COVER STORY

Optics in Finland

By Ari T. Friberg

Finland, site of the Image Science '85 conference to be held in June, is a highly developed industrial nation in the manner of other Scandinavian countries. And Finnish universities and companies are actively engaged in research and development in optics; lasers, and imaging.

The following article highlights some key optical research projects and applications that are being pursued in Finland, first in the universities and then in industry.

University research

An active laser technology and applications group in the Department of Technical Physics at the Helsinki University of Technology is headed by E. Byckling (an ICO vice president). An accurate and fast laser recorder, utilizing an argon-ion laser and novel beam deflection and control techniques, has been constructed for the needs of the graphics industry.

Combined with a diode matrix camera and microcomputer workstations, the laser recorder system has grown into an automatic digital system for producing complete pages, including text, line art and halftones. A commercial version of the system has been sold to the printing industry, and systems of this type will also find applications in automation of document production.

A pulsed laser system, consisting of an excimer pump laser and two independently tunable dye lasers, was recently installed. It is used mainly for ultratrace elemental and isotopic analysis by multistep resonance ionization spectroscopy and for combustion diagnostics by CARS. This is a joint project with The Technical Research Centre of Finland.

Theoretical studies on multimode operation of optically pumped lasers, second-harmonic generation in centrosymmetric systems, and on laser-plasma interactions have been carried out by R. Salomaa.

On the experimental side, semiconductor lasers in the 1.3 μm region are grown by liquid phase epitaxy from InGaAsP and InP melts on an InP substrate (T. Tuomi). The multilayer heterostructures are studied using x-ray topography, optical modulation spectroscopy, and other methods. Electroluminescent thin film and display devices made by atomic layer epitaxy are also investigated.

Integrated optics and optical fibers are extensively studied at the Electrical Engineering Department of HUT in collaboration with the Technical Research Centre of Finland (S. Halme, J. Sinkkonen, M. Leppihalme, and others).

The main topics of research include manufacture, analysis and characterization of waveguides; branching and coupling elements; monomode and multimode optical fibers; fiber optic sensors; solar cells; and semiconductor optocomponents. Applications deal with coherent optical systems, fiber optic networks, and experiments on computer communication using fiber optic data lines (K. Rahko).

Ari T. Friberg is a member of the Department of Technical Physics at Helsinki University of Technology and also belongs to the local organizing committee for Image Science '85.

Finland To Host Image Science '85

Image Science '85, the first international conference devoted to an in-depth coverage of the progress in image science and technology, will be held in Helsinki, Finland, June 11-14. It is jointly organized by the Helsinki University of Technology and the Technical Research Centre of Finland.

Sponsored by the International Commission for Optics, it will be the first in ICO's new series of topical meetings. The conference will address the fundamentals of:

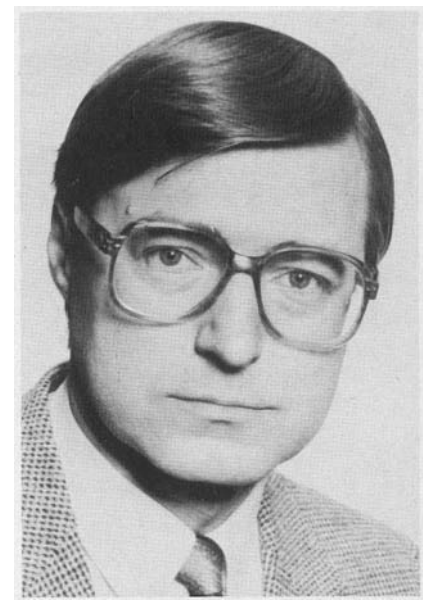
—Image formation: optics and optical components, imaging methods, and holography;

—Image processing: optical, digital, and video; and spatial light modulators; and

—Image quality: objective measurement and subjective evaluation.

Invited papers deal with the most recent advances and applications in image technology, such as high-density optical information storage and all-electronic camera and phase conjugate optics. Internationally recognized scientists from the U.S., Europe, U.S.S.R., Japan, Australia, and New Zealand.

More information on Image Science '85 is available from the conference secretary. Contact: P. Oittinen, Helsinki University of Technology, Laboratory of Graphic Arts Technology, Tekniikantie 3, SF-02150, Espoo 15, Finland.



E. Byckling, an ICO vice president and chairman of the local organizing committee for Image Science '85.

Image processing

In connection with the Image Science meeting, it is important to note the extensive research on image processing carried out at the Graphic Arts Laboratories of HUT and TRCF. Together these laboratories form the largest university research facility for the printing industry in Europe.

Work is carried out on digital picture processing, imaging and printing materials, and the quality of printed images (H. Saarelma, P. Oittinen, S. Karttunen). It should also be mentioned that automatic pattern recognition is one of the main research topics at the Laboratory of Computer and Information Science at HUT (T. Kohonen).

