Kodakery

FEBRUARY 3, 1982

disc

New Line of Cameras, Film Built Around Unique Disc

Amateur picture-taking takes a substantial leap forward in automation and improved results with Kodak's worldwide announcement today of a new line of compact cameras built around a unique rotating disc of film.

Kodak Chairman Walter Fallon said the new cameras and film combine to produce a new system for decision-free photography. "They will enable users to take good pictures virtually anywhere," he said.

At the touch of a button the new Kodak disc cameras, by means of two integrated electronic circuits, will analyze the scene, set the proper exposure, activate the built-in flash if necessary, take the picture, advance the film to the next frame and recharge the flash, all in a split second's time.

Fallon said, "the yield of good to excellent pictures routinely produced by consumers is expected to increase by 25 percent" when disc cameras and film are used.

The three new Kodak disc cameras are powered by new lithium cells that contain more energy than most users will need for years of camera use. Combined with an electronic brain, the Ultralife energy source provides 1⅓-second electronic flash recycling, automatic film advance and automatic exposure control.

"This means," Fallon said, "that users can take pictures practically as fast as they can press the shutter release . . . indoors or out. And they'll find themselves getting more good pictures in previously marginal or difficult picture-taking situations."

NEW PRODUCTS–Kodak's new disc cameras and film.

A key to the new system is the development of Kodacolor HR disc film for use in the extremely small (approximately 8 x 10 mm) format the system requires to provide maximum user benefits. To permit the smaller size, the 200 ISO-speed film has lower granularity and more sharpness than current 100-speed Kodacolor II film.

With the small format came the design of a short focal-length lens that combines a fast speed (f/2.8) and the depth of field needed for most picture-taking situations with fixed-focus cameras. The lens, which is near the theoretical limits of perfection, contains four glass elements. The format also permitted the design of cameras that fit easily into a shirt pocket.

The company also announced an extensive line of photofinishing equipment to handle the new disc film. The line ranges from fully automated high-output equipment for high-volume labs to smaller, manually operated equipment to meet the needs of the smallest lab.

Electronically Sophisticated

Fallon said the new cameras, available in the U.S. this May, are the most electronically sophisticated in the company's history. Combined with the new film, they can produce a higher percentage of good to excellent pictures over a dramatically wider range of picture-taking conditions.

"Kodak disc cameras and Kodacolor HR disc film should reduce the chance of underexposure by half, reduce camera shake that results in blurry pictures to less than two percent, and cut the number of blank frames and flash failures to less than a fraction of one percent."

Fallon described the new cameras as "pocket-size, precision instruments" that are truly decision-free and always ready to take a picture.

He said the new system is the biggest innovation in amateur photography since easy-load Kodak Instamatic cameras were introduced 19 years ago and a substantial leap forward in giving the user consistently better pictures under conditions where in the past picture-taking disappointments have been liable to occur.

The new Ultralite energy source, he said, will power camera and electronic flash for more than 2,000 exposures with normal usage. The flash automatically turns on and off, as needed.

Basic Features

The three cameras all have the same basic features: a six-volt lithium power source; four-element, 12.5 mm, f/2.8 glass lens; an automatic built-in electronic flash with a flash range from 4 to 18 feet (1.2 to 5.5 m); automatic film advance; 1⅓-second flash recycling time, and auto exposure control which selects the correct shutter speed and aperture. The fixed-focus lens provides sharp pictures from 4 feet (1.2 m) to infinity.

The Kodak disc 4000 camera outfit, which lists for $67.95, features a slide which covers the lens and viewfinder.

The Kodak disc 6000 camera outfit, with a list price of $89.95, offers a capability for pictures at subject distances as close as 18 inches (0.5 m). It also has a cover/handle which protects the lens and viewfinder when the camera is not in use and serves as a handle for picture-taking.

The Kodak disc 8000 camera outfit, listing for $142.95, includes all the features of the 6000 camera plus a self-timer, a rapid-sequence film advance, a digital alarm clock, and a gold-anodized appearance.

A disc of film, containing 15 exposures, will list for $3.19.

Nearly Perfect Lens

"Our selection of the disc format followed the development of a unique and nearly perfect lens," Fallon said. "The lens and an advanced Kodacolor emulsion of very high resolution led us to develop ways of maintaining sharpness throughout the system–from camera to photofinishing to the final customer print."

When Kodak disc cameras–measuring little more than ¾-inch (20 mm) in thickness–are loaded with Kodacolor HR disc film, all the user has to do is aim and press the button. There are no decisions to make, no settings, switching or waiting.

Kodacolor HR disc film is packaged in a light-tight disc. Each 15-picture disc is slim and flat for ease of carrying. The Kodak disc drops in the camera and only fits one way.

Film frame numbers are visible through the camera back, as is the film type. An individual film identification number makes it extremely convenient for customers to order extra prints and enlargements. It also helps photofinishers match prints with processed disc negatives.

Kodak and other photofinishers can provide a combination of information, including frame number and date, on the back of each print. In addition to receiving the same 3R-size prints customers now get from 110-size negatives, enlargements measuring 5 x 7 or 8 x 10-inches will be possible.

All three cameras and the Ultralife energy source carry five-year warranties from Kodak. The new cameras will first be available in the U.S., Canada, Puerto Rico, Japan and Panama. Worldwide availability is expected before the end of the year.

Commenting on prices, Fallon said that while the company suggests list prices for its merchandise, the dealer determines the actual selling price.

