing and tooling in order to establish a pilot line of jigs and fixtures that could be supplemented and changed after the rush production of the first few planes. As a result, the two engineering departments were divided up so that responsibility was dispersed over the various portions of the two ships – wings, fuselage, tail assembly, etc.

It was a hectic, trying period for all concerned. The matter of elbowroom in which to work became so critical, finally, that it was necessary to make other arrangements. With permission, Eastern Aircraft erected a large shack adjacent to the Grumman plant. This became the General Motors Bethpage Office – perhaps the fastest built, least ostentatious office in GM's history.



GM groups studied new products.

TRAINING AIRCRAFTSMEN

THE FIRST of many great contributions made by employes and potential employes came early in the new program. From towns, hamlets, and big cities they came in an ever-increasing tide to the five plants of the new Division. They were salesmen, housewives, reporters, collectors, musicians, craftsmen — many skilled in thousands of other lines, but few with aircraft experience. They were people who recognized the great task facing the nation, and were willing to start from the ground up and try their hand at a new trade.

Peak hourly employment had originally been estimated at 43,200. With a nucleus of less than 9,000 auto workers which was rapidly being depleted by Selective Service inroads, it meant that all training had to be put on a rapid, concentrated, yet thorough basis. Many a new employe to whom the factory was a strange labyrinth of noisy things, gritted his teeth and pitched in to learn, then did an outstanding job. It was this determination, this loyalty, that helped immensely in getting Eastern Aircraft underway.

Everyone had to learn something, supervisors and new employes alike, and with few exceptions, everyone stuck through a mighty rough period to contribute much to the job, and to the fighting strength of the Navy through production in the months to come.

The nucleus of auto workers, of which only 5,379 were available by October 31, 1942, had basic shop knowledge, such as familiarity with hand tools, but they had no skills that could apply to aircraft work. Riveting and welding in automotive building were vastly different skills than riveting and welding in aircraft manufacture. Nearly every part of the airplane is subject to some type of stress, and the metals that go into an airplane are alloys containing small quantities of metallurgical elements which can be easily impaired under wrong workmanship. An automobile welder generally had to first unlearn all that he knew about mild steel welding to become a good chrome-moly or aluminum aircraft welder. Perhaps the only experience that could be carried over from automotive to aircraft work in the entire conversion was in the upholstery department which, significantly, was a department that remained in front, production-wise, throughout the entire program.

The first step in the training program was to select a supervisory group to act as an advance guard in acquiring knowledge and then teaching all the others. As soon as it was finally determined that Linden was to do aircraft work, the personnel office called back a selected

group of automotive supervisors and put them through an elaborate program in shop math, blueprint reading, safety, first aid, elements of plant protection and other courses preliminary to aircraft training. A group of supervisors was organized at Trenton, where efforts were made to locate them in some suitable out-of-town aircraft vocational school. After several attempts a place was made for them at the government training school in Freeport, Long Island, which had the advantage of having many Grumman workers, and whose instructors were familiar with the Grumman bomber.

At Trenton, Linden, and the two ex-Fisher Body plants in Baltimore and Tarrytown (Bloomfield was finishing its Delco battery business through April) the training program developed into four distinct phases:

1. A training program for supervision and others at the Grumman plants.
2. Short familiarization and training courses at other aircraft plants.
3. Outside vocational school training for recalled automotive and new workers.
4. In-plant training for recalled automotive and new workers.

Under the first phase various groups of Eastern Aircraft supervisors actually worked on the production floor at Grumman. While they were working, they were also making mental and written observations which were to prove of the utmost value later on when production got underway.

Between the start of Eastern's program and the fall of 1942, hundreds of men had been given an early training at Grumman. Many from Trenton had taken formal sustained training there, while scores of others had made visits seeking information. Nearly 200 from the Tarrytown plant had spent more than 23,000 manhours as trainees. Several hundred Linden, Baltimore, and Bloomfield supervisors went through similar Grumman training, so that a large majority of Eastern's first group of production supervisors had received the rudiments of a training in the work they were called upon to supervise.