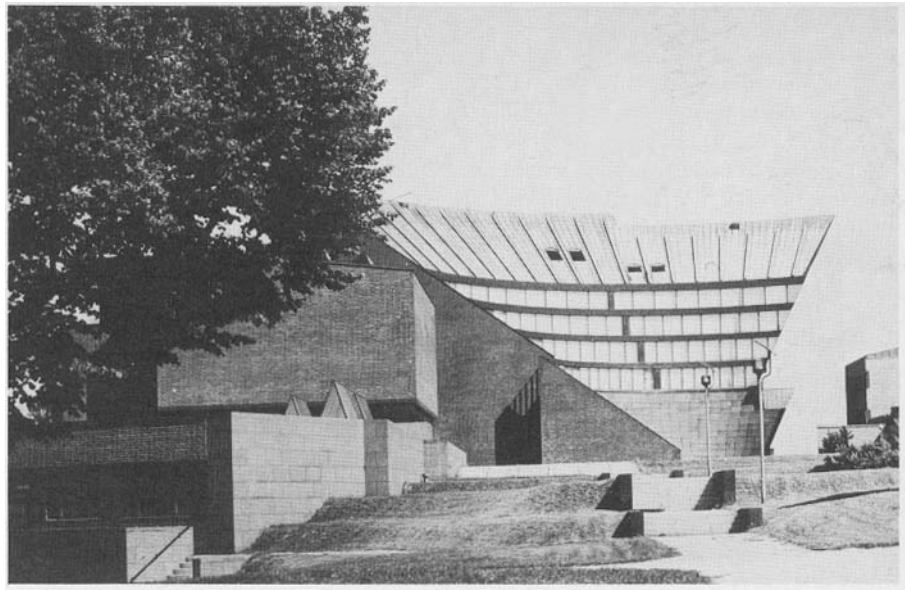
A strong theoretical research group on optical physics is directed by Professor S. Stenholm at the Research Institute for Theoretical Physics at the University of Helsinki. This group is concerned with the properties of high intensity radiation interacting with matter. Its manifestations are in nonlinear laser spectroscopy, laser theory and optical transients.

Work has included field fluctuation effects, free electron laser processes, and multiphoton ionization. One area of primary interest has been the mechanical effects of laser photons, with applications to laser cooling of free and trapped particles.

Other activities at UH are focused on high resolution Raman spectroscopy of solids, such as aromatic crystals and amino acids, calculation of vibrational frequencies of molecular crystals and isolated molecules, and creation of computer codes for spectral analysis. Commercial products, including a high-resolution Raman spectrometer and instrumental optics, have been developed with local industry.

In another research effort at UH, led by M. Luukkala, the photoacoustic effect is used to create audio frequency thermal waves to perform thermal wave imaging and non-destructive testing. Photoacoustics is also employed to study liquids, such as human whole blood, and the thermal properties of materials, such as paper.

At TRCF, optical research is conducted in several different laboratories, and therefore it covers various fields of optics and laser-related applications. Optical technologies, such as fiber, laser, silicon, imaging, and measurement and instrumentation techniques, are developed in seven laboratories. In addition, measurement techniques utilizing optics have been applied, for example, to mechanical and road technology, automation, metal, wood, and baking processes, and hospital technology.



The site of Image Science '85 is the campus of the Helsinki University of Technology. Pictured is the auditorium of the main building, designed by Elissa and Alvar Aalto and constructed in 1964.

Besides the normal activities at TRCF, optical measurement techniques and sensor technology will be studied under the supervision of V. Kelhä in a research program for measurement techniques, established for the years 1984-87.

Several laboratories at TRCF are also working on image processing techniques. These endeavors include aerial photography and satellite image processing, development of computer systems for TV image processing, and image compression for video conference systems.

Outside Helsinki

Outside the Helsinki area, one of the main centers of optical research activity is the University of Joensuu. Directed by R. Hämäläinen, the efforts of the research staff at this university are concentrated on the methods and storage materials of holography, holographic optical elements and on holographic methods in integrated optics. Also being investigated are optical spectroscopy of alkali halide crystals with color centers and the electromagnetic theory of the interaction between light and dielectric materials (P. Ketolainen).

Optics at the Department of Physics of the University of Oulu is concerned mainly with the development of spectroscopic instruments (R. Anttila and J. Kauppinen). A Fourier transform spectrometer based on a Michelson interferometer with corner cube mirrors and 8-m maximum optical path difference has been constructed. The spectrometer is used to record accurately and with high resolution absorption spectra of molecules in the wavenumber region below 1200 cm^{-1}.

Other objects of research interest include grating and diode laser spectrometers for molecular spectroscopy, and interferometric devices applied, for example, to fast film thickness measurements.

In the Department of Electrical Engineering of UO, optoelectronics and its applications form one of the main research fields (R. Myllylä). Endeavors presently concentrate on laser range finders based on time-of-flight method, such as sensors for industry and 3-D robot vision, appearance measurements using semiconductor emitters, and on applications of position sensitive detectors.

