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Title Planned Industrial Education and Experience for Young Engineers at the San Francisco Naval Shipyard

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The thesis "Planned Industrial Education and Experience for Young Engineers at the San Francisco Naval Shipyard" reviews the engineering manpower shortage problems of the naval shipyards, and discusses several approaches to the possible solution of this problem as suggested by a Bureau of Ships, Navy Department conference. The suggestion of a professional development program for young engineers by the San Francisco Naval Shipyard was approved by the Bureau of Ships and the author was engaged during June-September, 1951 in preparing such a program for the Electronics Branch of the Design Division at that Shipyard.

The thesis reviews the examination and analysis of the Branch, as to both personnel and position requirements, and outlines the training program which was developed. The Training Program consisted of the following sections:

Section I - Branch Orientation
Section II - On-Job Familiarization
Section III - Naval Electronics Training
Section IV - Ship-and-Shop Familiarization Program
Section V - Advanced Naval Engineering Training Program
Section VI - Naval Architects Course
Section VII - Engineering Aide Program
Section VIII - Special Training Programs

The success of this training program encouraged the Bureau of Ships to authorize the preparation of training programs for the other Branches of the Design Division based on the Electronics Branch Program. These programs were prepared by four engineering-educators employed during the summer of 1952 partially for this purpose, under the direction of the author. The Branch programs contained the same section titles as indicated for the Electronics Branch Program, but differed in certain

details due to the engineering speciality of each Branch. Programs were developed for the following Branches of the Design Division:

1. Structural and Fittings Branch
2. General Arrangements Branch
3. Piping and Ventilating Branch
4. Marine and Mechanical Branch
5. Electrical Branch
6. Electronics Branch

The present status of these training programs is reviewed, and future trends in the professional development of young engineers at the Naval Shipyards indicated.

PLANNED INDUSTRIAL EDUCATION AND EXPERIENCE FOR YOUNG ENGINEERS AT THE SAN FRANCISCO NAVAL SHIPYARD

by

LLOYD BERNARD CRAINE

A THESIS

submitted to

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in partial fulfillment of
the requirements for the
degree of

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APPROVED:

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Professor and Head of the Department of Electrical Engineering

Redacted for privacy

Chairman of School Graduate Committee

Redacted for privacy

Dean of Graduate School

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Typed by Janet Craine

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A. Zollars, Capt. U.S.N., Planning Officer
Robert Mills, Lt. Cmdr. U.S.N., Design Superintendent

The Head Engineer, Thomas H. Lowe, and Electronics Branch Chief Supervisor, Laurence M. Peterson, were the driving force, originally conceived the programs, and are responsible for their success. Their thoughtful assistance and constant interest in the programs did much to encourage and invigorate the programs. Other members, too numerous to mention, of the Design Division, Production Department, and Training School, were at all times ready and willing to offer information and valuable assistance.

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PLANNED INDUSTRIAL EDUCATION AND EXPERIENCE FOR YOUNG ENGINEERS AT THE SAN FRANCISCO NAVAL SHIPYARD

INTRODUCTION

The Naval Shipyards serving the United States Navy employ large numbers of engineers. In common with other industries, the current engineering manpower shortage has been alleviated in many ways. At the San Francisco Naval Shipyard, several approaches toward solution of this problem have been tried, among them training programs seeking to develop new engineering personnel from the shop or draftsman level by shipyard financed programs, and programs to develop the professional ability of the presently-employed engineers for more efficient and effective engineering. The author has been associated with the Professional Development Program at the San Francisco Naval Shipyard for the past two years, and in the following report presents the engineering manpower problem of the shipyards, the various approaches to the problem, and outlines the training programs developed for the Electronics Branch of the Design Division during June-September, 1951, and the programs developed for the other Branches of the Design Division under his direction in June-September, 1952. Portions of the program already in operation are reviewed and their effectiveness analyzed. Future trends in the training and utilization of engineering manpower at the naval shipyards are noted.

ENGINEERING MANPOWER PROBLEMS AT UNITED STATES NAVAL SHIPYARDS

The Role of the Engineer at the Naval Shipyards

The Naval Shipyards have had a long history of applying engineering fundamentals and knowledge to the problems of designing, constructing, modernizing, and repairing naval vessels. Some of the Naval Shipyards have served the United States Navy since the formation of this armed service.

As the country has expanded, the number and variety of naval vessels has increased, and the number and size of the Naval Shipyards has also increased. The parallel to the steady industrial growth of this country is readily apparent; however, the alternate cycles of feast and famine due to wars and disarmament have been exaggerated in the armed forces beyond normal variations. The long history, the vast expansion in the service during wars, and the let-down to standstill conditions during peacetime imposed a patchwork organizational plan on the shipyards which became increasingly complex and inefficient and made employment, especially in engineering positions, unattractive to many engineers.

In the engineering departments of the shipyards, the organizational pattern was such that groups of engineers were responsible for the design and other engineering work

for a type of vessel. Each engineer had to be conversant and experienced in the many fields of engineering which are applicable to naval vessels, as an engineer might be assigned to hull, mechanical, electrical, or armament work, depending on the immediate work load. Such variety of assignments developed all-around engineers, but the lack of specialization and the restriction to certain types of ships meant that many jobs were not as competently performed as possible. Although the Bureau of Ships correlated the basic design of ships, there was no overall similarity of design between all naval vessels, as even sister-ships became individuals after a few alterations in different shipyards.

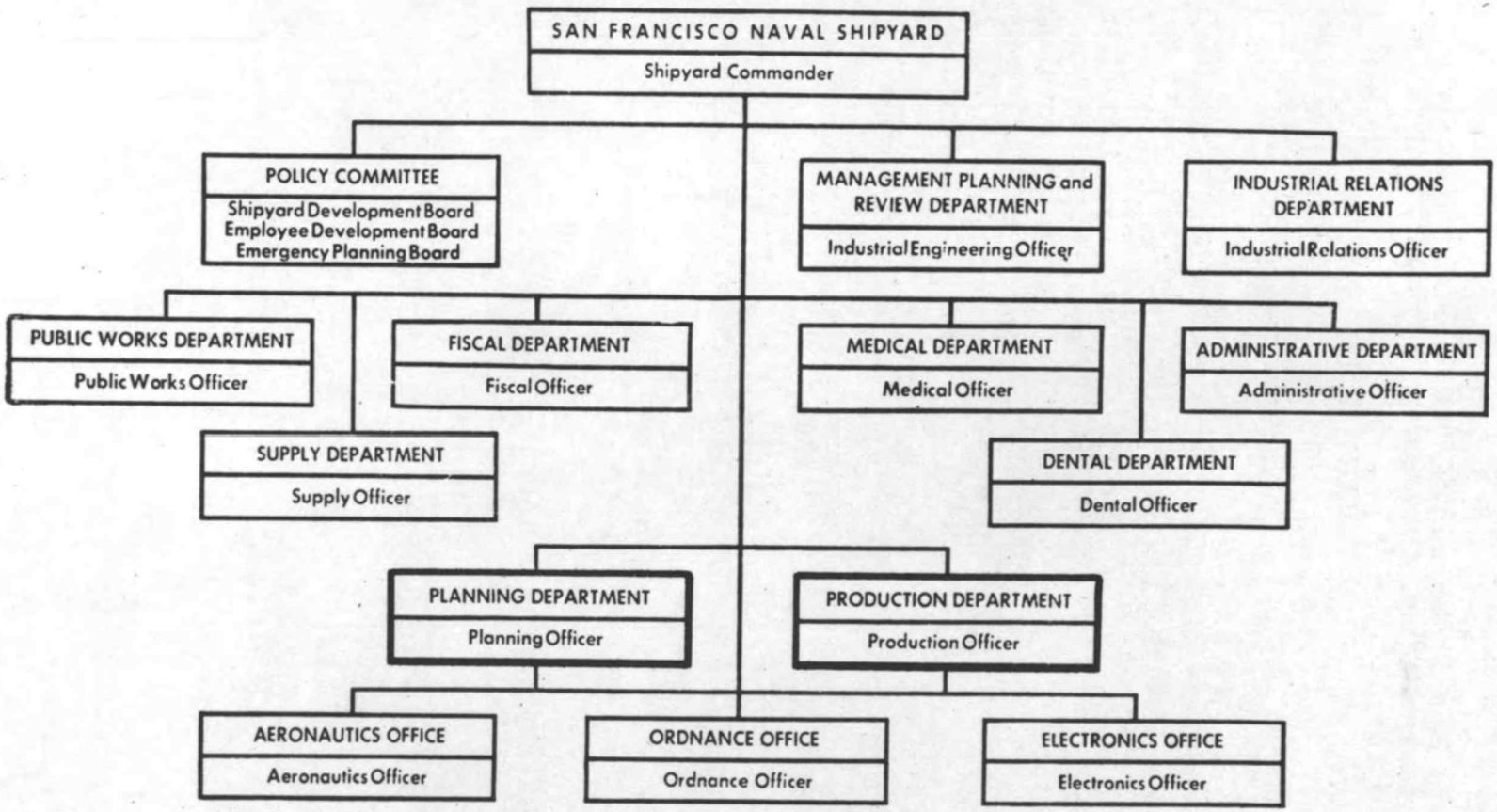
The Second World War, with the accompanying vast expansion of the Naval Shipyards brought out the fundamental deficiencies of this organizational plan, but due to the emergency a re-organization was not possible. The war work was accomplished, but the inability to rapidly expand the engineering staff in times of stress and to maintain a high quality of marine engineering became apparent. The decision was made to re-organize the shipyards along a functional pattern at the end of hostilities.

