Editorial

By H. J. Caulfield, Editor, Optical Engineering

Optical Engineering and Optical Engineering

Optical Engineering is a journal with a purpose. It is designed to serve a special group of people called "optical engineers" as their professional journal. As the new editor, I am concerned with what has been a major problem for Optical Engineering: many optical engineers do not publish.

Optical engineers have given me two main reasons for not publishing. I want to examine those:

Some optical engineers argue that the journals do not want their papers. Their papers contain few or no equations and no new science. These writers have picked the wrong journal. Optical Engineering, like all journals, wants good technical quality and originality. But originality and quality can characterize engineering as well as science. A technical paper is meant to share new insights and results. If your optical engineering work has taught you something, it may have something to teach your counterparts elsewhere. If so, you should consider publication.

Other optical engineers argue that publication is "giving away the family jewels." Notice that the first argument for not publishing was "my work is not good enough," while the second argument is "my work is too good." I have heard both arguments from the same person! There is a modicum of truth in the family jewels argument. You can say too much too soon. On the other hand, you can often describe the system components (where you did the innovative work) without spelling out the system function. At this point we reach a very delicate subject. A good technical paper can be good publicity for the company and its capability but it cannot be an advertisement (describing and claiming results without showing the means whereby they are achieved or the context of past work from which they arose). My point is simply this: publication can be premature or even illegal (classified) but it can also be good business. Each case needs to be examined.

There are other reasons the optical engineer should consider publishing:

- He gives something back to the knowledge pool from which he has borrowed freely.
- He helps advance his profession by helping others do their job better.
- He achieves public documentation of his most significant contributions.
- He subjects himself to discipline leading to better and more complete performance of the engineering task.
- He stimulates other optical engineers to publish and thereby help him.

I close my case for publication with three pledges:

- Optical Engineering welcomes real optical engineering papers.
- The criteria for acceptance are innovation and value to the readers, not mathematical erudition and new science.
- I will work with you to help get your manuscript into a form you will feel pride in.
The Business Side of Optics

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[This article is based on a paper given at the SPIE 22nd International Technical Symposium in San Diego, August 1978. It is written by Ernest A. Kuonen and Sawyer Thompson, Jr., who are involved in high technology optical program management at Pratt & Whitney Aircraft. The previous articles in this column have dealt with strategy for small business, new product decisions, optical fabrication, and patents. This paper gives a good methodology for planning and control of high technology programs. It is printed in its entirety in SPIE Proceedings Volume 151.]

Management Controls for High Technology Programs

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United Technologies Research Center

Sawyer Thompson, Jr.
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Abstract

In early 1975, Pratt & Whitney Aircraft Government Products Division (P&W) developed a management system that provided such improved management visibility, flexibility, and control that it was soon adapted to all major programs. An important element of the system is the establishment of management reserves in budget and schedule to offset the risks associated with development unknowns. Program tasks are defined and controlled through a Work Breakdown Structure (WBS). Functional budgets are established for time-phased tasks within each WBS element. Technical requirements are built into detailed milestones that are planned to meet contract and internal program schedules. These budgets and milestone schedules are firmly established as the performance measurement baseline. Simple and timely tracking techniques are utilized to monitor program progress. Daily meetings are held in an Action Center where all work elements, functional budgets, milestone lists, and critical items affecting technical performance, schedule, and cost are reviewed. Milestone status is updated daily and actual costs are posted weekly for monitoring cost trends and variances against budgets. Program performance is summarized monthly and reported in terms of a Performance Index (PI) defined as follows:

\[
PI = \frac{\text{completed milestones}}{\text{planned milestones}} \sqrt{\frac{\text{actual costs}}{\text{planned costs}}}
\]

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Introduction

Pratt & Whitney Aircraft, Government Products Division (P&W A) programs and business interests vary in both their size and the technologies employed. The division has multi-million dollar contracts that encompass research, development, production, and product support of major weapon systems, as well as programs that total only a few thousand dollars for a special study or research effort. The technologies range from jet engines to high-power lasers.

Our management must deal not only with state-of-the-art technical aspects of propulsion and power systems, but also with complex contracting and financial processes. In early 1975, P&W A developed and implemented an effective, advanced, and in many ways, simplified management system for use on the U.S. Air Force Airborne Laser Laboratory Fabrication program. This system provided management with such improved visibility, flexibility, and control that it was soon adopted to other major programs. It is currently being employed on our military, industrial gas turbine engine, laser, and company-funded programs.