Some of these men and other members of the recalled supervisory forces were then sent from the various plants to such firms as Wright, the Naval Aircraft Factory, Curtiss, Pratt & Whitney, Bendix, Liberty Aircraft, Frigidaire, Sperry, and other firms. At these places they underwent from two- to four-week familiarization courses where they learned the intricacies of airplane engines, propellers, instruments, and other components, making notes on how these items are assembled, installed on the planes, and how they must be handled.

Eastern Aircraft men were accorded a gracious cooperation by busy foremen and executives. Some of the visits were not only for training purposes, but also to help gather the badly needed engineering information. An example of this was a group of men from the Baltimore plant who visited Goodyear, a Grumman subcontractor, in Akron, Ohio, to learn how to make control surfaces for the bomber. Not only did the GM group gather engineering and tooling data while there, but also actual manual experience. An arrangement was made with Goodyear whereby the Baltimore men were put to work side by side with Goodyear workers and were paid the same rate as they learned Goodyear methods. They turned out to be such good workers that Goodyear expressed disappointment that they could not retain the men permanently on their jobs.

By April the training program at Linden, Trenton, Baltimore and Tarrytown was well into the third and fourth phases in which new workers were being hired from vocational schools where they had been given elementary aircraft training, which was then supplemented

by in-plant training. Of the five plants, Bloomfield alone did not use outside educational facilities for the training of its hourly workers. When Bloomfield turned to its Eastern Aircraft assignment on May 1, the supervisors trained the workers right in the plant.

Using the New Jersey State Training School, the Delehanty Institute and other local vocational facilities, between February and October, more than 2500 Trenton men and women had been given one type of training or another before being put on productive work at the plant. Nearly 3,000 had gone through a similar processing at Linden. Well over a thousand men and women took two to eight-weeks courses in the Elizabeth, N. J., schools. Smaller but substantial numbers were similarly trained at Baltimore and at Tarrytown, which used many local community schools.

In addition to this type of training, Eastern Aircraft sent many persons to higher educational institutions such as Johns Hopkins University, New York University, and the General Motors Institute.

Later in 1942, the training program was climaxed by a pioneering move whereby Eastern Aircraft Division sent 25 college-educated women to Rutgers University, on General Motors pay, to learn to become junior engineers in a concentrated three-months course. These women formed the first of a number of similar groups to take this training. At a later date several other aircraft companies followed suit.

Although the outside training system, which was arranged generally through the offices of the United States Employment Service, and the War Training Program, provided an early answer to Eastern's manpower problems, there were many reasons why in-plant training had to be eventually expanded to include all necessary instructions. For one thing, the vocational schools gave a generalized type of training which had to be supplemented anyway by the in-plant program. Some of Eastern's job applicants, when referred to the schools for free training on their own time, often found that they could get jobs immediately elsewhere without any training. As a result, a good many potential employes were lost before they could be hired. Hence, as quickly as the schools could be set up and the instructors themselves instructed, Eastern took over most of the vast training burden itself.

Attention to quality was carried to a point of refinement in every operation. For example, the Navy required that all welders — chromemoly or aluminum — be Navy-qualified. After the rigorous test, if successful, the welder was furnished a number on a steel stamp, and that number had to be stamped on every weld by that person.

Then, in the event of a weld failure in the field, that failure could be traced directly through Navy records clear back to the individual welder. This personalized responsibility created apprehension in the minds of many of the trainees, but after winning Navy qualification and their steel number stamp, pride swelled to the point where the stamp was valued as a watch charm or pocketbook treasure.