Following the war, a series of conferences held at the Bureau of Ships, in which all eleven Naval Shipyards were represented, developed the functional type of organization now in use. The present organizational plan is

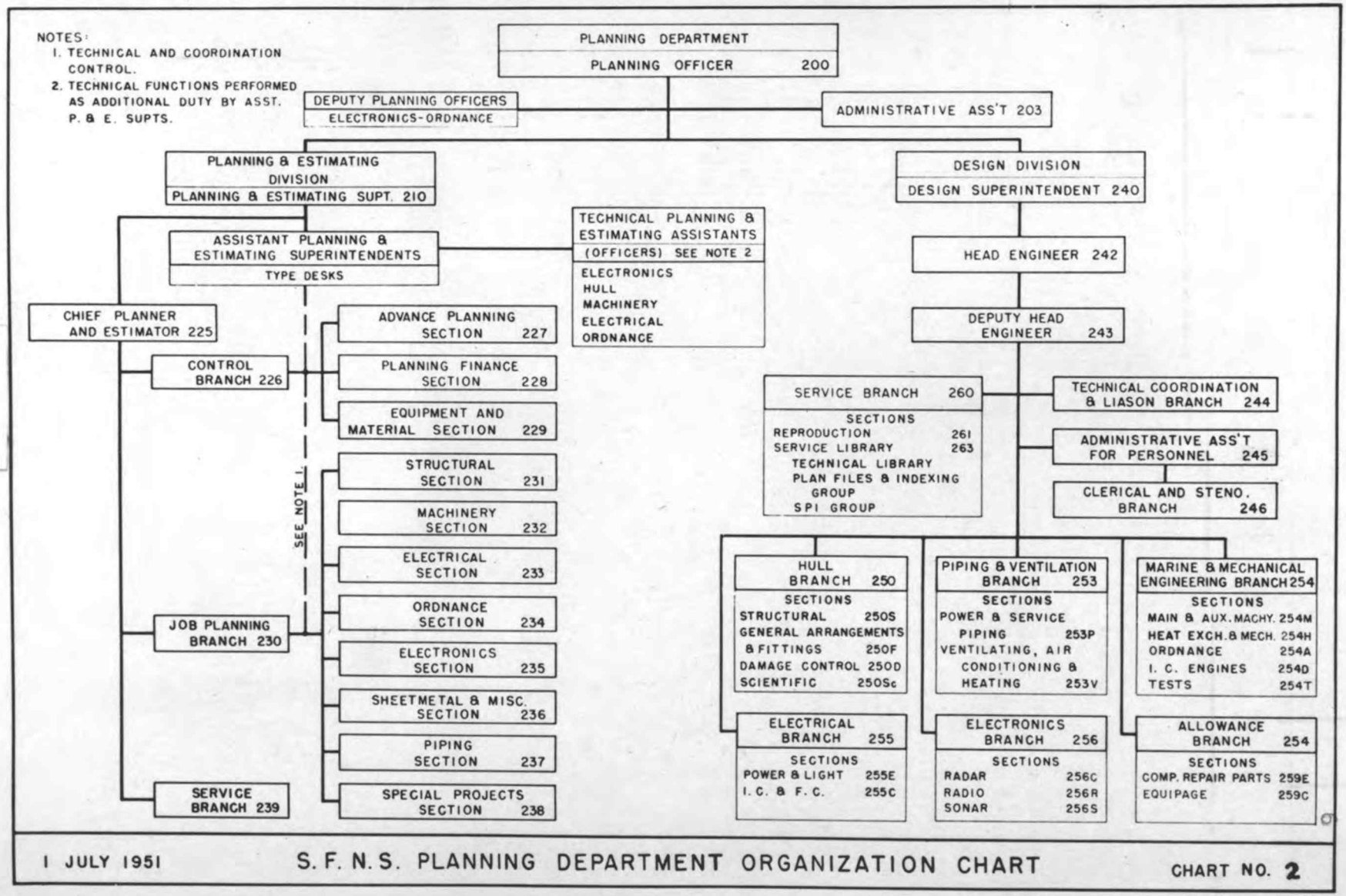
block-diagramed in Chart 1 (Shipyard Organization Chart), Chart 2 (Planning Department Organization Chart), and Chart 3 (Design Division Organizational Chart). The Design Division employs the majority of the engineers at work in the shipyard. An understanding of the duties and responsibilities of the various groups will outline the type of engineering work expected of the shipyard-employed engineer, and indicate the gap between the newly-graduated or young engineer, and the competent specialized naval engineer.

Chart 1, the Shipyard Organizational Chart, indicates the many departments under the direct supervision of the Shipyard Commander. The Shipyard Commander and the responsible head of each department is a Naval Officer. Of these departments, the Planning Department and the Production Department are the brains and body of the functioning shipyard; the others are service departments for these two fundamentally necessary organizations. The Planning Department does the design and development work, the planning and estimating, and co-ordinates the over-all work pattern. The Production Department comprises the various shipyard shops and does the new construction, installation, renovation, or repair authorized by the Planning Department.

Chart 2, the Planning Department Organization Chart, indicates two major divisions, the Planning and