Fallon said the disc photography system from Kodak will make millions of people better photographers than they could have been before. "It's truly a technology for the '80s. That these cameras combine extremely advanced features and capability at an affordable price is a tribute to Kodak's constant efforts to increase productivity, simplify manufacturing, and still advance the state of the art."

Thousands of Kodakers Bring Idea to Reality

"I did not know then–in fact, I do not know now after years of experiments–just how simple photography can be made."
George Eastman, 1920

Kodak founder George Eastman built his company around the idea that photography should be easy for everyone and, over the years, that philosophy has remained as a driving force for researchers, scientists and engineers who have designed and developed new cameras and film. This idea, coupled with the desire to increase the capabilities and performance of the photographic components, has been a century-long challenge for Kodak men and women the world over.

And now, simplicity and versatility have been brought together as never before in the new Kodak disc camera system that is being announced today. With the introduction of these products, Kodak crosses the threshold into a new era in photography.

At no time in the company's history have the talents, skills and resources of so many Kodak people been brought to bear on a single project. Thousands of Kodak men and women have played a part in turning this idea–this dream–into reality.

***DELICATE WORK**–George D'Ambrosia, KAD Electrical Engineering, uses a special computer design system to design an integrated circuit for use in the new products.*

A Concept Evolves

The new disc photography program started in the early 1970s with work that was being done in camera design by Don Harvey and Dana Wolcott, Advanced Development, KAD.

"The 110-size cameras had been introduced at that time but indications were that there was still room for improvement in camera pocketability and other features," Don said.

"We started with the idea that a person would like a camera that is no bigger than a man's wallet."

As the program grew, responsibility shifted to a development group headed by Dave Monks, now KAD Consumer Products. Working with him was Tom Rice, a systems analyst in Advanced Development.

Dave's group took the film and camera concept and began working on ways to use the small-format size to the best advantage. One of their goals was to make picture-taking simple, while reducing the opportunity for customers to make mistakes and get bad pictures.

"We had a lot of human factors information and knew that customers get bad pictures because of user error and because scene conditions don't meet the capabilities of the camera," Tom said. "I sat down and started looking at the parts of the system that we have control over–the camera and film–to see how we could balance those parameters."

With that in mind, Tom began mathematically manipulating two standard photographic equations. One deals with the interaction of scene illumination, film speed and lens aperture, and the other deals with depth of field determination.

"In the past, these equations had been dealt with separately," Tom explained. "What I did was take the two and combine them. When this is done, you can see in a quantitative sense what changing the different parameters will do."

From Tom's work it became clear that a short focal length was the key to making this new system work. A short-focal-length lens allows camera designers to increase depth of field or to increase light-gathering capability, thereby increasing the number of situations in which photographers can get good pictures.

"As the program began taking shape, management and coordination became a key concern," said Jim Dierks, KP Photographic Technology, the corporate project coordinator. Jim headed up a multi-disciplinary team that had been formed a couple of years earlier to study the feasibility of the new format. Once Tom's work established the feasibility, the team's activities shifted to development and implementation.

"We started with a project management matrix," he said. "In essence, we pretended this system was the sole product of a new independent organization. Then we tried to strip away our preconceptions and ask what talent and what resources were needed to design and manufacture our product."

The first step, Jim said, was to break the product into key tasks: camera, film, disc, photofinishing equipment and the system itself. Leaders were appointed for each task.

The result was a Product Implementation Team which included task leaders, marketing

Sharpness Will Be Feature Of Disc Pix, Via Lens Design

All models of the new Kodak disc camera feature a four-element, glass f/2.8 lens which has been designed to provide image quality nearly equivalent to that of a theoretically perfect lens with that aperture.

"Physicists would describe the performance of our lens as approaching the diffraction limit imposed by the wave nature of light," said Bill Price, KAD Optical Engineering. "Photographers will simply discover that the new camera system yields very sharp pictures.

"This lens went through about a dozen design modifications before we found the right combination to maximize manufacturability without jeopardizing quality. We are using very sophisticated automated manufacturing processes that enable us to hold tolerances to a few wavelengths of light." (A wavelength of light measures about 20 millionths of an inch.)

The four-element lens has a focal length of 12.5 mm and covers a 58 degree field of view. The four elements are made of three different types of glass chosen for both optical properties and physical or manufacturing properties.

However, the lead role in the lens assembly belongs to the second element which has an aspheric (non-spherical) surface. The primary function of this aspheric surface is to correct spherical aberration, one of several varieties of common optical errors that must be overcome in a high-quality lens system. Spherical aberration occurs because different sections of a spherical surface fail to bring all the light rays from an object point to a single focus.

"We could have designed a lens of equal quality without an aspheric element but we would have had to either use one more element and make the lens bigger, or else not achieve the desired f/2.8 aperture," Bill said. "The aspheric surface permitted us to meet the high quality, f/2.8 goals in a very compact design."

The mathematical computations required to design aspheric lens surfaces are more complex than those for spherical surfaces, as are the manufacturing and testing process requirements. That's one reason aspheres were uncommon in lenses until the 1970s, when computer design techniques, laser interferometers for testing, and mass-production fabrication processes all came together to make aspheres a practical option for camera lenses.

***CAMERA LENSES**–James Sage, KAD Mechanized Lens Assembly, examines lenses used in the new cameras.*

"Then the mass-produced fabrication process development followed for the next decade and finally in the '80s we are able to reap the benefits of our efforts, and enhance the quality of the Kodak disc camera lens with the world's first mass-produced glass aspheric lens," said Donald DeJager, Optical Engineering.