General Matrix Organization

The management concept used for all major high technology programs is based on a program management-functional organization matrix structure. The key to the concept is the effective distribution of manpower resources and full accountability of functional organizations such as engineering, design manufacturing, test, and quality control. The productivity of the program is enhanced since manpower loading skills can be tailored to the time-phased needs of the program. Functional managers are responsible for performance of assigned tasks within budgets and schedules negotiated with program management.

The Program Manager

A Program Manager is carefully selected and assigned to each new program. For major programs there is a full-time Program Manager supported by a management team (organization) termed the Program Management Office (PMO). The PMO is comprised of the Program Manager, his support staff, a deputy program or engineering manager, and a group of task managers that is usually selected from the functional organizations. A typical PMO is illustrated in Figure 1. The Program Manager is dedicated to the program and he is given full authority and responsibility to conduct it. Because the Program Manager is accountable to top management for the overall effort, he issues all program directives, establishes budgets for the program work, authorizes functional organization efforts, assesses program performance, and reports program progress to his customer and top level management.

Program Planning

A key element of the program management system is the planning necessary to assure effective execution of the program's technical requirements on schedule and within a budget. The Program Manager is responsible for developing the planning and documenting it in a Program Operating Plan (POP) for management approval. This document is his assessment of the program requirements and how and with what resources he plans to meet them to the satisfaction of his customer and management. The Program Manager, in consultation with the business manager, establishes the control system he will use to provide visibility for overall performance measurement and early detection of problems. Com-
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**Work Breakdown Structure**

<table>
<thead>
<tr>
<th>WBS Level</th>
<th>Laser System</th>
<th>Resonator</th>
<th>CORNL</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Design</td>
<td></td>
<td>Fabrication</td>
</tr>
<tr>
<td>III</td>
<td>Final Design</td>
<td>Options</td>
<td>Aero Window</td>
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<tr>
<td>IV Preliminary Design</td>
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<td></td>
<td>Inst</td>
</tr>
</tbody>
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**Budget Planning**

The budget for the contract originates from the cost estimate generated for the proposal. The program budget baseline is then developed on the basis of the negotiated contract. Care is taken to ensure that budget and task time-phasing agrees with the program schedules and milestones.

The establishment of a management reserve is usually considered since almost every development program involves unknowns that cannot be resolved until the program is underway. Consequently, a Program Manager will often withhold and control a portion of the total budget from the functional departments to offset the potential cost fluctuations due to design changes, schedule slippage, or fabrication/test problems. The Program Manager establishes the management reserve (generally about 10%) based on the specific program's risks.

Functional task budgets are negotiated by the Program Manager in a participative management mode. The functional managers participate in the budgeting process by developing subtask or work package plans and budgets. Functional participation is optional for programs that are either small in scope, contain mostly level-of-effort tasks, or require only single functional department involvement.

Program baseline budgets are formally established and maintained in the Cost Performance System (CPS). This is a computerized data processing system established as a formal cost and schedule performance measurement tool. The CPS integrates the basic management subsystems for technical accomplishment relative to the baseline plan. Specific technical requirements are built into the description of each milestone and easily measurable criteria for completion are defined at the outset. These milestones must be compatible with other program schedules. Such milestone schedules form the program baseline that is used for performance measurement purposes such as the calculation of the Performance Index (PI). There are three levels of milestones. The top level are those milestones which are established with the customer to measure and report the overall program progress. A broader set of supporting milestones is generated by the Program Manager, his task managers, and the functional department managers to form the internal baseline for performance monitoring. These are reviewed daily or weekly as the program demands. Additional support milestones are generated within the functional organizations to assist them in managing their efforts at a more detailed level. Changes in contract schedules are negotiated with the customer and handled by formal contract changes. Internal baseline schedule changes which do not impact contract milestones must be negotiated with and approved by the Program Manager.