SHIPYARD ORGANIZATION CHART



1 JULY 1951

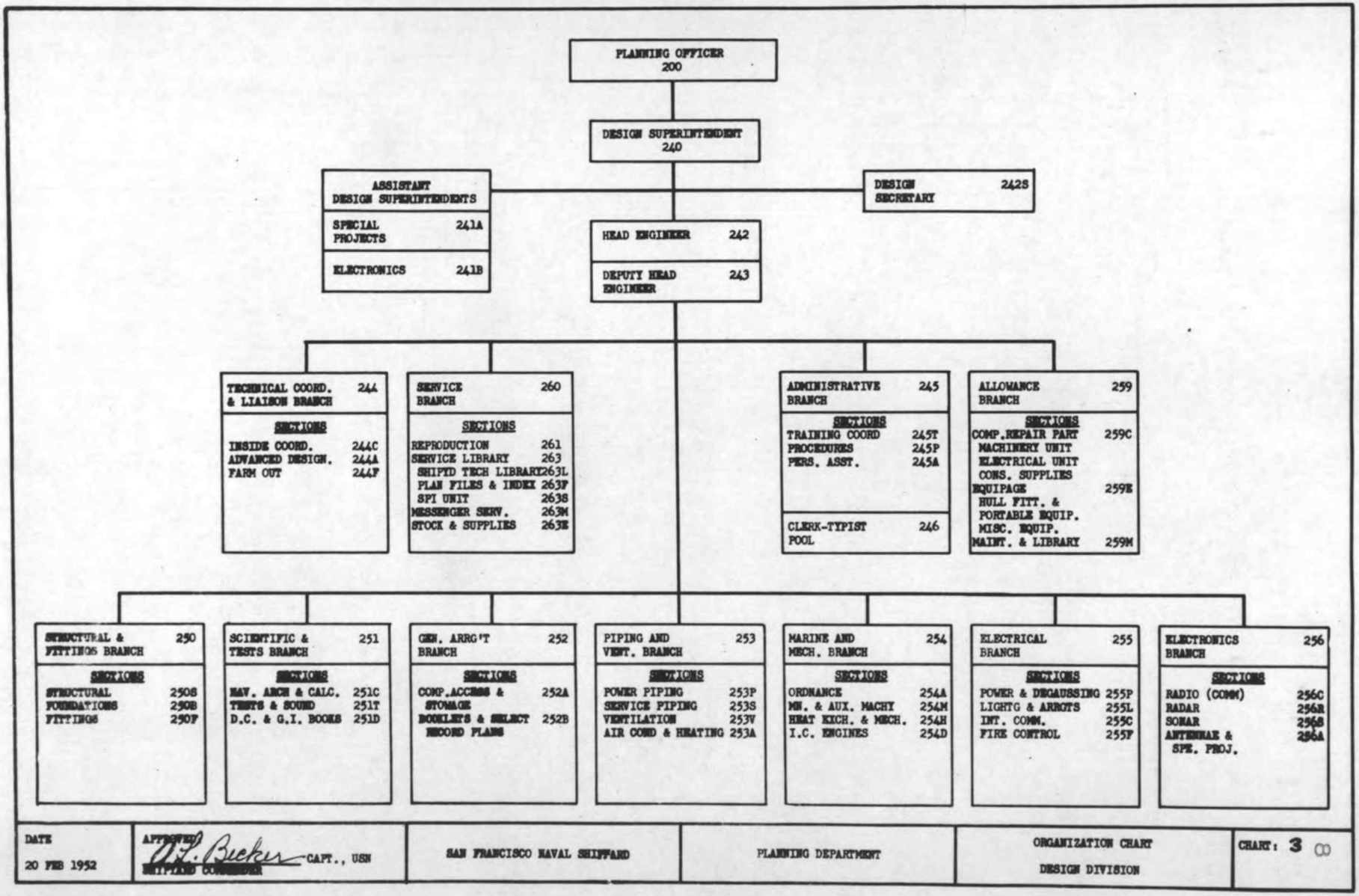
S. F. N. S. PLANNING DEPARTMENT ORGANIZATION CHART

CHART NO. 2

Estimating Division, and the Design Division.

The Planners and Estimators order the material, compute the man-days of labor, and allocate the budgeted funds. A portion of the requirement for a good Planner and Estimator is a comprehensive knowledge of shop manpower, equipment, and supply requirements for various jobs, hence, the personnel of this department usually have been advanced from the shops.

Chart 3, the Design Division Organization Chart, shows in more detail the structure of this group. The Planning Officer, Design Superintendent, and the Assistant Design Superintendent are all ranking Naval Officers; the Head Engineer and all other personnel of the Design Division are civilian Civil Service employees. As the Naval Officers rotate to other establishments about every two years, the continuity of leadership is carried by the civilian Head Engineer. At the San Francisco Naval Shipyard, the Division has over 400 employees, comprising engineers, draftsmen, secretarial, and filing help. The preponderance of employees are engineers. The functional break-down into major engineering specialities is apparent in the block diagram. Further specialization is indicated by the sectioning of each branch of the Division. At present, each engineer works in one section of the speciality branch. Seven of the eleven branches are directly concerned with the engineering aspects of ship building,



DATE	APPROVED				
20 FEB 1952	W. Becker CAPT., USN SHIPYARD COMMANDER	SAN FRANCISCO NAVAL SHIPYARD	PLANNING DEPARTMENT	ORGANIZATION CHART DESIGN DIVISION	CHART: 3

modernization or repair. The production of detailed plans or memoranda indicating work to be done is the major responsibility of these branches.

Prior to 1951, although the organizational pattern had been changed, the development of the engineer in his profession still continued by chance or individual initiative. No concerted organized effort was made to rapidly develop a competent, trustworthy engineer from the young graduate engineer in a short period of time. The general feeling was that it took years to make a good engineer and that it required a sort of osmosis. The degree of specialization in the new organization tended to narrow the job and experience opportunities, and the perpetual rush to keep even with the work schedule dictated that every man do the job he then did best. Under such conditions, the young engineer became a repetitive draftsman, little different in responsibility or in type of work from the men hired as draftsmen, and the breadth of engineering knowledge required for advancement to supervisory positions was difficult to obtain. The functional organization pattern led to efficiency in work production, but the channeling of engineering manpower into confined specialities stifled professional development and reduced the value of the young engineer as a potential supervisor should a rapid expansion of the working force be necessary.

The Present Engineering Man-Power Problem

The national shortage in engineering manpower also became a shipyard problem, although the severity of the shortage was accented by certain unfortunate governmental actions. During World War II, employees of the Civil Service did not receive permanent job ratings, and as the shipyard force was reduced following the war, many of the engineers also left. The Armed Forces-Civil Service economy program of 1948 and the resulting drastic cut in the number of shipyard employees caused more employees to leave, and the natural unrest among the remainder disrupted morale.

The start of the Korean police action in 1950 found the shipyard man-power poor, especially in the vital engineering field. Efforts to recruit competent naval engineers or old employees did not fill the gap, and with the number of college-graduate engineers becoming less each year and not likely to increase for the next several years, the situation became serious. Due to the increased knowledge and competance demanded of each engineer by the increased technological advances in the art of all-out warfare, and the increasing pressures of immediate work to get a moth-balled fleet modernized and into action, a back-log of design work piled up. A further consequence of the personnel policies of the war years and late 1940's was

that some men had been promoted to supervisory positions which, under the conditions of larger staffs and the pressures for plan production from many groups, they were not competent to hold. The lack of competent supervision reduced the efficiency of some of the Design Branches or Sections, and directly or indirectly affected the other sections due to the close co-operation and rigid scheduling of work production demanded by such large-scale and intricate naval work.

A New Approach to the Engineering Man-Power Problem

Recognizing that the complete shipyard production problem involved the following individual Design Division problems:

a. Increased design and development work
b. Decreased available engineering man-power
c. Increased technical knowledge and competance required of the personnel
d. Inadequate supervision,

and that each of the shipyards had been endeavoring to solve these problems in its own way, the Bureau of Ships called a conference in June, 1951 to discuss these problems and formulate some method of improving the situation.

The Naval Shipyards Training Conference held at the Bureau of Ships, June 4-6, 1951 (Reference 9) served to

acquaint representatives of each shipyard with the man-power problems of the others, and to reveal the various methods then in use in mitigating the situation. Although the lack of competent personnel versed in the peculiar problems of naval construction and repair was felt as keenly by the shops as by the engineering staff, the consensus of the conference was that the Shipyard Training School, staffed almost entirely by former shop personnel, could expand its already-functioning apprentice training program and meet the emergency. The real shop problem was in attracting new apprentices and retaining journeymen in the competitive labor market. Although the shops normally expand and contract the labor force in response to the work-load, definite planning and scheduling is done to equalize the work-load throughout the year, thus virtually guaranteeing long employment to those qualifying under Civil Service regulations.

The engineering man-power shortage in personnel and training was not as easily remedied. The basic principle of a group of highly-qualified men who would serve as the hard nucleus of a rapidly-expanding engineering force was easily recognized. The accomplishment of this desire was difficult, and several suggestions were offered at the conference. Among these recommended programs were:

1. An intensive recruiting program to bring newly-graduated engineers to the shipyards was

proposed. The Civil Service rules and regulations required the shipyards to hire newly-graduated engineers at the GS-5 level, a pay-level which could not compete with the offerings of private industry. Recognizing this recruiting disability, the Civil Service Commission reduced the period-in-grade before advancement from the GS-5 to the GS-7 level to six months, thus somewhat equalizing the pay scales. Due to the vacant positions in the organization, the shipyards had many GS-9 level positions open, and this fact was publicized as part of the recruiting inducement. Energetic recruiting at the various universities by engineers from the Design Division rather than Personnel people resulted in a large influx of new engineers in the summer of 1951 and again in 1952.