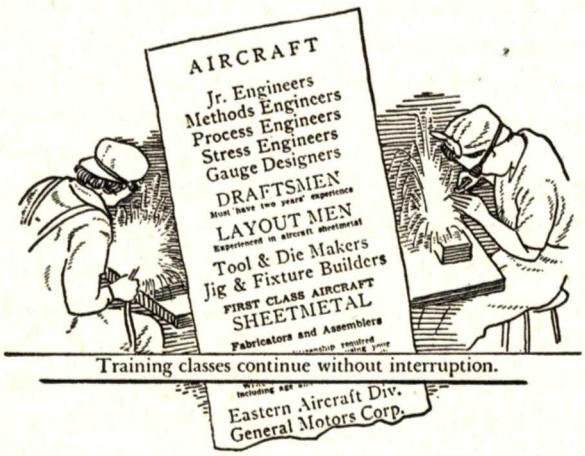
Less than a year previous, there were no more than a handful of Navy-qualified women welders in the whole country. The welding job was considered rather unpleasant, and a "male only" type of job, yet the Eastern Aircraft plants were training as high as 15 to 20% of women for these jobs.

Despite innumerable difficulties encountered, the welding instruction at Eastern Aircraft was highly successful. Two of these difficulties are worth recounting. At the start of the program the Linden plant advertised

throughout New York State newspapers for a welding instructor. Only one application was received. At the beginning of its program, Linden could not get even enough scrap aluminum and chrome-moly for the use of its trainees. It was learned that a quantity of this material destined for Russia had been sunk in the harbor aboard a lighter. It was salvaged and Linden speedily acquired a large part of the jetsam. Welding classes continued without interruption.

It would be difficult to visualize Eastern's vast training program as it gained momentum in the first few months. Yet, within the plants, and within schools for miles around the five plant areas, people wrestled with, and quickly grasped new learning, and instructors worked tirelessly night and day to prepare their new groups for Eastern's great production program.

Everywhere instructors were streamlining courses for speedy and solid presentation, for a real test was coming up. Would this form of condensed training prove adequate for the job ahead? Would these new people be able to grasp the subject? Only production figures could tell the story in months to come.



Training classes continue without interruption.

GETTING UNDERWAY

EASTERN AIRCRAFT had contracted with the Navy to build two *specific* Grumman planes. Moreover, the Navy was insisting that the GM planes' assemblies be interchangeable with those of Grumman. This added to Eastern Aircraft's problems.

Heretofore, in the aircraft industry, a great deal of faith had been placed in human skill and training. Eastern Aircraft placed its faith on these, too, but also upon detailed engineering data which, in spite of everything, it still felt could be developed on the two planes. It was known that there was no skilled labor for aircraft to be picked up at the employment offices. Eastern had a staggering contract schedule to meet and knew that it could neither be met nor sustained without the proper engineering information.

Thus, when it was discovered that the Linden and Trenton product engineering departments could not get the type of information they were used to, the idea of the "PK" ships was developed.

The PK ships and the PK parts — with which each of the various plants was to live for so many months — were assemblies and complete planes that had been built as standard at Grumman and had passed through regular Navy inspection there. They were called PK, for instead of being put together in permanent form, all parts were fastened temporarily with Parker-Kalon fasteners. This allowed easy disassembly and reassembly.

Thus, the PK ships and parts served GM as actual samples of the products they must build. They could be dissected, analyzed, measured and put together again by Eastern Aircraft's novices, and not only could they serve as references for product and process engineering groups, but they could also serve purchasing, material control, inspection, and other departments to gather the data these departments required.

In theory, the PK ships would effect a happy compromise between Eastern Aircraft's idea of how to get started on the program, i.e., with detailed data; and the aircraft industry's idea of skilled fabrication, i.e., through practice training on a sample ship.

Prior to the arrival of the PK ships in Trenton and Linden, the Navy had sent to these plants so-called "dog ships" — one a bomber and the other a fighter. The purpose of the dog ships was purely for reference and observation and to provide Eastern's management and employes with a glimpse of the products they were supposed to duplicate. The ships could not be worked on in any way and

they were always roped off in a restricted area.

But the PK ships and parts were made available. Trenton received its first PK samples on February 27, its first PK fuselage on April 4, and its second on May 8. Linden received its PK fighter on March 21.