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**Development of Plans and Schedules**

Program Planning begins with the proposal, and, where we are the successful bidder, these plans are updated to reflect the negotiated contract and are converted into a management approved operating plan. The Program Manager establishes a cost margin or management reserve to offset the technical cost risks associated with development program unknowns. The key elements of the planning process as illustrated in Figure 2 are:

- Program Work Breakdown Structure
- Program Master Schedule
- Task Plans
- Task and Functional Budgeting
- Technical Performance Planning
- Program Operating Plan

**Program Work Breakdown**

Program task and technical plans are developed on the basis of WBS to provide appropriate cost, technical, and schedule baselines for performance measurement at selected levels of the functional organizations and the technical work units. Most government agencies require End Item work breakdown and planning. Consequently, the WBS is usually established during the negotiation phase of larger programs. Initial task plans for each WBS element are prepared by the Program Manager to describe work requirements and schedules, functional department responsibilities, and time-phased budgets. These task plans and budgets are then negotiated with the functional organization managers and finalizing with their commitments to performance. Program task plans are sufficiently detailed in the WBS to enable the functional organizations to understand their specific tasks and schedules. Detailed work package plans for each task are then prepared by the performing organization to the level required for effective program control. A sample WBS is shown in Figure 3.

**Schedule Planning**

Program scheduling starts with the sequencing of events required to produce the contracted end items. The scope and complexity of the program may demand several levels of schedules, i.e., the Program Master Schedule, end item schedules, and WBS task schedules. Earlier completion dates for major events are incorporated into the baseline schedules when there are potential schedule risks in meeting contract milestone dates. Detailed technical milestones are identified and scheduled for selected task and organization levels to provide program control through the measurement of technical accomplishment relative to the baseline plan. Specific technical requirements are built into the description of each milestone and easily measurable criteria for completion are defined at the outset. These milestones must be compatible with other program schedules. Such milestone schedules form the program baseline that is used for performance measurement purposes such as the calculation of the Performance Index (PI). There are three levels of milestones. The top level are those milestones which are established with the customer to measure and report the overall program progress. A broader set of supporting milestones is generated by the Program Manager, his task managers, and the functional department managers to form the internal baseline for performance monitoring. These are reviewed daily or weekly as the program demands. Additional support milestones are generated within the functional organizations to assist them in managing their efforts at a more detailed level. Changes in contract schedules are negotiated with the customer and handled by formal contract changes. Internal baseline schedule changes which do not impact contract milestones must be negotiated with and approved by the Program Manager.
used for task authorization, scheduling, budgeting, cost accumulation, and work measurement. The subsystems are all oriented to the WBS.

Technical Planning

Contracts usually will specify product performance goals and the Program Manager must plan the steps required to produce these results. More stringent product performance targets may be established as part of the internal operating plan to assure contract performance. For example, history supports the fact that system weight may increase during the development life of a product, and, where this is anticipated, a weight less than that specified by the contract is generally targeted. Other typical product performance parameters may be operational characteristics such as reliability, maintainability, and safety.

Many program plans contain technical performance supporting goals not specifically imposed by contract. These, of course, are established to be compatible with contracted cost and schedule, and do not provide a means of measuring technical progress toward a formal goal.

Program Operating Plan (POP)

During the initial program planning phase, the Program Manager prepares a formal POP. This is the master plan for managing the program and requires approval of the functional department managers and Division Management. The POP consists of the Program Manager’s brief description of the program and its purpose, its primary objectives and risks, resources required, management style, systems and techniques to be employed, program management operation, task and functional schedule, and budget information.

Program Control

The following brief description will serve to highlight the visibility which is available and the various program control techniques employed to measure program performance.

Work Authorization

Plans are implemented through a Work Package Authorization system. This system ensures that only the work specified in the contract is performed and that all cost, schedule, and technical limits which constitute the program performance baseline are clearly defined. The Program Manager and task managers initiate, control, and cancel their applicable work authorization forms in a timely manner to ensure efficient allocation of resources and to control costs for the program. These forms bear the cost control number to collect direct charges for specific departments and work packages. A sample of the Work Package Authorization is shown in Figure 4.

Cost Performance Data Accumulation and Reporting

Cost and schedule tracking is accomplished with the aid of a computerized Cost Performance System (CPS). The CPS retains the time-phased baseline budget that has been established at the selected WBS task/work package and organization levels. The reports include budgeted costs, actual costs, scheduled costs, value of work accomplished, and estimated cost at completion, with significant variances highlighted for examination.

In addition, daily and weekly “actual” cost

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data are produced routinely and are made available to the Program Manager and task managers. Weekly and monthly reports include all cost performance data from the lowest work package level, selected intermediate levels, and the total program level in terms of the elements of cost, including labor hours, labor dollars, and material dollars. These reports reflect current period (week or month) costs and cumulative program costs, and are summarized by the functional organization.