2. A program of selecting qualified apprentices or journeymen from the shops, giving them preparatory engineering training in the Shipyard Training School or at local Pre-Engineering schools, transferring them to the Design Division, and sending them to school during part of the week to acquire the first two years of a college engineering program. These men would then qualify as Engineering Aides and, on their own

initiative and time, complete the additional two years of schooling and become qualified engineers. This program was called the Engineering Aide Training Program and was to be administered by the Shipyard Training School. The time required was estimated at three years for the Associate in Arts degree, and seven years for a Bachelor of Science degree.

3. Several of the shipyards were convinced that the defficiencies in plan production were due to a lack of draftsmen, and that few additional engineers were needed. These shipyards wanted to establish drafting schools within the Training School, and to recruit young high school or junior college students on a half-work, half-school-time at full-pay basis. Several shipyards established these drafting schools. The time required was estimated at 12-18 months. Experience proved that the mortality rate was about sixty per cent in these courses.

4. All shipyards were in need of Naval Architects. As only three schools in the country graduate Naval Architects as such, a Naval Architects Training Program for converting engineers, particularly Civil Engineers, to Naval Architects was desired. This program was to be

taught by faculty members from near-by Universities and would require about four hours a week instruction, during working hours, for six months.

5. An Orientation and Indoctrination Course for new engineering employees, both engineers and draftsmen was endorsed. This course would introduce shipyard policies and procedures, and outline the functions, duties, responsibilities, and required procedures of the various Branches of the Design Division. Such an over-all picture of his organization and his place, purpose, and road to advancement had not previously been presented to the new employee.

6. The San Francisco Naval Shipyard requested that special training programs for each Branch be developed to rapidly integrate the new employee into the Branch by a planned program of employee development through specific education and experience in the particular field of the Branch. The Electronics Branch of the Design Division was chosen to develop this experimental program and the author was selected in June, 1951 to prepare this program, and spent the succeeding two months at the San Francisco Naval Shipyard working with the personnel of the Electronics

Branch and Design Division.

7. The conference also recommended that a position as Training Co-ordinator be established within each Design Division, chief requirements to be:

   1. A graduate Engineer with engineering experience
   2. An educator

These positions were not authorized until August, 1951, and in some shipyards were unfilled, or filled part-time by already-employed engineers. The position at the San Francisco Naval Shipyard was filled in September, 1951 and the training programs prepared during the summer were implemented.

PROFESSIONAL DEVELOPMENT PROGRAM FOR THE ELECTRONICS BRANCH, 1951

Appraisal and Analysis of the Electronics Branch, Design Division

The Electronics Branch of the Design Division had been formed in January, 1951 by raising the Electronics Section of the Electrical Branch to full Branch status. The increasing amount and importance of electronic material aboard ship made such a re-organization necessary and desirable. This section contained the largest number of relatively inexperienced engineers as well as the most job vacancies.

An appraisal of the Electronics Branch in 1951 showed that the engineers in this branch were either new to the profession and held a Civil Service rating of GS-5 or GS-7, or were older engineers with long experience who were at the GS-11 or GS-12 level. The middle group of young experienced engineers was conspicuously absent, due to the personnel policies and reduction in force prevalent following the Second World War. The increased work load occasioned by de-moth-balling and modernizing the fleet, and the increased back-log of work indicated in a first analysis that each employee should devote full-time to presently-productive work. A more careful analysis and consideration of present work priorities, and the expected increased work-load, especially should all-out war result

from or follow the Korean police action, indicated that 1951 and 1952 were the years to recruit new engineers and draftsmen and to allocate part of the working day to training. Many supervisors in the Design Division were so busy barely meeting present work requirements that they determinedly closed their eyes to the necessity of training during the present to form a more productive and efficient unit capable of handling the predicted increased work-loads of the future. Fortunately the Head Engineer and Electronics Branch Supervisor were men of vision and action, and were successful in obtaining permission to test a training program in the Electronics Branch.

The Branch is divided into three sections:

1. Radio Section
2. Radar Section
3. Sonar Section

Each Section requires the new engineer to have the basic background of electronics obtained in engineering schools. However, the new engineer rapidly becomes specialized in the systems peculiar to that section and acquires experience in that field. The shifting of work from one section to another, due to this specializing, is difficult, especially where the young engineer has not acquired an understanding of the other speciality. Specific courses such as Sonar, Radar, Radio Teletype, Facsimile, and Inter-Communication are not a part of the engineer's college work.

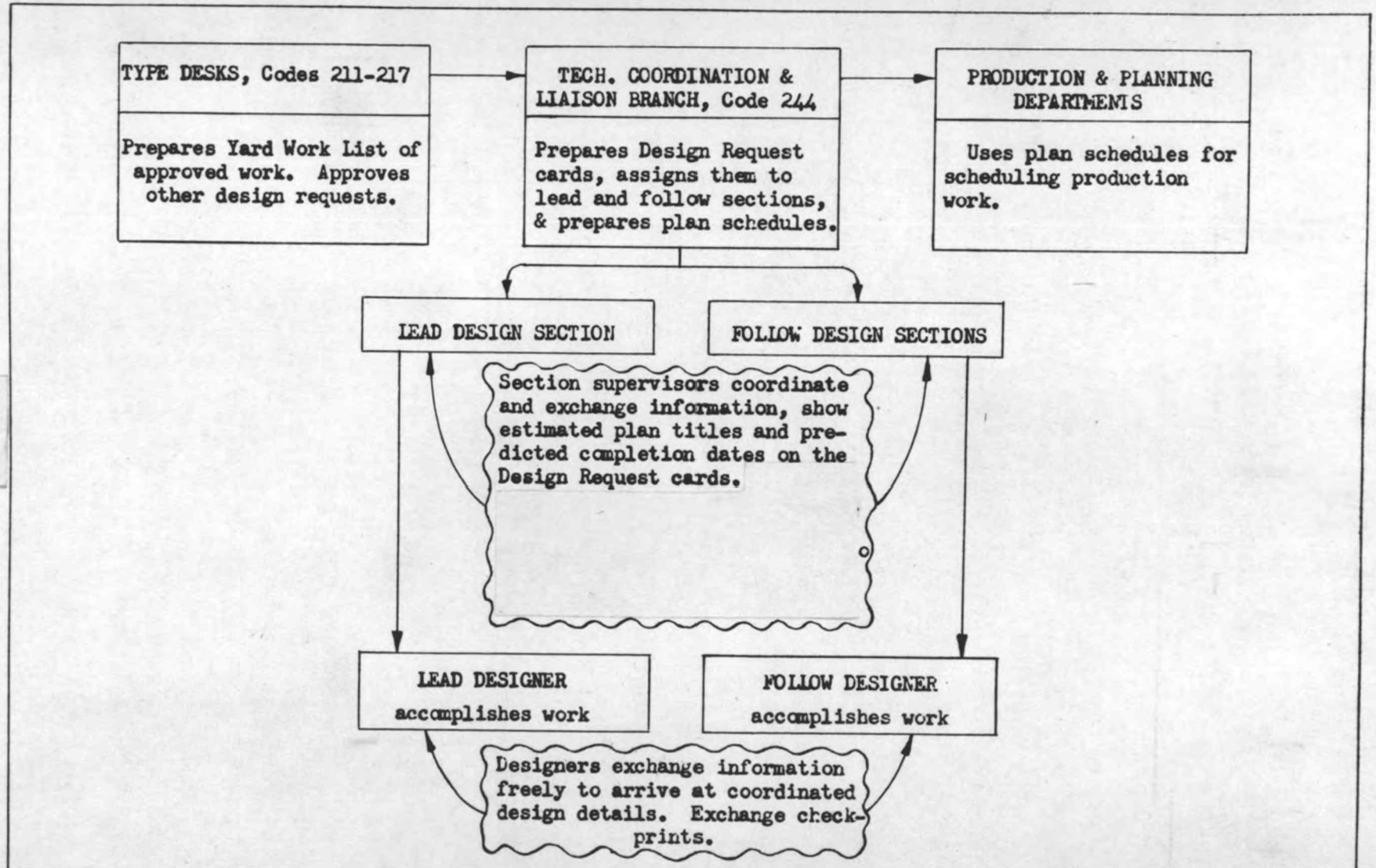
The usual work of each section of the Branch consists of:

1. Preparing memorandums specifying the electronic material to be removed from the ship with its associated cables and components, or giving installation instructions where detailed plans are not required.
2. Preparing detailed drawings (plans) showing the installation of new electronic equipment or the alteration of existing electronic material.
3. Making detailed engineering calculations and performing or directing experimental work necessary in preparing final installation plans.
4. Making investigations and preparing reports giving recommendations, estimates, and comments regarding the suitability of plans and materials.
5. Co-ordinating the electronic installations with installations of the other sections of the various Design Branches to avoid conflict or to give information required by those sections in performing their portion of the ship's work.
6. Checking plans of other shipyards for applicability to the present job and modifying these plans, if satisfactory, to expedite plan production.
7. Special investigations as directed by the Bureau of Ships.