At Linden the inspection department went to work first on the PK. Management had decided that it would be inspection's first responsibility to disassemble the PK ship, measure each part and to furnish this information to product engineering. While inspection was doing this job, other departments began working on the PK parts themselves — all of them eager to start solving their own respective problems. Thus, the process and product engineers, the purchasing departments, personnel and others were constantly in the "PK crib" handling parts, showing them to subcontractors, mixing them up, and very often damaging them. The inspectors, doggedly measuring each little part, incorporated many an accidental bend or distorted form into their information, not realizing the part had been thus damaged.

This situation was not without humor. In one plant, for instance, an employe was charged with the responsibility of making forming blocks for several parts. While he was away from his bench one of the small sheet metal parts fell on the floor. While there a truck ran over it, giving the part a deep concave form. Back came the employe to his bench to build a form block which balked production men when they tried to assemble the resulting part into a plane.

At that time engineering for the three plants working on the bomber was done at Trenton, and the product and process engineering departments there were beehives of activity. Like Linden, they attempted to establish new and better information on the Grumman product by careful examination and notations of the parts. They, too, ran into the many difficulties caused by overeagerness of the other departments to get underway.

It had been specified that parts for the first Eastern Aircraft-built ships would be supplied by Grumman on both the bomber and the fighter — which by this time were designated by the Navy as TBM-1 and FM-1. The exact number of parts was left to an oral agreement — enough for the first ten fighters and the first ten bombers.

But Grumman, too, was extremely busy. They were in production, and the Navy, vitally needing these planes which had literally saved the Allied cause in the South Pacific, was demanding more and more Wildcats and Avengers. As a consequence, Eastern Aircraft was supplied all the parts for the first two fighters, and with 12.1% in value of the parts for the next six fighters. To the production of the first two bombers Grumman supplied respectively 48% and 28% in value.

However, as soon as any of the parts arrived, production men went to work on their assembly. For tooling during this period, production used what rough copies of Grumman jigs the process engineers had been able to duplicate. Then the production supervisors dipped into well-thumbed notebooks, and with their erstwhile green employes they set to work putting the first ships together by hand.

Working conditions were particularly difficult throughout all of the plants at the start of the program because everything seemed to be going on at one time. The demolition, the structural changes in the plants, the shifting of office space, building cafeterias, enlarging washroom facilities and other physical changes contributed a major part of the confusion. A small group of Linden engineers which had been organized to start a modified lofting pro-

gram found themselves moved five different times around the plant – each time having to collect everything and repack for the movers. These non-production staffs were also constantly enlarging and requiring office facilities and equipment that could not be immediately had during those hectic months of early 1942. The Linden purchasing department, which was due to expand by November to 54, started in February with five people and two telephones. Trenton engineering jumped in the space of a few months from 35 to 520. Supervisory group employes in Baltimore, which had formerly comprised 80 persons, jumped to more than 250. Production engineering during peacetime in the Trenton plant amounted to less than 40 persons. During early 1942 it started increasing, until by late in the year there were well over 500 product and process engineers in the plant. Purchasing at Trenton rose from 6 to 88.

It was a rapid, confusing expansion with not only new persons coming into the Division, but also hundreds of new machines and parts and materials. The procurement program was centralized at Linden and Trenton where the rapidly growing purchasing departments were being swamped by requisitions not only for regular office equipment, but – more urgently – for machine tools, jigs, fixtures, raw material and subcontracted parts.

The machine tool program got off to a hurried start, due to the fact that a Washington directive conveyed the idea that all machine tools required by industry for the year 1942 would have to be placed on order by the end of March, hardly two months after Eastern's birth. With Linden requiring a large machine shop where none formerly existed, and Trenton, Baltimore, Tarrytown and Bloomfield all requiring tremendous amounts of machines and presses, orders were placed by the two purchasing departments at a rapid tempo. Trenton placed orders for a total of 1,210 machine tool needs for its three plants, and of these 1,115 were received at the various plants by late October, 1942. Linden placed a total of 1,030 orders before April, of which some 84% were received by October. Eastern's priority rating on these machines was A-1-a. On May 1 a freezing order came through, with the result that delivery promises on machine tools were so vague that appeal was made to Washington. This resulted in the awarding to Eastern, on May 7, of a No. 4 Urgency Rating on machine tools – fourth highest in the country and topped only by Boeing, Wright and Curtiss.