By incorporating an aspheric surface, designers were able to satisfactorily correct the spherical aberration. A lens designer's job is to perform an optical balancing act, canceling optical errors of one type by introducing opposing errors.

Another major innovation of the lens design was the positioning of the aperture and shutter between the second and third lens elements. This design conserves space, but it makes pairing of lens assembly and camera body all the more difficult.

A critical element is the lens barrel, which must be made with as much care as the precision glass elements.

"Computerized drawings of lenses always assume that multiple lens elements are perfectly positioned and squared to exactly align the centers of curvature along the same optical axis," Bill said. "To make reality approach this design assumption, manufacturing tolerances for critical dimensions of the barrel structure must be held to within a thousandth of an inch."

representatives and coordinators to represent Kodak Research Laboratories, Kodak Park, Kodak Apparatus Div. and Photographic Technology.

Jim said the biggest complication of managing this project was the non-linear nature of product development. If, for example, camera designers had been handed a completed disc and told to develop a camera to use it, there would have been no need to negotiate disc/camera interface characteristics.

According to Jim, computer modeling proved a valuable aid in determining the precise contribution each system element had to make to reach image quality and sensitometric system goals.

"When quantifiable and realistic contributions were assigned to individual components, film researchers, lens makers, camera designers and developers of other system elements were faced with demanding goals," Jim said. "But at least those goals were clearly defined. That meant work could proceed much more effectively and productively."

A New Camera

At KAD, a team of designers, quality control specialists, manufacturing and systems engineers and others began coming together. They were charged with taking the list of tough product goals and building a camera that would meet them.

"This was not just a change in camera format but a whole new concept for us," said Brad Paxton, KAD project coordinator. "The tolerances in the camera are so critical that it required improvements across the board in manufacturing and design operations."

From a design standpoint, the new disc cameras were a technological challenge. Dick Close, Still Camera Product Design, the project design supervisor, said the new models are more advanced mechanically and electronically than any other consumer camera ever built by KAD.

"Conventional camera design people had a difficult challenge because of all the new technology that's been incorporated into these products," Dick said. "The job required a lot of sophisticated analytical tools, and ability and support from Research and Engineering.

"The real challenge, though, was to fit everything in a camera body that was only 20 mm thick."

To help conserve space, designers incorporated two companion integrated circuits to handle the camera logic. One measures the scene light level and communicates with the master IC which controls camera functions.

Acting in concert, the ICs measure scene brightness, charge the flash capacitor if necessary, set lens aperture and shutter speed, clamp the film to hold it flat, fire the flash if necessary, release the shutter, rotate the disc to the next picture and recharge the flash. All this happens in less than a second.

At the heart of the camera's mechanical operations is a micro-precision gear train driven by a reversible electric motor. This system transfers power to the exposure control and film advance systems. Because the movements of the gear train were so precise and critical, KAD designers traveled to Switzerland to learn from the experts in such matters–Swiss watchmakers.

An important contributor to the design and development activities was the systems analysis group at KAD.

"This program represents the first time in the history of Kodak consumer products that a systems analysis effort has been carried out in conjunction with a camera design and development effort," said Tom Rice. "We were involved in providing analysis support to the entire gamut of engineering activities such as development of camera requirements, modeling/analysis of flash and battery systems, gear train analysis, development of human factors tests, red-eye analysis and modeling and analysis of overall system performance."

Even as designers worked on the basic camera design, men and women in various KAD manufacturing organizations were coming together to begin planning their strategies for producing the cameras. Since the manufacturing equipment would be new rather than just an adaptation of existing equipment, the desire was to take advantage of state-of-the-art manufacturing technologies.

"What we foresaw was a relatively low number of parts, high production volume and very special challenges in the areas of optics and electronics," said John Schmits, project manager, KAD Manufacturing. "We felt this combination of factors presented many opportunities for the application of state-of-the-art technologies in our manufacturing process.

"One key element in our planning was the establishment of manufacturing facilities solely for this product. This represented a significant change in approach when compared to all previous projects."

State-of-the-art technologies and dedicated parts manufacturing facilities were brought together in the electronics assembly area where circuit board assemblies for the camera are produced. Here,

***VISUAL INSPECTION**–An inspector at KAD looks over circuit boards.*

manufacturing engineers took equipment that was commercially available and adapted it to handle the unique needs of these subassemblies.

State-of-the-art technologies also were vital in the design and manufacture of the camera's unique lens. An aspheric surface has been included in the all-glass, four-element design, to provide enhanced photographic sharpness and contrast.

"This design innovation is coupled with the manufacture and assembly of all components to tolerance levels not previously attainable," said Bill Sexton, Optics Manufacturing Engineering. "It's been made possible now through a sophisticated, highly-automated process where each lens assembly is tested 100 percent during manufacture."

Lou Tiberio, Opaque Plastic Molding, said the disc camera project also served as an opportunity to bring new concepts to the molding operations.

In the traditional setup for molding machines, four machines are clustered together with a lot of support equipment such as heaters and coolers in the central area. Boxes of plastic pellets usually are nearby with hoses drawing out material for each machine.

In the new area constructed for this project, the molding machines are supplied with plastic pellets and other support services through overhead hoses that originate on a mezzanine. This setup helps to conserve space and allows for better quality control.

"In addition, each machine is computer monitored and production data is constantly being updated," Lou added. "This enables supervisors or quality control people to determine current machine operating parameters or the conditions that existed when parts were made."