In order to accomplish these various jobs, the Design Electronics Engineer must be skilled in:

1. Principles, circuits, and practices of his speciality in electronics.
2. Principles, circuits, and practices of electronic engineering.
3. Principles, circuits and practices of electrical engineering.
4. Principles and practices of shock absorption.
5. Principles of electro-magnetic radiation and transmission.
6. Materials and components available in the industry.
7. Naval construction, nomenclature, specifications, and operating practices.
8. Drafting room technique.
9. Reproduction methods.
10. Interpreting and writing commercial and Naval letters, dispatches, and reports.

Chart 4 (Flow Chart of Design Work Assignments) shows the sequence of a job assignment to the designer. The Design Request originates in the Planning and Estimating Division's Type Desks. These requests are transferred to the Technical Co-ordination and Liason Branch of the Design Division where the complete job is broken down into the parts corresponding to the speciality of each Branch.



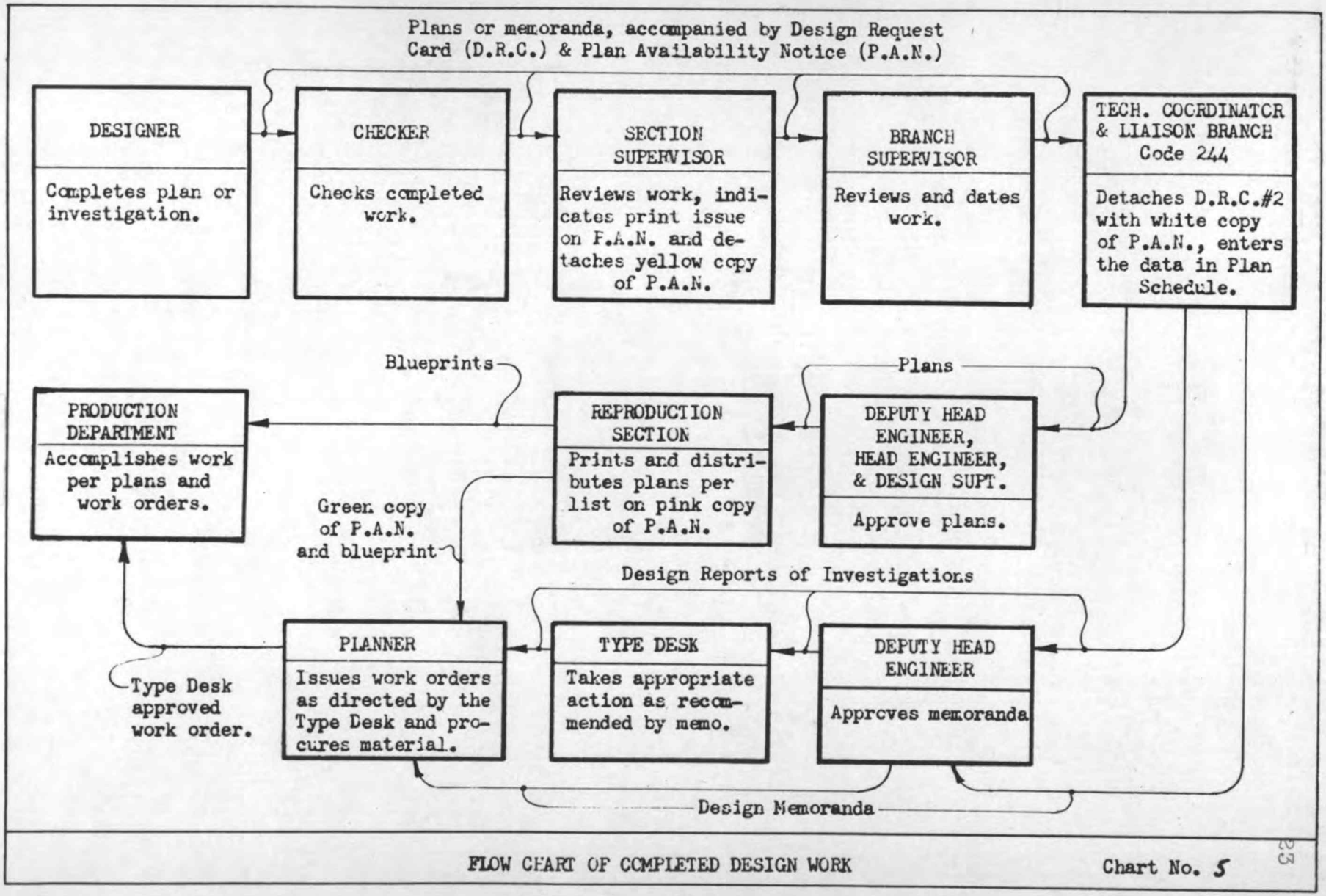
FLOW CHART OF DESIGN WORK ASSIGNMENTS

Chart No. 4

A Lead Design Section and the Follow Design Sections are designated, and a plan production schedule arranged by conferring with the Branch supervisors. The portion of the Design Request allocated to that Branch is then assigned to a designer, who performs the design work, co-ordinating his design with the other Branches or Sections involved in the complete Design Request.

Chart 5 (Flow Chart of Completed Design Work) shows the route of the completed plan from the original designer, through the Section Plan Checker, Section and Branch Supervisor, to the Technical Co-ordination and Liason Branch. This Branch records the plan completion on the Plan Production Schedule and routes the plan for further approval by the deputy Head Engineer, Head Engineer, and Design Superintendent. The plans are then reproduced and sent to the Planners and Estimator Division and to the Production Department for work accomplishment. Design Memoranda follow much the same path of review.

This appraisal and analysis of the Electronics Branch mission was coupled with interviews with the young engineers who had been working in the Branch and interviews with the just-hired newly-graduated engineers. The author's inexperience in shipyard work proved a decided advantage, as the development of the training program could be approached from the viewpoint of the new employee, but guided and directed by more mature deliberation and



FLOW CHART OF COMPLETED DESIGN WORK Chart No. 5

judgement.

Indoctrination Program

At the San Francisco Naval Shipyard, a determined effort was made to recruit the 1951 college-graduate engineers to fill positions in the various engineering fields of the Design Division. The recruitment program did not fill all of the job vacancies, however, there was a considerable influx of young engineers during June and July. To introduce these new engineers to the Design Division in a more organized manner than had previously been done, a committee of supervisors, in conjunction with the Training School, prepared an Indoctrination Program and a Design Division Handbook (Reference 12) designed to inform the new employee of the fundamental aspects and requirements of his job, and the various services which were available in the shipyard, This program, started at the end of June, 1951, was conducted by various supervisors in six meetings and covered the following items:

1. Welcoming address
2. History and organization of the shipyard
3. Organization of the Design Division
4. Origin, procedures, processing, and follow-up of design job assignments
5. Plan production services, plan index, and

technical library facilities

6. Government specifications
7. Civil Service personnel policies and shipyard regulations
8. Employee services
9. Shipyard tour

The author, being as new to the shipyard as any of the young engineers, attended this course, prepared a questionnaire, and analyzed the results to evaluate the success of the course. The course was given for the new employees and employees who had worked at the yard the previous year. Both groups indicated that they had received much help and guidance from the course as well as an increased enthusiasm for their job.

Recommendations concerning material included or omitted, sequence of topics, and instructor personnel were made by the author and considered in preparing the course for presentation in 1952.

Electronics Branch Training Program, 1951

The critical appraisal and analysis of the new engineer's position in the Electronics Branch resulted in the tabulation of types of work assignments shown on page 19, and technical background requirements shown on page 20; Interviews with the new engineer and a knowledge of the

material usually covered in an undergraduate program coupled with a review of typical job assignments for the young engineer revealed that the major immediate deficiencies were in:

1. Principles, circuits, and practices of the assigned electronic speciality
2. Circuits and practices of electronic engineering.
3. Practices of electrical engineering.
4. Material and proprietary articles available in the industry.
5. Naval construction, nomenclature, specifications, and operating practices.