In Turku, two universities are engaged in the study of optics and laser physics. At the University of Turku (R. Laiho), a sealed-off N_2 laser has been developed for various laboratory applications. Currently a series of medium power CO_2 lasers for industrial and clinical purposes are also under construction.

In solid state physics, lasers are employed in Brillouin spectroscopy of phonons and magnons. The research conducted at the Swedish-language Åbo Akademi has contributed, in collaboration with HU and industry, to the development of a high resolution Raman spectrometer (P. Lindblom).

The Computer Systems Laboratory of the Tampere University of Technology is actively doing research in image pro-

cessing algorithms and processors (Y. Neuvo). With local industry, the laboratory has developed some imaging systems that are presently in industrial use in several countries.

The interests of the Fiberoptics Laboratory of TUT are primarily directed toward optical communication (A. B. Sharma). Current research is related to the characterization of single-mode fibers with a view towards the eventual formulation of generalized models for systems designers. Instruction at TUT is also given in interactive computer graphics (L. Sintonen).

Research efforts in the laser spectroscopy group at the University of Jyväskylä (J. Korppi-Tommola) deal with ultrafast (picosecond) processes in solutions, solvent-solute interactions, dimers, and relaxation of protein molecules. Absorption recovery and single-photon counting fluorescence techniques are used. Other scientific interests concern laser-induced fluorescence of surfaces and small molecules in the gaseous state. A study of fluorescence of supersonic jets will also be started in the near future.

At the Lappeenranta University of Technology, technical and medical applications of optics and charge-coupled device cameras are investigated (M. Järvinen and S. Penttinen).

Industrial optics

Traditionally the Finnish industries have been conservative, so-called smokestack industries. Wood products, paper and pulp products, metal products, and ships such as icebreakers still make up about three quarters of the exported goods. Optical techniques in the analysis and process control are now starting to penetrate into these industries.

Even more promising is the fact that numerous smaller companies specializing in research and development of high-tech optics and laser applications have recently been formed. Their main markets are in the fields of medical optics, display technology, spectroscopy, and laser printing.

Examples of specialized industrial optics applications in Finland are provided by the measurement and automation problems in the pulp and paper industry and in the mechanical forest industry, particularly in sawmill technology. Desired information about the processes are quantities characterizing properties such as pulp brightness, pulp consistency, and fiber lengths.

The optical components developed for these purposes make use of light polarization, absorption, reflection, and scattering, and operate in wavelengths ranging from UV to near IR (Kanjaani Electronics). Optical measuring devices and computerized optimization systems for surface defect detection and different sawing processes have been developed by Altim Control and by the Sawmill Machinery Group of A. Ahlström, Ltd.

The size, shape and quality of the lumber of block will be measured using white, IR, or microwave radiation and matrix or video cameras. A computer then evaluates the optimal result in price and sets the saw blades accordingly.

In the Helsinki area several companies are engaged in R&D in medical technology. Lasertek produces laser equipment for medical use, especially for opthalmology. Its commercially available products presently include an argon-krypton photocoagulator, and an opthalmic pulsed Nd:YAG laser is being developed. EFLAB manufactures photometers and fluorometers used in healthcare laboratories. In medical appliances, Datex makes use of optical sensors that rely on IR absorption.

Other commercial areas of active research and development in Helsinki are thin-film electroluminescent display devices (Lohja Corporation) and optical fiber transmission systems (Nokia Ltd).

An atomic layer epitaxy process developed by Lohja for growing thin films is used to achieve extreme chemical stability and well controlled electrical properties. The resulting light emitting display components have high performance electro-optical characteristics and are intended for state-of-the-art electronic systems in portable computers and quality instruments.

Nokia uses modified chemical-vapor deposition preform manufacturing and fiber drawing to produce optical cables, optical fibers, and digital line equipment.

Printing systems

Newer applications of optics and laser technology are represented by the page production systems developed by Typlan and Opme. The Typlan system is intended for newspapers and uses highly efficient image processors for fast production of pages containing complex text and pictorial elements. The system represents the highest performance in image throughput presently available for the printing industry.

Page composition systems developed by Opme use professional microcomputer workstations equipped with high-resolution displays. Continuous tone and line art images are input to the system with a diode array camera, and pages are produced by high-resolution laser recorders.

Scanoptics in Espoo produces optoelectronic imaging systems and laser-based pointing and tracking devices. In addition, it is engaged in the development of a supermillion resolution optical spectrometer jointly with Åbo Akademi and a high resolution Fourier transform infrared spectrometer with the University of Oulu.

Several optics and laser technology firms are located outside the greater Helsinki area, where one also finds the heavy industries. Wallac, in Turku, is focusing on medical analysis equipment and instrument development for industrial production. The research carried out there includes applications of metal optics, lens design, interference filters, photodiodes, and photon sources based on radioisotopic excitation. Noptel in Oulu is working in the field of optoelectronics.