In establishing a group of productive suppliers and subcontractors, Trenton and Linden had very little information. One of the first moves was a canvass of each one of the subcontractors furnished on the two Grumman lists which Grumman had not marked "Hands Off." This circularization, which took place in March, 1942, uncovered little in the way of subcontractor sources. For one thing, every aircraft supplier in the country was already busy. Many of these suppliers had grown up with the aircraft industry and had acquired a loyalty to the older companies.

By far the bulk of Eastern's purchasing efforts were put into a determined effort to locate new sources. Buyers were scurrying around the country; trade registers were combed; the War Production Board's aid was repeatedly enlisted. Sources were eventually found, ranging from alley shops to the country's largest corporations. Linden secured several former GM dealers as regular subcontractors; Bloomfield purchasing, once it got underway after May 1, began locating sources for switch parts, clips and terminals among former hairpin manufacturers, Woolworth, Sears Roebuck suppliers, and padlock makers.

Vendor sources located close to the plants were naturally given preference, but many orders had to be placed far afield. Some 23 states from coast to coast and Canada were tapped for sources; nearly 200 cities, of which 60% were small cities under 50,000 population, contributed to the making of the GM Wildcats and Avengers.

Every piece of material that goes into a Navy plane must conform to a rigid set of Navy specifications and in the case of subcontracted items the inspection must be made by the Navy at the source. Otherwise elaborate documents and affidavits would have to be filled out to get the material into the plants.

Navy inspectors cooperated very closely in expediting subcontracting and often gave help considerably beyond their line of duty.

During the vast subcontracting program, which entailed locating more than a thousand sources for some 10,000 different aircraft parts, almost daily meetings were held between product and process engineering, purchasing and the various plant managements to determine whether an item would be designated "make" or "purchase."

An example of the latter was the hydraulic activating mechanism for the bomber. The Grumman subcontractor of this part could not even take care of Grumman's needs, and since Eastern Aircraft was also on the verge of bogging down under the rush of new business, it was necessary to search elsewhere for a subcontractor — fast.

A representative thereupon set out for Dayton, Ohio, to try to persuade Delco Products Division of GM to take the job. On his arrival there he found that Delco was already loaded with more war business than it wanted to handle. He then tried to interest Frigidaire, which produced a similar assembly for North American Aviation. This Division, too, was overloaded with war business. Finally, he returned to Delco and appealing entirely on the basis of friendship and GM spirit, the Delco management finally agreed to try to find some way to help out.

There was no contract, nothing in writing to assure Eastern Aircraft any protection on Delco's intention to carry out its promise. There was only the word of one GM executive to another. With that promise Eastern's management then made arrangements for shop and patent rights through Washington. There still remained the problem of getting Delco Products tooled for this work. Meanwhile, at considerable expense and trouble, Delco produced the first urgently needed assembly for the Trenton bomber in its own tool shop, using the services of its skilled toolmakers.

The earliest actual subcontracting of parts and assemblies was with Grumman, under an agreement that they would furnish parts for the first two planes. This was later extended to another agreement wherein they would supply parts for the next eight ships in the event that GM failed to find subcontractors elsewhere.