Some of the other items, such as drafting room technique and methods, would require review, others, such as shock absorption and English composition were of less immediate concern. It was decided to design a training program emphasizing the above five technical requirements.

The objective of the Branch Training Program was to increase the effectiveness of the present Design personnel and to rapidly develop the professional and productive ability of the new employee. The complete program was designed particularly for the new employee; however, it was so developed that already-employed engineers or draftsmen could benefit from certain selected portions of the program. The specialization in sections within the Branch did not facilitate the transfer of an excess in

work-load in one speciality to another speciality section, hence, it was decided to broaden the background of all employees of the Branch by giving each the basic material pertaining to each speciality.

Personnel to instruct certain courses in the training program were selected from among the supervisory and older-employee groups of the Electronics Design Branch and the Electronics Office. Most of the selected personnel had previous teaching experience of one kind or another and indicated an interest in, and a desire to participate in the program. Much of the course material was selected and prepared with the assistance of the selected instructors.

Only the major divisions of the complete training program will be introduced in this report; the complete detailed program is contained in Electronics Branch Training Program (Reference 3).

Section I - Branch Orientation

A serious effect of the previous lack of method in introducing the new employee, engineer or draftsman, to his job and his supervisors was the actual loss of new recruits or the decrease in morale, job enthusiasm, and efficiency of learning if the man remained.

This morale problem was usually due to the man's

supervisor being engrossed in some immediate problem and neglecting to take the time to acquaint him fully with the requirements and opportunities of the job, and the sources of information and material. Oftentimes the new employee would have to wait several days for a job assignment, or would be given several huge volumes of naval specifications and told to read them for several days. Not knowing much about the job requirements, the new employee would fumble around, feeling lost and unwanted. Gradually, if he stayed, the new employee would pick up through casual conversation with other employees some idea of the job requirements and work procedures. The Electronics Branch supervisors were not as remiss in this in-attention to the new employee as supervisors of some of the other branches or sections, but, the supervisors were men of considerable experience, and often failed to realize the exact information and proper sequence of presenting such information necessary to properly introduce the new employee to the job.

The first part of a training program for the new employee should then include an Orientation section to kindle job enthusiasm and build morale, and to introduce the new employee to his job. Having such a planned program available, and convinced of its merit, a supervisor could efficiently integrate the new man into his organization. The first section of the Training Program

contained:

1. Introduction to Branch organization, work assignments and responsibilities.
2. Initial job assignments.
3. Plan production and procedures.
4. Sources of information.
5. Drawing standards, aids, and short-cuts.

The training time required for this portion of the program was estimated as nine hours, was to be started the hour the man reported for work in the Branch, and was to be completed within the first two weeks of duty.

Section II - On-Job Familiarization

Following the initial job orientation and close contact with his supervisor, the new employee needed a diminishing amount of personal guidance and assistance. This continuing portion of his productive work training counseled the supervisor to:

1. Continue the advancement of the employee by renewing job enthusiasm and imparting increased responsibility and confidence.
2. Outline the complete design problem where the new employee is only performing a small portion of the over-all design.
3. Encourage the employee to ask questions when

necessary.

4. Encourage the employee to widen his knowledge by reading and discussion with fellow employees and to utilize the knowledge of others by maintaining close friendly relations with persons in other sections and branches.
5. Allow the employee time to follow up his plan by observing the shipboard installation and operation to improve his design technique.

Section III - Naval Electronics Training

A major portion of the training program was devoted to basic electronics training in the speciality fields of the Electronics Branch. This program was outlined in great detail in the Training Program (Reference 2), including texts, reference material, selected training aids, and lesson outlines. Only the major sub-divisions are listed below:

1. Principles of Radio Communication
2. Introduction to Radar
3. Servo-Mechanisms, Synchros, and Computers
4. Principles of Sonar
5. New Electronic Devices

The estimated training time for this course was sixty-eight hours, with two hours of training scheduled

each week.

Section IV - Ship-and-Shop Familiarization Program

The groups associated with complete ship electronic installations have individual assigned functions, but must operate as a co-ordinated team. The physical and organizational distance separating these groups leads to the formation of isolated groups having contact mainly by plans and memoranda. The new employee of the Design Division has little practical knowledge of the equipment, techniques, and problems of installation or operation of a shipboard electronic installation. This portion of the program was developed to meet this need, and to lead to closer personal relationships between groups when difficulties arose, and to encourage the engineer to utilize the knowledge, skill, and experience of these men in solving design problems. A feeling of mutual respect for the other person's knowledge and ability is important in such Design-Shop organizational separations. The feeling of working together toward a common goal was lacking in many of the Design Division-Production Department groups. A feeling of suspicion, resentment, and criticism, due in many cases to the lack of personal contacts, and a failure to understand the limitations of the group, appeared. This program was scheduled to require four

working-weeks, during which time the employee would follow a rotating work plan in the shops and would not be doing plan production work. Only a few employees were to be assigned to this portion of the program at any given time, such an employee to have completed most of Section III, Naval Electronics Training. Each new employee was to prepare a report covering his shop-ship experience.

Section V
Advanced Naval Engineering Training Program

The young engineer to advance in his profession will require additional college-level education. The two institutions offering graduate-level work, the University of California and Stanford University, would give such courses, but without credit, as the Academic Senate of the University of California requires that work for advanced degrees be taken in residence, and Stanford does not have an extension program. Faculty members, however, are at liberty to teach such classes. As the young engineer would usually like to apply course credits toward an advanced degree, and as transportation difficulties made residence course work unlikely, a list of advanced-course subjects was prepared, and the course arrangements were left to the Training School for completion during the academic year. The suggested courses, in order of priority, were:

1. Antennas, Transmission Lines and Wave Guides.
2. Electronic Servo-mechanisms.
3. Electrical Conducting, Semi-comducting, and Insulating Materials.
4. Propagation of Sound and Radio Waves.
5. Advanced Electronic Circuits.
6. Nuclear Physics.
7. Nuclear-reactor Theory and Engineering.

These courses were to require from two to four hours a week, half work-time, and half employee's time, with the cost of instruction furnished by the shipyard.

Section VI - Naval Architects Course

The course to convert Civil Engineers to Naval Architects has already been mentioned (Page 14). Certain electronics engineers could benefit from this course, particularly those with supervisory possibilities, therefore, some engineers of the Electronics Branch were selected to attend this ninety class-room hour course. The course was given by the University of California Extension at the shipyard.

Section VII - Engineering Aide Program

To meet the shortage of engineers, the Head Engineer and the Training School had developed a program in late

1950 to bring qualified shop personnel into the Design Division on a semi-professional level. Course material in Mathematics, Physics, and elementary Engineering was given at the shipyard by the City College of San Francisco as a part of their Adult-Education Program. This program was not developed by the author but was included in the Branch Training Program Report for the employee's information.

Section VIII - Special Training Programs

From time to time, special training courses on specific types of naval electronic equipment are given at various manufacturers' or service schools. Such courses would prove of value to the Design Branch by increasing the overall design knowledge of the Branch. Certain employees are selected for these schools and review the course content for the other employees upon their return from the school.

Suggestions and Recommendations

The final section of the report listed suggestions and recommendations concerning the programs directed to the supervisors, employees, and course instructors.

Review of the Electronics Branch Program in Operation, 1951-1952

The Electronics Branch Training Program was officially inaugurated at the San Francisco Naval Shipyard January 7, 1952 with an address by the Shipyard Commander to the class members starting Section III, Naval Electronics Training Program. The Orientation Program (Section I) and the On-Job Familiarization (Section II) were in operation during the fall of 1951. The delay in beginning the classroom work was due to the time required for approval of the program by the Bureau of Ships, and the allocation of training funds.

The students, originally, were to be the engineers and draftsmen of the Electronics Branch, however, other groups concerned with electronics, or using electronic components in their field, requested permission to send selected men to the course. Final course enrollment was sixty-six. The training time required was one hour, twice each week, with course completion scheduled in September, 1952.