Milestone Tracking

The milestone tracking system is used by the PMO and task managers to identify potential problems early in the program and to develop recovery plans to avoid or reduce their potential impact on contract goals. Milestones are tracked daily by the responsible task managers and the PMO, and “fixes” for critical problems are presented to the Program Manager for approval. The preferred tracking technique is the daily posting of green (accomplished) and red (missed) balls on milestone plans located in a Program Action Center. Milestone completion status may be summarized weekly, or at least monthly, as determined by the type and size of the program and the visibility required by the Program Manager.

Technical Assessment

Technical performance is tracked against time-phased baseline plans in order to assure meeting contract and/or internal objectives. Assessment of technical progress is made through use of (1) milestones which define key functional events, and (2) tracking of component and end item performance parameters (analytical and/or test results, against planned performance goals).

Performance Measurement & Reporting

Effective performance measurement presumes a valid baseline and accurate timely tracking and reporting of accomplishments. These steps are probably the most critical in the program planning and control processes. Timely feedback and analysis, evaluation of progress and problems, and implementation of effective recovery plans are essential to achieving program success.

Performance Measurement

Program performance of the three elements (cost, schedule, and technical) may be measured by either separate or integrated techniques. They must be evaluated simultaneously to achieve the optimum balance and best potential for meeting program goals. Conducting tradeoff analyses to achieve this is an important function of the Program Manager and the PMO. The CPS is used to process baseline, actual, and projected cost and schedule information. It provides automatic comparisons of accomplishment to the baseline, calculates variances, and reports performance in terms of both the task structure (WBS) and organization structure. The CPS is a tool for large and small programs because of its structure and flexibility.

As mentioned earlier, the work package plans form the basis for establishing the baseline for performance measurement. On larger programs, milestone completion status is formally summarized weekly. This status compares actual completions to forecast completions of open milestones. The forecast completions form the basis for time-phased estimated cost-to-complete inputs into the CPS system. These data provide visibility into the projected financial health of the program.

Actual costs are obtained through a routine cost collection system and reported by the CPS. In addition to actual cost data, the CPS is the source of budgeted costs for work scheduled and budgeted costs for work performed for Cost/Schedule Control System performance measurement data.

Technical performance measurement is monitored using product control charts where actual or calculated accomplishment data are plotted.
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All of these tools provide early warning of impending problems. Significant deviations from plans are subject to extensive variance analysis and recovery planning.

**Performance Review**

Functional department performance is continually monitored by Program Management at organization and end item WBS levels. Functional managers ensure that internal management control systems provide for performance review at all levels of management.

An integral activity of the performance review cycle is the variance analysis needed to identify cause and impact of significant deviations from plans. The Program Manager establishes the program variance thresholds for cost/schedule data that require formal variance analysis.

Milestone status is evaluated by the PMO to determine real and potential schedule slips. Functional organization data are used to provide insight into identified problem areas. The PMO issues directives to affected functional departments to develop coordinated schedule variance analysis and associated corrective action planning.

The PMO, assisted by the functional organizations, also evaluates progress against technical performance requirements. Actual status data are analyzed to determine if satisfactory progress against plans is being maintained.

**Performance Indexes**

Program status and progress are measured and reported by both a PI and an index trend. The PI relating cost status to schedule status is the technique used at J&WA for reporting the performance on all current programs to program management, division general management, and customers. Where warranted, it may be used for reporting performance against both the higher level WBS task and these more detailed functional organization baselines. The performance index calculation employs the following procedures:

- Summarizing the program events and milestones into a planned accomplishment curve.
- Summarizing the budgeted cost for these planned activities into a planned cost curve.
- Comparing units of work completed against the plan.
- Comparing actual costs against budgeted cost.
- Measuring the program status by combining cost and schedule.

\[
\text{Schedule Ratio} = \frac{\text{Milestone Completed}}{\text{Planned Milestones}}
\]

\[
\text{Cost Ratio} = \frac{\text{Actual Costs}}{\text{Planned Costs}}
\]

\[
\text{Performance Index} = \frac{\text{Schedule Ratio}}{\text{Cost Ratio}}
\]

A PI = 1 indicates full value received for dollars spent. Total program PIs are reported to

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**Figures 5 and 6**

against the planned performance. Typical financial and milestone status charts are shown in Figures 5 and 6.

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senior management in monthly reviews and are generally reviewed on a weekly basis by the Program Manager to assess either the overall performance of his program or the performance of a specific WBS task or functional organization.