Camera Assembly

The various parts and subassemblies from throughout KAD come together in the final assembly area where new technologies also are playing an

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***CAREFUL INSPECTION**–Lisa Ciarpelli, KAD Manual Assembly and Packaging, inspects a camera at a test point in the assembly operation.*

Program Challenged Many EKers

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important role. Among the innovations, according to Neil Ober, KAD Manufacturing, Consumer Product Assembly, is a computer link between parts manufacturing and assembly departments.

"Using real time information, we know what parts have been assembled and how many parts we'll need," Neil said. "The parts manufacturing people can watch our use of parts on their computer terminals, compare that with the requirements and plan their production schedules accordingly."

Another innovative change in assembly operations is the handling of cameras on individual pallets. Each camera moves along the assembly line on an individual carrier, thus eliminating the need for assemblers to handle large trays of cameras.

The single-pallet system minimizes work that does not add value to the product, namely product and tray handling," Neil said. "Because they're on individual pallets, we're able to automatically integrate mechanized assembly and extensive testing operations into a manual assembly line."

A bar code, similar to the universal product codes seen on grocery items, is put on each camera so a computer can keep track of it through the assembly operation. This code becomes particularly valuable if a camera shows a problem at one of the numerous quality control check points along the way.

"The computer records the camera number and problem, and then the camera is sent to a repair station," Neil explained. "The operator calls the camera number up on a viewing screen and the computer lists the problems. After repairs are made, the computer is updated, and the camera goes back into the assembly line for repeat testing."

Working closely with the manufacturing and assembly departments throughout the project was a team of quality control engineers and technicians headed by Chris Mattson, Advanced Products Quality Control. Chris said that quality control people joined the program early to help define quality control systems to be built into the manufacturing operations.

"The QC engineers worked with the design and manufacturing people to develop a product design and manufacturing process that would yield a more reliable product," Chris said. "One goal was to have automatic test equipment integrated into the manufacturing process.

"The use of integrated equipment allows us to find problems as close to the source as possible. This way, corrective action can be taken before much inventory is built up."

Automatic tests performed range from dimensional checks on parts to functional checks on subassemblies and the final products. Pressure springs for the rear door, for example, are checked automatically during manufacture and after assembly to the rear door. The electronic flash is tested as a subassembly, as part of the complete circuit board and again in the final camera.

Along with the on-line testing, the quality control group regularly selects cameras from the assembly line for audits. In the audits, cameras are put through actual picture-taking exercises and are subjected to a multitude of stress tests including a 30-inch drop onto concrete.

As quality control people conduct their evaluations and manufacturing and assembly people produce their products, a mass of valuable information is generated. Helping record, analyze and share this data is a complex computerized information network that links the operations together.

Maury Wills, Assembly Buffer, who coordinated development of the information system, said it became apparent very early that the magnitude of the program required sophisticated information management.

"Without computers, information would have to be gathered and maintained manually, requiring additional people," he said. "Manually maintained records tend to be less timely and accurate. "

While this data is valuable for the KAD operations, it also provided a continuous source of information for Kodakers who were working the other aspects of the disc system.

KP Challenges

As men and women at KAD struggled to build the new camera, people at Kodak Park were facing two challenges of their own–to develop a new film and a disc.

The Kodak Park effort got under way in early 1976. In the fall of 1977, Frank Allen, then KP division coordinator and the first disc task leader, pulled together an interdivisional group and organized a matrix approach to disc development. This group worked across divisional lines and established the communications channels that were so important in those early stages.

"In any project or task, there are many stages, including concept, feasibility, development and production," he said. "In this project, we tried to be extremely sensitive to the transitions between those stages."

The new film grew out of work that was being conducted at the Kodak Research Laboratories. It was here that researchers first began tackling a tough assignment–to build a film that was faster, yet sharper and less grainy than Kodacolor II film.

"Never before had we been asked to make such a huge improvement in one film," said Dave Nelander, who coordinated the Research Labs efforts for the project. "It's not unusual to be faced with a request for a faster film with the same grain and sharpness characteristics as its predecessor, or even a finer-grain film which has the same speed. But here we were asked to pull out all stops to obtain simultaneous improvements in speed, grain and sharpness."

Because researchers were achieving new levels in film sharpness, they also had to replace conventional measuring tools with new devices that were much more precise. One researcher designed a new optics system for measuring sharpness which has since been shared with the world's scientific community.

"The previous optical system didn't offer the precision that Kodak camera designers planned to build into the new lens for the Kodak disc cameras," Dave said. "Manufacturing precision is such that the camera lens is calibrated to focus on the green-sensitive recording layers in the middle of the new film emulsion."