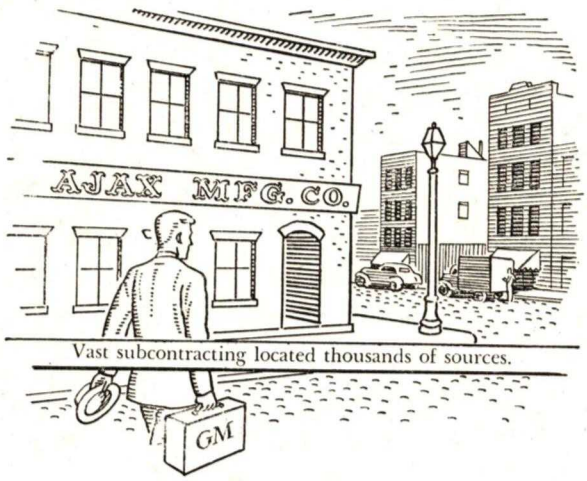
There were many pleading telephone calls from Linden and Trenton to Bethpage in an endeavor to get delivery of these Grumman parts. The latter firm needed every one that it made for its own planes and its reluctance to deliver was understandable. Grumman's tight hold on its own subcontractor sources was also understandable in the light of the hectic industrial conditions of the time. But for Eastern, still leaning on Grumman for every crumb of information and help, the condition was disheartening.

Before the year 1942 was ended, Eastern Aircraft had placed orders for supplies, parts, assemblies and services with more than 3,000 outside firms and had placed Navy and Defense

Plant Corporation purchases to a value reaching nearly 80 millions of dollars. Compared with the value of purchasing done by the same plants during the peacetime year of 1939, this represented an increase of nearly 400%.

It was clear that Eastern Aircraft was making elaborate use of subcontracting as a means of getting into production faster – of spreading its contract liberally and extensively to firms which could efficiently handle the various parts of it, of relieving its own stringent manpower and equipment conditions, and of following the government's desire to avoid over-concentration.

Because of Eastern's far-flung subcontracting program, an increased burden was placed on many new departments within the plants, such as planning and scheduling, traffic, purchasing, material control, and others, because parts and assemblies had to be on hand when needed. A group of expediters were already fanning out to pre-established key points throughout the nation to pounce quickly upon any slow-down and to break up material bottlenecks. It was no longer a case of five plants working toward one end, it was now a case of hundreds of plants, pushing toward the same goal – rapid production of the Avenger and the Wildcat.



Vast subcontracting located thousands of sources.

TOOLING UP

IF THE two initial flight dates – October for the fighter, November for the bomber – were to be met, Eastern's production at first would have to proceed by hand fabrication, although the formidable production schedules laid down by the Navy called for a tooling program far different than the initial copying of Grumman's two pilot lines.

Major assembly fixtures in many aircraft plants generally comprised at this time little more than two upright posts, a horizontal beam, and some taut piano wire to serve as reference for locating points. It was obvious at the very start that not only would Eastern require a more foolproof type of tooling – self-gauging fixtures wherever possible—but would also require a more complete breakdown of tooling for subassemblies, to allow a fast progression of manufacture. This was a technique which had reached a high state of perfection in the automotive industry and was one of the fundamentals of mass production. Parts flowed to departments making subassemblies. In turn, subassemblies from a number of departments or even plants came together in other assembly departments and finally arrived at the end of highly controlled flow as a completed product. This allowed literally thousands of people, rather than comparatively few, to work on an automobile. Obviously this manufacturing technique required a more complete tooling. And to design this tooling, Eastern needed complete products specifications.

When the various parts of the PK ships and assemblies had been measured and compared with the dimensions and specifications on the Grumman prints that had earlier been received, both Linden and Trenton engineers thought this difficulty could be overcome merely by correcting the prints to the PK, and establishing the resultant information as standard. However, as soon as the first parts began to arrive at the plants another discrepancy was revealed. The supposedly "standard" parts varied with each other, with the PK parts, with the Grumman prints and GM corrected prints.

There still was no absolute as far as engineering was concerned.

Since these prints, PK ships and parts all came to Eastern Aircraft plants at different times over a long period, a great number of tools had been made to each of the four references. A major assembly jig might be built to one reference while three different subassembly jigs feeding into each other and into the major jig were made from three other separate references. What was the result? They did not fit!

Grumman, because of its well-trained, highly experienced mechanics, was building a series of custom-built, tailor-made, excellent planes, each of which differed slightly from the other.