**Action Center**

The PMO maintains a Program Action Center as an integral part of the Program Management System. The Action Center concept is a forward-looking style of program management which has proven effective on large programs or groups of small programs. The Action Center serves as a program focal point by displaying charts of the technical, cost, and schedule plans, especially milestone charts, current program status, and critical problem recovery plans. It is accessible to all Division personnel and customer representatives. The center, and data contained therein, is used to direct the program, conduct management briefings, assess program performance, coordinate corrective action, and provide a single location for program information.

On a daily basis, missed milestones are posted in the Action Center with a red ball and completed milestones with a green ball. Actual costs are posted weekly for monitoring cost trends and variations against budgets. Program performance is summarized monthly and reported in terms of the PI. These PI levels are denoted in the Action Center by color indicators posted on the WBS charts. In addition, PI trends are posted to indicate an improving or worsening condition.

Corrective action plans approved by the PMO are also displayed in the Action Center. Progress against these plans is reviewed at the daily meetings by the PMO and functional managers to ensure their satisfactory execution. The Action Center philosophy is one of the key elements of the management system and is extremely effective once a cooperative attitude and a willingness to share problems and concerns has been established between the program team members. Its key impacts on the conduct of a successful program are it's ability to provide a constant, up-to-date, quick look at performance states and trends and its dissolution of problem areas. In addition to the daily review of Action Center data, formal program reviews are conducted for the customers and the company.

Monthly division or quarterly corporate program reviews are presented by the product vice presidents and are the primary means by which senior management assesses the effectiveness of program and functional management in meeting specific program and product area objectives. Program problems and plans requiring top management guidance and/or decisions are highlighted during these reviews.

**Redirection**

A great deal of flexibility has been incorporated into this management system by minimizing the formal procedures necessary to permit incorporation of internally directed corrective action with minimum response time. However, certain disciplined controls are imposed to ensure maintenance of the integrity of technical and program direction.

Planning changes may be made at any level of task definition. At the internal functional department work package level, no system requirements are imposed if the resulting direction does not require a change in the work package planning data.

Changes to the higher level work package plans are directed by the PMO through issuance of a Program Management Instruction. Associated budget revision data is then input to the CPS System.

As long as work package plan direction does not affect the associated overall Program Task Plans no further controls are required.

**Summary**

This management system provides full visibility of program plans and progress at all WBS levels and all functional department levels. Indications of program problems usually surface in the early stages, thus making recovery possible. Missed milestones and cost problems are positively identified in the Action Center, where problem analysis and recovery planning is performed on a continuous basis. All information is readily available for customer review and is used as the basis for informal and formal program reporting.

People manage; good systems help them manage better. At P&WA we have established a management system based on the concepts of participative management, which has motivated our people to effectively achieve program objectives to the benefits of both our customers and our company.

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T. Kallard. Foreword by Rosemary H. Jackson,
Director, Museum of Holography, New York.
This is an unusual but interesting volume that contains a large number (242) of relatively attractive photographs. It is not a technical book for the scientist or engineer; it is a book concerned largely with the artistic creations that can be achieved by laser scanning and diffraction, laser light scattering, optical diffraction and holography.

The volume has a foreword by Rosemary H. Jackson, who is Director of the Museum of Holography. The foreword is aptly entitled “A little light writing.” The idea that the laser as a light source is “simply another tool for the art process” is really the main message of the book, and the many photographs are given to support this contention. Specifically, Rosemary Jackson claims that laser light falls into the same category, as far as art is concerned, as “egg tempera, stained glass and charred sticks.” She also states that “it is no more unusual for the modern artist to be working with a laser than it was for Albrecht Durer to use the printing press.”

Certainly I find no objection at all to the use of any medium or technology to express the artist’s ideas. On the other hand, we must remember that art is as good as the artist; and in that sense, the medium is not of prime importance.

Thomas Kallard, who created the volume, has one foot firmly planted in the technology associated with laser art. He starts off with a rather interesting historical perspective which traces the use of light as an artistic medium from the work Laszlo Moholy-Nagy to “Op-Art” to holography to light shows. I was surprised to read that “Dennis Gabor developed the theory of holography while he worked at the Rugby Electrical Company in Scotland”! To my knowledge, the work was carried out and published from the Research Laboratories, British Thomson-Houston Company, Ltd., Rugby, England. I hope the remaining facts in this historical perspective are correct.