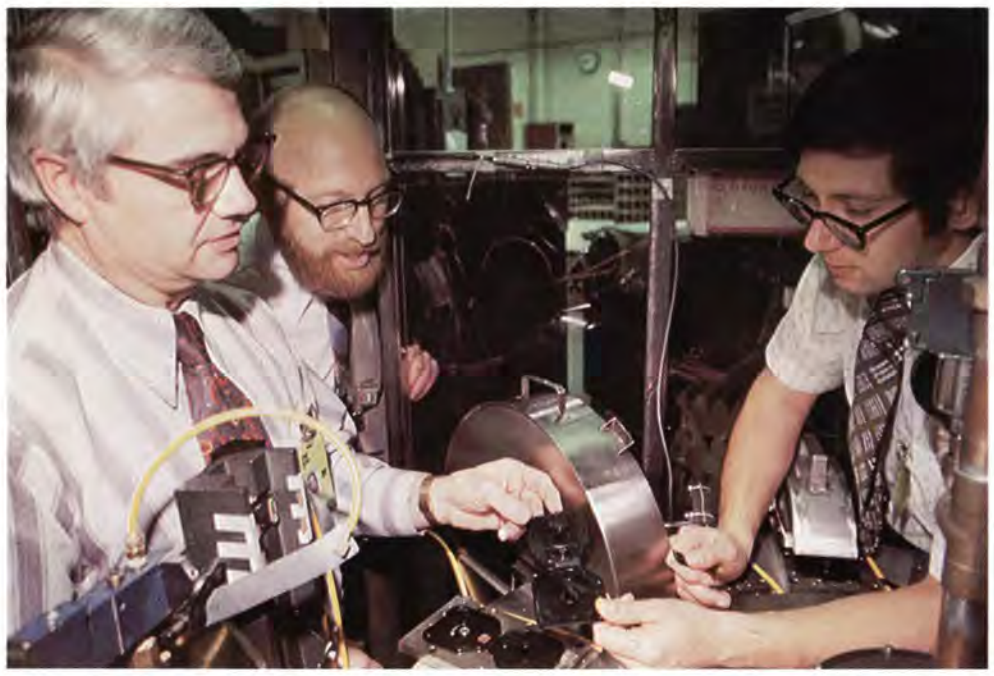
Throughout much of the development process, KRL people worked closely with the KP Film Manufacturing Organization and other divisions to ensure that lab results could be translated into high-volume production. KP Synthetic Chemicals, for instance, was called in early to make sure that the new chemicals needed for the film could be obtained or produced in sufficient quantities.

Even before KRL had zeroed in on the final emulsion package, EKers in Film Emulsion and Plate Manufacturing were busy scaling up the experimental emulsions and evaluating them on coating machines. To help identify potential film research/manufacturing conflicts at an early stage, John Babbitt, Film Emulsion and Plate Manufacturing, opened a second office at the Research Labs.

"When new chemicals are used in film emulsions, there often are complications," he said. "Researchers may have little difficulty mixing ten grams of a new chemical in a lab, but using large volumes in a production environment may not be so simple and may require formula changes. Scaling up production of complex organic molecules and the final formulations needed for coating can't be done by simply multiplying the various ingredients in a recipe.

"Our early involvement also was important because the film's exact physical characteristics had not been determined. Surface properties had to be decided in concert with disc and camera designers who were trying to determine the optimum materials for parts of the system, like the camera

***RESEARCH EFFORT**–William Keller, Kodak Research Laboratories, carries out an experiment related to development of the new film.*



***DISC ASSEMBLY**—Discussing one of the assembly operations are, from left, John Black, Facilities Engineering; Mark Harris, Roll and Sheet Film, and Vince Rybicki, Plastic and Metal Products.*

***QUALITY CHECK**—Looking over the results of a quality control check are, from left, Deep Sethi, Facilities Engineering; Newt Landis, Manufacturing Technology Div., and Al Wever, KP Photographic Technology.*

rails that ultimately contact the film."

Another characteristic of concern was film curl. Because film flatness is extremely critical in the camera, film manufacturing people had to develop techniques to control curl during manufacture and handling.

Working closely with the film manufacturing group was the team which has been led since 1978 by John Black, Facilities Engineering. This team, composed of representatives from Plastic and Metal Products, Roll and Sheet Film, Manufacturing Technology, Facilities Engineering and Management Services, was responsible for developing the plastic disc to hold the film as well as the manufacturing process for finishing the film.

"From a design standpoint, the disc enclosure posed some tough challenges," John said. "Tolerances were more critical than in any film cartridge we produce and there were a number of moving parts that had to perform reliably every time. It had to be strong enough to withstand customer handling and still protect the film."

Probably no single aspect of disc development drew more concern than the issue of maintaining film flatness during exposure in the camera. Flatness was more critical with this film format than with any other because of the high magnification and short depth of focus associated with the fast f/2.8 lens.

"We had to achieve a film plane flatness that was within half-a-thousandths of an inch," John said. "That was an astronomical task, significantly more precise than anything we had done before."

Dave Hill, Roll and Sheet Film, was assigned to head up a team of KP, KAD and Research Labs people to devise a way to achieve the required flatness. Their work led to a small pressure platen located behind the film frame being exposed. A spring in the camera pushes the platen against the film at the moment of exposure and then releases so the disc film can freely advance to the next frame.

Another key element of the disc is a dark slide that automatically opens when the disc is put in the camera and automatically closes when it is removed. The dark slide has a number of primary and secondary locks to prevent the user from accidentally sliding it open outside the camera and damaging the film.

Keeping the dark slide closed outside the camera was one problem but making sure it opened properly in the camera was another. With the help of Manufacturing Technology, developers of the disc conducted extensive tests and finally developed a satisfactory material for the dark slide to allow it to move smoothly.

Of the parts that comprise the disc, the largest and most complicated is the disc enclosure. Product designers looked at a number of methods for producing this item and decided on injection-molding.

One advantage of the molding operation, according to the designers, is that it allows both halves of the enclosure to be made at the same time with a flexible hinge connecting them. This connection ensures that the same two halves of the enclosure always mate.

New Facilities

For Kodak Park, one goal of the program was to create a manufacturing facility capable of very high quality, reasonable costs and high volume.

"When we started looking at the design of equipment, there were many sessions among Roll and Sheet Film, Plastic and Metal Products, and Facilities people to decide where we were going to put the facilities," said Deep Sethi, Facilities Engineering. "Studies were made and everyone felt we should integrate manufacturing in one building to improve situations we've encountered with other products."