To better prepare the instructors selected for the various sections of the course, the Training School gave an Instructor Training Course in December, 1951.

The first two sections of the training program designed to introduce the new man to his work properly, and to improve his job performance, had resulted in

improved spirit of work accomplishment and co-operation in the Branch. The third section, giving the basic fundamentals of each speciality section to the men of the other sections, and reviewing or improving the knowledge of the men already in that section, began to pay dividends in the transfer of work-load from an over-loaded section to a lightly-loaded section. With the continual change in emphasis from Sonar, to Radio, to Radar, and back again, depending on the work schedule, this flexibility of job assignment was important. The basic information about his speciality in engineering, presented in a comprehensive and practical manner by men experienced in that field, gave the new engineer or draftsman an opportunity to fit his portion of the plan development into the complete plan with more skill and confidence and less revision.

The sum total of the morale implications of a concrete training program, the factual knowledge gained from the program, and the competant fitting of young engineers to job assignment by the supervisors led to increased productivity and efficiency. The Electronics Branch became recognized for its ability to meet plan production schedules, take on additional engineering work, and reduce back-log design work. The Branch was awarded several design and development problems by the Bureau of Ships. The training program had not decreased the work output of the Branch as predicted by supervisors of some of the other

Design Branches. Much of the success of the Electronics Branch is due to the energetic and competent leadership of the Branch Chief and Section Supervisors.

EXPERIMENTAL SUMMER FACULTY EMPLOYMENT PROGRAM, 1952

The success of the Electronics Branch Training Program led the San Francisco Naval Shipyard to consider the preparation of similar programs for the other Branches of the Design Division. Bureau of Ships permission was granted the shipyard to employ six engineering-educators during the summer of 1952. Engineering School faculties throughout the West were contacted and of the many applicants, six men were selected. One man declined at the last moment, and only five professors reported for duty June 18, 1952. These men were:

Assistant Professor Lloyd B. Craine
Electrical Engineering
University of Idaho

Associate Professor Arnet B. Epple
Mechanical Engineering
University of Michigan

Professor Frank J. McCormick
Applied Mechanics
Kansas State College

Associate Professor Joy O. Richardson
Mechanical Engineering
California State Polytechnic College

Professor (and Head of Department) Ralph W. Tapy
Electrical Engineering
University of New Mexico

Unfortunately, Professor Epple became ill after ten days of employment and was forced to leave. A replacement, Associate Professor Mac E. Van Valkenberg of the

University of Utah was obtained during August to teach a special course in Servomechanisms of immediate need to the Design Division.

The author, although the junior in age and experience, was appointed Dean of the Summer Faculty, and, as such, directed the efforts of the group. The group operated in close co-operation during the summer, and have retained the personal friendships established during this time.

Summer Faculty Duty Assignments

Each Professor was assigned a Design Branch of the Design Division. Each Branch was to have a program tailored to its requirements. The format of the Electronics Branch Program was also suitable for the other Design Branch Programs and several sections of this program, although requiring slight revision, were directly transferable.

The other professors were new to the shipyard and to naval work and procedures. At a series of conferences the first two weeks of employment, the author, assisted by various shipyard supervisors, gave a rapid orientation and indoctrination program. During this time the professors were also becoming acquainted with their Branches, the men and mission of the Branch, and the other shipyard organizations contacted by the Branch. Much of the training

program material was obtainable from the men of the Branch. The job was in assembling, analyzing, organizing, condensing, and preparing the material in usable form. Many of the supervisors and some employees did not believe in the value of a training program; day-to-day work accomplishment was their only objective. The training programs required the co-operation of many persons outside of the Design Division, hence, much of the work was in establishing personal contacts with the proper people and convincing them of the value and necessity of training. The firm conviction of the Head Engineer and the Shipyard Commander in the value of training did much to encourage co-operation.

The duties of the summer faculty, as assigned by the Head Engineer (Reference 10, pp 1-3) included:

1. Prepare training programs for the individual Design Branches.
2. Act as technical employee counsellors investigating the needs of the individual engineer and offering unbiased counsel and advice to the individual engineer.
3. Analyze and evaluate the current operation and training in the assigned Design Branch.
4. Prepare a joint report on suggested means of improving the over-all management of the Design Division for more efficient operation, simplification of systems, and better utilization of

manpower.

5. Critically examine the Branch supervision and devise means of strengthening supervision in the Branch.
6. Act as technical consultant on design and development work in the Branch.

In performing these duties, each professor had to:

1. Identify the position of the Design Division relative to the other groups in the shipyard.
2. Recognize the specific mission assigned to the Design Division, its scope and its limitations.
3. Comprehend the degree of independance and dependance of each Branch relative to the other Branches in completing a ship job-assignment.
4. Know the technical knowledge and manual proficiency required of the men at the various Branch and section position levels.
5. Appreciate the many problems facing the shipyard designer.
6. Understand and apply the many factors which weld a group of individuals into an efficient team.

Outline of the Programs Prepared

In the training field, the professors concentrated on three major programs:

1. Revision of the Indoctrination program first devised by the Branch Supervisors and Training School in 1951.
2. Preparation of individual Branch Training Programs based on the 1951 Electronics Branch Program.
3. Completion of a Supervisor Training Program developed by the Head Engineer and the Training School.

The new professors attended the meetings of the 1952 Indoctrination Program. Following this program and the sequence of shop tours, the program was analyzed and evaluated in several conferences. The program was then revised to reduce the required training time and emphasize the essential information needed immediately by the new employee. Details of the program are contained in the Design Division Indoctrination Program (Reference 13). The program contains the elements of the 1951 program outlined on Page 28 with some condensation and revision.

Individual Branch Training Programs

The preparation of the Individual Branch Training Programs required the greatest amount of effort. The training needs of the Branch had to be ascertained, the ideas of various Branch members, both supervisory and plan

production personnel, had to be obtained, compiled, evaluated and organized, and time-consuming training balanced against the hard necessities of scheduled plan production. Furthermore, many of the Branch personnel had to be convinced of the desirability and necessity of the training. The necessary information was obtained by informal interviews, usually at the employee's work table. Thus the professor had to simultaneously perform the role of investigator, counsellor, engineering consultant, salesman and confidant. The un-biased attitude and discretion of the professors encouraged employees to discuss procedural and supervisory difficulties, and revealed several hidden sources of discontent within the Branches. Often-times the explanation by the outsider of the necessity of what seemed to the employee to be unnecessary procedures would be satisfactory. Where the comments were justified, the professors brought the problem to the supervisor concerned or the Head Engineer and the difficulties were usually resolved.

The individual Branch programs were developed from these interviews with the Branch Personnel (References 3, 5, 6, 7, 8). The Electronics Branch Program (Reference 4) was reviewed in light of the program operation since January, and revised accordingly.

Each Design Branch had a specific program prepared for that Branch, however, the sections of the program

applicable to all Branches were generalized and appeared in each program. These Sections were revised from the original Electronics Branch Program outlined on Pages 27-34 at thrice-weekly conferences of the professors. These common sections were:

1. Section I - Orientation and Indoctrination
2. Section II - On-the-Job Familiarization
3. Section VI - Naval Architect Training
4. Section VII - Engineering Aide Program
5. Section VIII - Off-Campus Engineering

Three of these programs, the Naval Architect Training, Engineering Aide Program, and Off-Campus Engineering Program were not developed by the professors, but were included in the Branch Training Programs for completeness.

The sections which were prepared individually for each Branch were:

1. Section III - Fundamental Naval Engineering (in the speciality of the Branch)
2. Section IV - Ship-and-Shop Familiarization
3. Section V - Advanced Naval Engineering (in the speciality of the Branch)
4. Section IX - Special Courses

Programs were developed for each of the following Branches:

1. Structural and Fittings Branch
2. General Arrangements Branch

3. Piping and Ventilating Branch
4. Marine and Mechanical Branch
5. Electrical Branch
6. Electronics Branch

Simultaneously with the information gathering of Branch training needs, the professors endeavored to analyze the supervisory problems of the Division. Although the Head Engineer had requested an analysis of each supervisor, it was soon apparent that the strengths and weaknesses of his supervisors were well-known to him. The various supervisors had, for years, been exposed to Supervisor Training Sessions at the Training School with increasing dissatisfaction. The professors endeavored to discover the reasons for this discord by luncheon conferences with individual supervisors.