Complicating the tooling situation already aggravated were the numerous engineering and design changes constantly coming through on both planes. They were particularly heavy in the case of the Avenger torpedo bomber which had been rapidly pushed into production, and was new even to Grumman.

The Wildcat fighter, too, was receiving many changes as a result of battle-front experience. The Navy, for good reasons, decided to make a change in the number of guns — and this change had to begin with the eleventh ship produced by Eastern Aircraft. To the laymen it sounded simple. But that change involved more than 4,000 engineering orders!

The Navy changes were a part of the inescapable problems of manufacturing military planes. It has been said that "the enemy designs our planes." Certainly a combat plane must be kept fluid in its design in order to meet entirely new and surprising conditions of warfare. And when a "Navy change" came through from the Bureau of Aeronautics, there was no alternative but to make that change. It might mean life or death to a Navy flier.

The net result of all this was simply to make an already difficult situation even worse. There was no absolute standard of engineering information to which Eastern could moor its tooling program, and what information there was, constantly and unexpectedly changed from week to week.

The engineers were baffled. What should they do? There was absolutely no way in which they could get caught up on engineering unless an arrangement was worked out whereby Eastern Aircraft was allowed to freeze the existing design, then proceed slowly and tortuously to work the whole thing out — from Grumman drawings, from PK parts, from their corrected drawings, and from Grumman production parts. It would take months and months to determine the correct specifications from the five sources. But the Navy could not wait!

When it was finally and fully realized that not one of the above sources of information checked with the other and that there was no human way of getting the right data needed to build a quantity of the two planes with inexperienced employes — that was the lowest day in Eastern's first year of operation.

There was one slow way out of that mess. Production could still hammer, cut and bend and fit the parts to make the first few planes — just by dogged hand working. And there was still one thing that — though it would take months of laborious work — the two engineering departments could do. They could loft the two planes.

Lofting a complete plane was still an innovation in the aircraft industry. It was a method of laying out in full scale the external lines of the plane, a practice taken from a somewhat similar practice in shipbuilding. Once these external lines of the plane are established — in actual and full-size curves — then following GM's automotive design practice, every single one of the 10,000 to 15,000 detailed parts can be laid in on the drawing, thereby establishing their exact measurements. This gave the centerline of every tolerance in the plane. It established once and for all the correct product engineering on both planes.

So it was decided: "Loft both planes full scale and lay in all the detailed parts immediately and as fast as you can, so that we can get a coordinated plan of the ships — like the master drawing of a new model automobile. We'll incorporate every design change into this master layout as fast as they come through.

Loft completely, down to the smallest detail and we'll use this master information as fast as possible for new tooling.

"And meanwhile, we'll keep pushing hand production of these two planes down on the floor. We'll work this out – somehow."

They lofted – at both Linden and Trenton. They began at the critical points – the spar beam on the Wildcat, the cowl and wings of the Avenger. More and more men came on the task and sprawled over huge white-painted masonite tables to lay out both planes full size, fair in the contours and work in the details.

It took months, and they worked feverishly at it, knowing that these new engineering drawings – after all others had failed – would produce the right, the accurate information. Only on the white masonite boards would the dimensions come out exactly right with the known centerline from which allowable tolerances could be determined.

Thus the wall that had surrounded engineering was broken. The break-through could produce no immediate results on production, but at least it gave the engineers a place from which to start and a direction in which they could proceed.

Although both Linden and Trenton had early started a drafting program similar to lofting, which was intended to act eventually as a reference only to the two planes, it was not until April that management envisioned a lofting program that would be more than just reference – something that could constantly feed data into the tooling program.

From April through the rest of the year a point of view was taken which began to permeate the entire Eastern Aircraft organization. It was a policy at wide variance with automotive practice. The following excerpt from a Linden plant management meeting reflects the new point of view: "It was agreed, therefore, that we would remove from the Tool Room the templates and form-blocks that are in the Tool Room awaiting change, and use them as they are, provided they will make a satisfactory part for use."