Creation of this new facility and design of the equipment were handled by the KP Facilities Organization. The result of their effort was a complex that uses a large number of computers to control the operations. In the facility are molding, extrusion, stamping, automatic assembly and packaging equipment supported by sophisticated inspection machines.

The workflow starts in the Plastic and Metal Products area where injection molding presses, punch presses and extruders produce parts and webs. The largest component, the disc enclosure, is produced in a complex mold.

"Each injection molding machine is monitored by a computer that gathers data on the parts being produced and feeds that information to a larger system," said Vince Rybicki, Plastic and Metal Products. "This data not only is helpful for a production evaluation, but it is a tremendous aid to quality control people."

In the area of quality assurance and control, state-of-the-art measuring equipment coupled with automatic parts-handling provides rapid and reliable data collection.

"Our automatic optical micrometers take measurement data many times faster and with greater precision than traditional methods," said John Yunger, Plastic and Metal Products. "As a result, molds can be produced faster and with greater uniformity among molds. This translates to improved levels of product quality."

After components are produced, they are sent by conveyer to the assembly area of the building where the film is cut to proper configuration and inserted in the disc enclosure.

"One thing we changed in the finishing operations was the tradition of dark rooms," said Mark Harris, Roll and Sheet Film. "There were certain sections of the final assembly machines that needed to be in the dark, but we wanted most of the operations to be in white light."

Another innovation is the design of the finishing equipment in a modular format. If part of a machine develops a problem, the malfunctioning component can simply be removed and a new one immediately installed.

As the film and disc come together in the final assembly machines, the film identification number that is on the outside label also is flashed onto the film. This code is important for photofinishers (see photofinishing story on Page 6) and it helps keep track of the film through the manufacturing operations.

"If, for instance, we receive a question from a customer about a disc, we can trace it back and tell when it was made and from what machine it came," Mark said.

Reliability is a critical factor in the system and discs must perform every time. That put a heavy burden on the quality control people.

"The machines perform functional inspections on each disc," Mark continued. "They rotate each film disc and check the torque.

"The tolerances are tighter and more critical than anything in the past. We have to make sure those tolerances are being met."

Marketing Plans Biggest Ever

A considerable part of the efforts of Kodakers in Consumer/Professional and Finishing Markets were devoted to developing the programs and strategies to promote and sell the new consumer and photofinishing products.

Phil Samper, general manager of the Photographic Marketing Group, said the new disc cameras and film will be supported with the largest advertising campaign in the company's history. In addition, there will be an extensive array of sales promotion materials and a nationwide training program for retail sales counter personnel in 80 cities across the U.S.

Future issues of Kodakery will take an in-depth look at upcoming advertising and promotion efforts and the people behind them.

Advertising efforts will be directed primarily to amateur photographers, such as pocket camera users, Phil said. The initial commercials and print advertisements will herald the "brand-new world of decision-free photography" made possible by Kodak's new cameras and film.

100-Plus New Items in Photofinishing Line

While Kodak people throughout the company concentrated on producing the new cameras and film, another group of EK men and women were bringing state-of-the-art technology to bear on a new line of photofinishing equipment for the disc film.

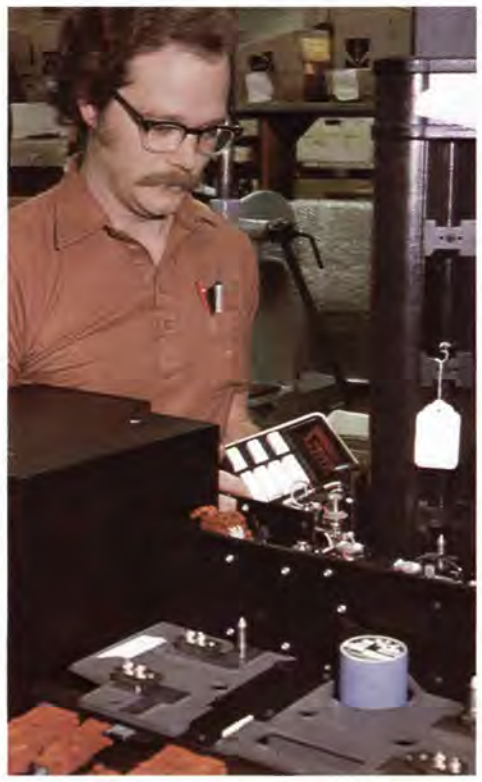
This new line, which includes more than 100 separate products, is intended to satisfy the needs of high-, medium- and low-volume photofinishers. At the core of this product line are 13 mainframe items that handle opening of the disc enclosure, film processing, printing and finishing.

The major responsibility for the new products was shouldered by the Business and Professional Products group at KAD. Working closely with KP Photographic Technology Div., Customer Equipment Services Div., and other groups within KAD, they directed design, development, and building of the new products.

Dave Schwardt, B&PP Professional and Finishing Products Engineering, said development of the photofinishing products started some six years ago, about the same time as camera and film activities. A considerable part of this early effort on photofinishing concepts, feasibility studies and design bread boards was based on work done at Photo Tech.

The parallel development of consumer and professional products put a greater strain on the talents of Kodak people but it was necessary to bring the entire system to market by launch date.

***PRODUCT TEST**–Bonnie Jimerson, Professional Products Quality Control, tests one of the photofinishing products at KAD.*



***FINAL CHECK**–Frank Baron, B&PP Equipment Assembly, does a final check on a printer attachment.*

***CLOSE LOOK**–Earl Pankratz, B&PP Equipment Assembly, looks over a spindle loaded with disc film.*

The New Challenge

One of the first challenges that the equipment designers faced was how to handle efficiently the new film format. In traditional photofinishing, many rolls of film are spliced together and handled as a giant composite roll, but that system wouldn't work with film in disc form.