The uniform complaint was that the Training School course was:

1. Designed for shop supervisors.
2. Illustrated by shop problems in supervision.
3. Taught by former shop personnel who knew little of the problems of supervising engineering personnel.
4. Repetitious, the same material being presented each year.
5. Un-instructive, as only the simplest problems were analyzed.

The luncheon conferences also gave the supervisor a chance to review and express his ideas on supervision, and forced him to organize and solidify his often nebulous ideas on proper supervision. The discussion also allowed the professors to inject new ideas and thoughts about supervisory practices, and thus helped to clarify and co-ordinate the practices of various supervisors. A few of the supervisors were still un-convinced of the value of present-training-for-future-work-improvement. These individual conferences did much to persuade these supervisors of the value of a specific training program to alleviate plan production difficulties.

The Head Engineer, in conjunction with the Training School, had worked out a tentative Supervisor Training Program. This Supervisor Training Program was reviewed and slightly re-organized. The heart of the program was the selection of outstanding men from without the shipyard to lead the discussion in each particular field. The topic titles of the various meetings were:

1. The Significance of Supervision.
2. Theories, Principles and Purposes of Organization.
3. The Shipyard Design Division as a Field Office of the Bureau of Ships.
4. An Organization at Work.
5. Employee Relations, Problems, and Objectives.

6. The Importance of the Individual Employee.
7. The Design Supervisor's Part in Strengthening Employee Relationships.
8. Conference Leading in the Solution of Unit Problems.
9. Co-ordinating Design Branches, Controlling Progress, and Following-up Design Division Work.
10. Estimating Manpower Requirements, Shifting Personnel to Balance Work-Load, Budgeting Implications.
11. Preparation of Reports and Correspondence.
12. Scheduling and Work Simplification.
13. Professional Development of Engineers.
14. Analyzing the Training Problem.
15. The Preparation and Presentation Job of the Instructing Supervisor.
16. Training Aids.
17. Instruction of Technical Employees.
18. Position Classification in the Engineering and Drafting Fields from a Supervisor's Viewpoint.
19. Preparation of Job Descriptions.
20. Civil Service Qualification Standards.
21. Employee Interviewing, Selection and Placement.
22. Employee Personnel Actions.
23. Employee Control.
24. Course Summary.

The total time required for this Supervisor's Training Program was thirty-six hours, to be scheduled in one or two hour sessions each week. Many of the meetings were scheduled as discussion sessions, others as a lecture followed by a discussion of pertinent problems.

The Ship and Shop Training Program

The original Electronics Branch Program contained a section providing shop experience for the new engineers. This program was initiated by the Branch during the summer of 1952 to evaluate the value of such training, and to work out co-ordination details between the Design Branch and the Shops involved. Details of the shop training for the other Design Branches were worked out between the professor assigned to that Branch, the Branch Supervisors, and the Shop Masters. A conference of the Design Supervisors, Shop Masters, Industrial Relations Department and Professors reviewed and standardized the administrative details of the program and heard a resume' of the pilot-run of Electronics Branch Engineers with the Electronics Shop. The enthusiasm of the Branch Supervisors and Shop Masters for the program makes its success seem assured.

The trial program with the Electronics Branch-Electronics Shop brought out the:

1. Expected closer personal contact and exchange of

confidence between engineer and technician.

2. Shop facilities and equipment.
3. Problems of Shop personnel in interpreting and executing design plans.
4. Examples of poor design and good design.
5. Co-ordinated functions of Electronics Shop, Electrical Shop, and other Shops in a complete installation.
6. Role of the Planning and Estimating Division in complete ship's work.
7. Relative cost of materials, equipment, and manpower.

An unexpected dividend of the pilot-program was the liason work which was performed by these engineers in answering questions on design plans and in modifying certain plans during construction by contacting directly the engineers involved. The usual channel of communication on discrepencies in plans through the Planners and Estimators required from two to four days for the information to reach the original designer from the shop. In many cases, especially when the shop personnel and design engineer were acquainted, telephoned inquiries or personal visits resolved immediate installation problems. One of the objectives of the Shop Training Program was to increase this personal contact and confidence. Changes in plans requiring additional money allocations required approval of

the Planners and Estimators, however, many of the common shop problems were installation interference problems where arbitrary re-arrangements by Shop personnel of design plans without approval often led to expensive re-installation. A knowledge of the function of the Planners and Estimators assisted the engineer in determining the extent of his authority in revising approved plans of the job.

Present Status of Engineer Development Programs

At the present time, February, 1953, the following sections of the training program are in operation:

1. Section I - Orientation and Indoctrination.
2. Section II - On-the-Job Familiarization.
3. Section IV - Ship and Shop Familiarization.
4. Section VII - Engineering Aide Program.
5. Section VIII - Off-Campus Engineering Program.
6. Section IX - Special Courses.

The remaining sections of the program await Bureau of Ships approval, the allocation of training funds, or completed course arrangements with the University of California or Stanford University.

Benefits of the Summer Faculty Employment Program

The summer Faculty Employment Program had manifold

benefits for the shipyard, and particularly for the professors. The shipyard could show the following tangible evidence of the professors' activities:

1. Design Branch Training Programs for six of the seven Design Branches.
2. Completed Supervisor Training Program.
3. Presentation of an intensive sixteen-hour Servomechanism course by one of the professors.
4. Report on a confidential Design-Development project by the author.
5. Consulting work on various design problems by all of the professors.

The intangible benefits of this short-time employment program might be:

1. Improvement in recruiting efficiency due to a planned training program for the young engineer.
2. Improved employee job satisfaction due to a better concept of his job, its future possibilities, and its relationship to other shipyard activities.
3. Improved personal relationships between engineers and shop personnel.
4. Improved Branch morale due to the un-bias observer position of the professors, and the direct access of the professors to all ranks of the shipyard administrative force.

Some of the benefits to the professors were:

1. Opportunity to observe all divisions of an 11,000 man industrial giant in operation.
2. Occasion to follow newly-graduated engineers from the classroom to their first job, analyze the job and its requirements, and observe the transition process from new graduate to young competent engineer.
3. Close and intimate contacts with executives of experience, responsibility, and authority.
4. An increased respect for at least one governmental agency which has a cost-conscience and feeling of responsibility for the tax-paying public.
5. The opportunity to work on design problems involving ships and thus gain some knowledge of the problems of his speciality when used in marine work.
6. For the author and one other professor the joy of being at sea without sea-sickness via a submarine trip.
7. The opportunity to exchange ideas and information with engineering-educators from other schools and to form close friendships with these colleagues.

EVALUATION OF, AND FUTURE TRENDS IN, ENGINEER PROFESSIONAL DEVELOPMENT PROGRAMS AT NAVAL SHIPYARDS

The continueing trend in important segments of industry is to plan the transition period from newly-graduate engineer to young engineer (Ref. 1, p. 250; 9, p. 316). The advantages of this systemized introduction to his specific job, and the further enlargement of his professional growth by allocating training time at the start of his career pays off in better retention of new employees, and in eventual placement of these men in important and responsible executive positions. This trend is not universal, however, as such training costs money, both in actual additional funds required and in lost production time. A prospective professional development program must be carefully balanced; expected results against cost to the employer, and such evaluation is often difficult.

The programs developed for the San Francisco Naval Shipyard were specifically designed to provide industrial education and experience for the young engineer in his engineering speciality. Further expansion of his training in this field by further university-type training was provided, and the opportunity to extend his job opportunities to the supervisory level was available. Although the programs required contributions of money and employee working time by the shipyard, it was felt that the expense was justified in more efficient future plan production and

work-load shifting capabilities. The improved employee morale and recruiting inducement made the programs essential in these times of a shortage of engineering personnel.

The Naval Shipyards have long devoted a proportionately larger amount of time to employee training than have many comparable industries. Much of this training has been in industrial safety and job technics in the shop. This planned program for young engineers at the San Francisco Naval Shipyard is a new approach to the young engineer education and experience problem at the shipyards. The other ten Naval Shipyards are observing with interest the experimental engineering training at this shipyard. Should the program prove as effective as expected, modifications of the Branch Programs will undoubtedly be adopted by the other yards and integrated into their own engineer professional development pattern.

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