After a short section on the laser, laser light and safety, a more detailed chapter gives some excellent “how to do it” discussions and diagrams. The simplest technique is to merely create your own image by writing with the laser beam in a dark room onto a photographic material. A generalization of optically produced Lissajous figures to produce repeatable patterns are termed spirograms. Considerable attention is given to “light caustics,” a term used to describe the spatial and temporal modulation of a beam by combination of reflection, refraction, interference, dispersion, and diffraction. Kallard has produced some very attractive “lacy” patterns with the technique.

Laser theatre is discussed in a separate chapter. Again there is a mixture of technical information, including simplified block diagrams of the automated projection system designed by Brian O’Brien, Jr. for “Lovelights,” and still photographs of images from Laserium and Laserrock and Soleil.

It is well known that I have a predilection for optical transforms; thus I did enjoy and appreciate the many unusual optical transforms displayed on some 59 pages. Most of them were created for their symmetry and pattern formation and not because they have any particular scientific purpose.

Finally, there is, of course, a chapter on holography that discusses various methods of producing holograms. Some of the results shown are merely of historical interest or illustrate a
particular method. Others have unintended (?) artistic merit; I was particularly attracted to the photograph of the reconstruction of Donatello's John the Baptist by R. F. Wuerker; of course, the subject matter helps here!

I enjoyed the book and found much in it that fascinated me.


Reviewed by Brian J. Thompson, Dean, College of Engineering & Applied Science, University of Rochester.

The International Commission for Optics holds conferences every three years and provides an opportunity for workers in the field of optics from around the world to get together and renew acquaintances and friendships. Often the technical program is secondary to the informal discussions that take place in the halls. This reviewer was not able to attend the eleventh congress and I know that I missed the stimulating conversations and discussions of things optical with my international colleagues. After reading the proceedings, I find that I also missed an excellent technical program.

This volume contains 190 papers, 11 of which were invited, that were listened to by 319 participants from 30 countries. Thus it certainly lived up to its reputation as a truly international conference.

The editors are to be congratulated on putting the papers in an organized form by using subject headings. The first group of papers is on vision. This section starts off with four invited papers, followed by six papers on “Eye Optical System.” The remaining sections are Receptors (6 papers), Colour Vision (4 papers), and Psychophysics (7 papers).

The second major section deals with Image Formation and Processing and again starts with a series of invited papers, followed by topical groupings on Optical Design (8 papers), Image Formation (12 papers), Optical Image Processing (18 papers), Optical Information Processing (12 papers), Digital Image Processing (9 papers), and Holography I (8 papers). I personally found a number of papers in this section of particular interest and the overall quality is high. C. S. I has a short paper reminding us of his extensive work on Fourier Color Holograms and Color Image Preservation. Since there are no color plates in this book, it is unfortunate that a black-and-white photograph in this paper has a caption “3-Color Image Reconstructed from FCH.” From a teaching point of view, the paper by Y. Ishii and K. Murata is valuable since it discusses how to display aberrated diffraction patterns (impulse response or point spread function) using computer-generated holograms. By this method, the effect of individual aberrations on the point spread function can be readily demonstrated for classroom use.

The third and final section is on Optical Physics with four invited papers. The subsections are Lasers and Spectroscopy (6 papers), Optical Fibers and Integrated Optics (7 papers), Coherence and Statistical Optics (6 papers), Speckle (16 papers), Holography II (10 papers), Inter-

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BOOK REVIEW


Reviewed by James C. Wyant, Optical Sciences Center, The University of Arizona, Tucson.

This book is actually the first issue of a new journal which is intended to be published four times per year. The editor’s preface states that “The intent of this new international journal is to furnish scientists, engineers, and researchers with a forum for findings, heretofore scattered throughout the literature, in the field of acoustical imaging and holography.”

The first article by Byron Brenden and Gerald Fitzpatrick is an excellent review article. They start with a review of holography and then discuss holography and acoustics. Scanned receiver, scanned source, and simultaneous source-receiver scan systems are discussed, as well as different recording techniques. Industrial and medical applications of acoustical-holography systems are discussed and results are shown. This is the perfect article for someone who wants to become familiar with acoustical holography.