"Eventually the concept of handling the film on spindles evolved," Dave said. "The benefit for the photofinisher is that stacking the film on spindles provides a compact batch."

Another requirement of the program was high volume. The color printing attachment, for example, had to produce about 9,000 prints per hour.

"To get that kind of volume required a great deal of automation," Dave said. "That's why we're using microprocessors in the equipment."

A key contribution to the high-volume capabilities of the printers was made by the Kodak Research Laboratories. EKers in the Physics Div. invented a unique device which is used on all the high-intensity printers to keep the negatives cool during printing.

"The amount of light which must go through an 8 x 10 mm negative is sufficient to damage the negative," said Dave Nelander, who coordinated the KRL activities. "The device uses a cooling ribbon of air that reaches the surface of the film when needed, yet doesn't move or disturb the negative. Without this invention, the printers would have had to use less light and work at a slower pace, which would have adversely affected photofinishing productivity."

Product Assembly

With the design concepts in hand, the photofinishing efforts shifted to the tooling up and building of the products. Rol Campbell, B&PP Operations, was given the task of pulling together an action team to coordinate that phase.

From the beginning, time was a constant concern for the purchasing, manufacturing and assembly organizations. The photofinishing equipment had to be ready for shipping at the time of announcement so that photofinishers could be ready to process customer film as soon as cameras were available.

"This meant that there were no opportunities for trade testing the equipment," Rol said. "We did more in-company and interdivisional testing on these units than with any other product line because we had to have everything ready up front."

Adding to the technical complexity of the equipment are a large number of electrical components. Many functions handled mechanically on other equipment are now handled with electronics.

Rol called the new products both electrical and mechanical challenges. There are more than 50 circuit boards and 800 electrical assemblies in them.

The boards, assemblies and wiring harnesses were built and tested in KAD Electronic Products Assembly. A combination of automatic and semi-automatic equipment was used to insert the components into the boards, solder the connections and run comprehensive tests.

"This program required a great deal of integrated circuit technology," said Dick Hamer, Electronic Products Assembly. "ICs make the boards less complex to build but much more complicated to test."

Because the processors, printers, work centers and other equipment had to be ready without any sort of trade test, a tremendous burden of responsibility was placed on the quality control organization. These KADers had to test and evaluate all the components and verify that the equipment would perform reliably once it reached the customer.

"These are the most complex products we've made," said Bob Sestrick, Professional Products Quality Control. "The mechanical parts required more precision than ever before and tighter tolerances."

Though many of the products are equipped with microprocessors and have complicated electro-mechanical interfaces, one of the most critical components in the system is a simple-looking spindle that holds the disc film through the photofinishing process.

"What makes this spindle so critical is that it has to interface with ten pieces of equipment," Bob explained. "We had to make sure it was produced with correct tolerances and remained in tolerance throughout the process cycle."

Part of the testing process for the QC organization was not only to use the products but abuse them. The idea behind this, Bob said, was to make sure the equipment continued performing reliably even after it was subjected to some of the worst possible conditions.

In one test, for example, equipment was operated at very low and very high voltages to make sure the electronics continued to function. Some of the disc openers require gravity to feed the disc enclosures into the unit, so the equipment was tested on a variety of tilted floors.

Since the products will be available in foreign countries as well as in the U.S., quality control people had to make sure they met foreign electrical standards. That required a multitude of complex and difficult tests because the standards varied, Bob noted.

Multi-Division Effort

Joining in the development effort for the photofinishing equipment were experts from KP Photographic Technology Div. Harry Walker, who headed up the Photo Tech group, said opening, processing, printing and finishing people were involved from the beginning because Kodak realized success was contingent on a systems approach and on the company's ability to supply customers of all sizes with equipment that would fit into their existing operations.

Photo Tech, in conjunction with KAD and KP, also spent considerable time and effort in developing the film identification number that appears on the film and label. It's intended to aid photofinishers in keeping track of customer orders as they pass through the processing lab.

"We developed photofinishing equipment that automatically transfers the number on the label to an order envelope and, with some equipment, backprints that number on every print," Harry said. "This system reduces manual intervention and translates to higher productivity and better record control for the photofinisher."

Harry noted that Photo Tech and KAD often turned for advice to one future user of the new equipment–Kodak's Color Print and Processing Organization.

"We continually bounced ideas back and forth," he said. "Each group had important contributions to make and legitimate concerns. KAD stressed the need to design models that met system specifications and were practical from a manufacturing viewpoint. CP&P served as a development resource, critically evaluating equipment performance from the viewpoint of a large, quality-conscious lab interested in productivity."

Another resource that was valuable in the development process was Customer Equipment Services Div.,

the organization that will install and service the equipment. CESD personnel were present at KAD throughout the development process to advise and to learn about the equipment as it was being designed and built.

"We had more than 30 people working full time at KAD for more than three years," said Bob Wynne, CESD Program Management. "Their job was to work with designers to ensure that reliability and serviceability were built into the equipment."

With the new technology that has gone into the photofinishing equipment, CESD needed state-of-the-art technology for service, too. CESD engineers assisted in developing a portable computer diagnostic tool that will help equipment service representatives more accurately and quickly diagnose a problem.

"Today, an ESR may spend up to 70 percent of the time on a service call finding out what's wrong and what caused it," Bob said. "With all the electronics in the new equipment, we knew the ESRs would have to do a lot more diagnosing and we wanted to give them a tool to help do the job more effectively in less time."