In other words, use the tool if it will make a part that will fit the plane. Otherwise, cancel the tool. But in any event, there could be no standing on precedent or on the ceremonial practices of the automobile industry. Over a period of months, Eastern Aircraft was going to violate nearly all of the sacred precepts of mass production philosophy – but out of these violations and compromises a new technique of manufacturing was born.

This was a policy of purchasing only general purpose machine tools which were adaptable to many different types of jobs rather than one specific processing. The tooling the aircraft industry itself had developed in peacetime was similar. The rubber platen presses – virtually unknown to automobile people – were standard in the aircraft industry. Few automobile people had ever bothered to inquire why they were standard, and to inquire why the aircraft manufacturers did not use expensive steel dies and specialized tooling.

The answer, discovered early in the program, was that steel dies require frozen design, whereas in aircraft manufacture, "the only thing constant is change."

So Eastern took a leaf from the aircraft industry's book of rules. It bought many rubber platen presses. It built form-blocks, and cast inexpensive kirksite dies instead of hard steel dies. It settled on a policy of flexible tooling.

But this policy was not settled with any wonderful union of minds. Many of Eastern's engineers were hard to convert to the new type of philosophy. Some of them could not understand the need for the design changes,

the small press runs, and the light tooling.

A selling job had to be done within the organization. But there was a powerful argument in favor of the new philosophy. The young American boys, who were piloting these Navy planes, had to be considered.

The names of some of them were becoming legendary in American history, every week. Flying a Grumman Wildcat over the South Pacific on the twentieth of February, the 28-year-old Lt. Edward H. O'Hare plunged at nine Japanese bombers roaring toward the American fleet. Five of the bombers fell into the sea; the remainder fled, one of them badly damaged.

On June 1, 1942, the Avenger made its world premiere at the Battle of Midway. Mistaken for a fighter by the Japs who allowed it to come in too close, the Avenger slipped torpedoes from its fat belly, wreaking havoc among the enemy, havoc that may well have caused a turning point in the Pacific War.

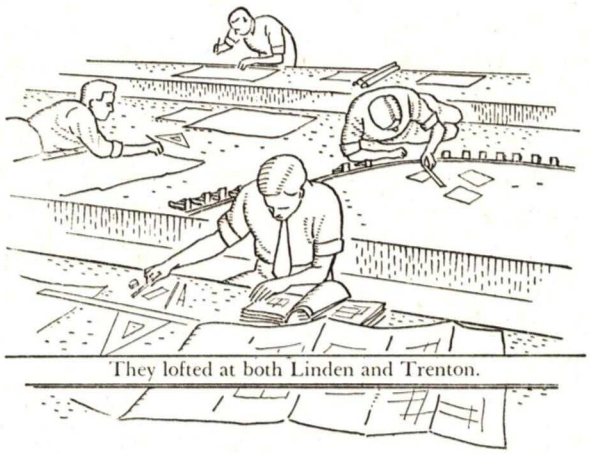
These and other thrilling events were spread over the American newspapers, and broadcast with almost wild joy from the radio stations. Clippings were posted on Eastern Aircraft plant bulletin boards; the plant paper — the *Eastern Aircraftsman* — played up every one with stories inspiring the workers to a new eagerness.

Ten days after the Battle of Midway a sheaf of design changes came through on both planes from the Navy. Obviously, these young pilots had found certain ways in which their planes could be improved over those of the enemy — discovered sometimes at the sacrifice of their lives.

"These changes are not made just because somebody had an idea," said the Navy. "Some of them may be questionable, but most of them have been forced because combat experiences developed weaknesses, or because the theatre of war itself changed."

It was pointed out that quality affected our side two ways. First, it helped the morale of the fighting forces. Second, quantity doesn't always win a battle. You yourself would rather have the best weapon than an obsolete one.

Eastern Aircraft's entire organization came around to this thinking, and conversion took a giant's step forward. The entire Division was in a whirl of activity.



They lofted at both Linden and Trenton.