The second article by R. L. Cohen and M. S. Lang gives a comparison of digital versus optical reconstructions from an acoustical hologram. The article also starts with a brief discussion of holography and then compares the results of optical and digital images from the same hologram generated from a circular plate acoustically irradiated. The paper concludes that digital reconstructions have several advantages over optical images. The digital image can be represented in three dimensions, whereas the optical display represents only two, relative intensities of radiators can be viewed easily, and intensities can be cleanly removed leaving only the most prominent sources.

The third article by Yoshinao Aoki and Noriaki Itoh describes an ultrasonic-field display device constructed using transducer and light-emitting-diode linear arrays of 128 elements. The construction is briefly described and results are shown. While the use of a linear array greatly reduces the scan time, uniformity of the distinct channels is required. Since uniformity of the channels for the device described in this paper was not achieved, the quality of the obtained image was poor.

The last paper by G. L. Fitzpatrick and L.P. Yoder discusses the use of phase shifting the reference beam between exposures in double or triple exposure holographic interferometry to increase the sensitivity to small phase changes. In particular, the use of a 90-degree phase shift between the first and second exposure and another 90-degree change between the second and third exposure, where the phase of the object changed between the first and second exposure, is shown to be useful in delineating objects of geophysical interest. If it is possible to introduce phase shifts other than 90 degrees, only two exposures need be made to obtain similar results. The techniques are similar to those often used in visible holographic nondestructive testing.

While this reviewer found Vol. 1, No. 1, of ACOUSTICAL IMAGING AND HOLOGRAPHY interesting and useful, the editor now has the problem of keeping the remaining issues of the same caliber. I, for one, am not convinced that there is the need for a new specialized journal in acoustical imaging and holography. I think the editor has a very difficult task in store for himself.

SHORT COURSES

University of Wisconsin Short Course on DE- SPACEMENTS IN OPTICAL SYSTEMS, Sep. 17-21, 1979. Aim of course is to give the engineer involved in optics a useful degree of familiarity with the optical elements so that he may lay out a system to perform a given task. Discussion of aberrations, practical limitations, and tolerances is included. Fee $450. For program information, contact Dept. of Wisconsin—Extension, 432 N. Lake Street, Madison, Wisconsin 53706; phone 608/262-2061.

University of Wisconsin Short Course on PREVENTING VIBRATION FAILURE IN ELECTRONIC EQUIPMENT, Sep. 24-28, 1979. Intended for designers, engineers, others working in the mechanical packaging, mechanical design or testing of electronic equipment that must operate in any sort of vibration environment. Course deals with the real electronic hardware being used by the industry today and with problems that may develop during exposure to different vibration environments. Many cost effective solutions will be presented which are easy to apply and which can dramatically increase the fatigue life of almost any electronic system. Fee $425. Contact program director, John T. Snedeker, 414/224-4193.

UCLA Short Course on GEOMETRIC OPTICS 12 meetings starting Sep. 18, 1979. Design of optical systems, emphasizing geometric design aspects. First order or Gaussian optics, image formation, third order aberrations, prism, and mirrors, spherical and aspheric surfaces, pupils, and optical materials, Application to telescopes, microscopes, photographic lenses, projectors, and other devices. Prerequisite: BS in engineering or science or consent of instructor. Tuition $135. For additional information, call the instructor, Milton Larkin, at 213/640-0470.

Society for Applied Spectroscopy Two-Day Short Courses, Philadelphia, Sep. 15-16, 1979. ATOMIC ABSORPTION SPECTROSCOPY: Theory of absorption spectrometry, basic instrumentation, sample preparation, interferences and methods of elimination, analytical instrumentation, special analytical techniques. ATOMIC EMISSION SPECTROSCOPY: Introduction to emission spectroscopy, measurement of spectrochemical information (videotape), selection of multielement techniques (videotape), sample preparation for multielement analysis, DC plasma discharges, microwave plasma discharges, introduction to ICP discharges, ICP applications to inorganic materials, ICP applications to organic materials. FOURIER TRANSFORM SPECTROSCOPY: Introduction to multiplex methods, fast Fourier transform algorithm, introduction to FT-IR, introduction to FT-NMR, applications of FT-IR, advanced FT-NMR, chromatography and FT-IR, minicomputer in FT spectroscopy. SURFACE ANALYSIS: Overview of surface analysis, x-ray photoelectron spectroscopy or ESCA, Auger-electron spectroscopy, secondary-ion mass spectroscopy, ion-scattering spectroscopy, summary and contrast of techniques. For information: Dr. R. Barnes, 413/545-2294.