Another major effort for CESD was the preparation of more than 65 different service manuals in several different languages.

"We have developed the Kodak International Service Language (KISL) which uses a limited vocabulary and a lot of photos and line drawings," Bob said. "KISL helps eliminate some of the problems that you encounter when you have to try to translate words."

During the next several months, installation teams of ESRs and TSRs will be traveling throughout the country to install the new equipment in photofinishing plants.

Programs Planned For Employees

Kodak people throughout the country will have an opportunity to learn more about the new disc photography system through a variety of programs and exhibits that have been planned for announcement week.

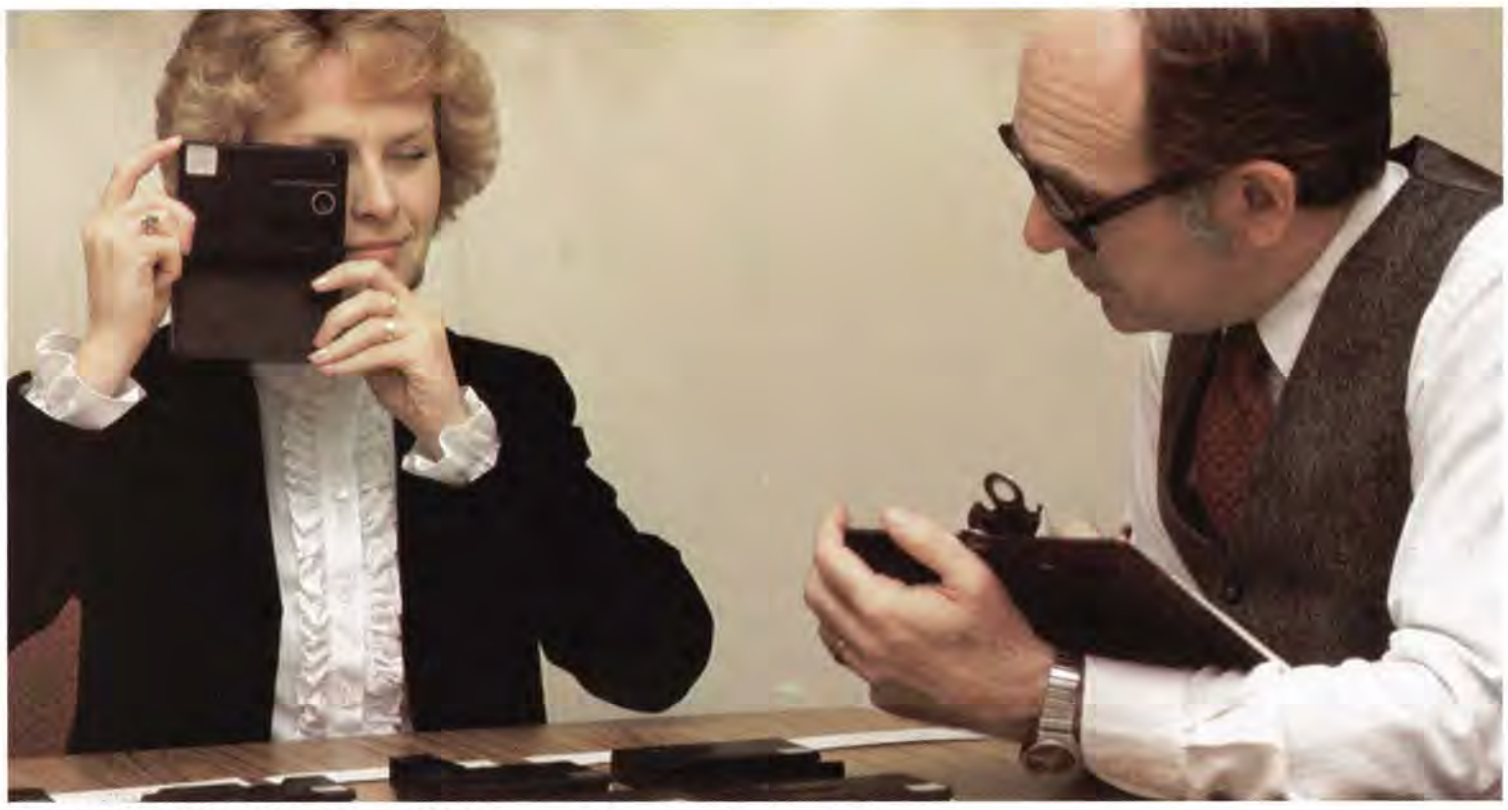
Special tabletop exhibits showing pictures taken with the new cameras plus an inside look at the camera mechanism will be on display at facilities across the U.S. With these displays will be literature on the new products and copies of this special issue of Kodakery.

An 11-minute movie covering key elements of the new system will be shown at company facilities following announcement. Bulletin board posters will give times and locations.

On Thursday, Feb. 4, and Monday, Feb. 8, a special presentation of "Kodak Products in Review," will be made in the auditorium of the EK Recreation Center, KP Bldg. 28. Admission is by invitation only.

A management letter also will be distributed.

Human Aspects Factored in Early



***HUMAN FACTORS**–Debbie Trottier, KP Management Services, tries out one of several model cameras during a test conducted by Terry Faulkner, Health, Safety and Human Factors Laboratory.*

What features should be included in the new disc cameras?

How should the cameras look?

How should they feel?

Those questions and dozens of others faced camera designers as they began developing the new Kodak disc cameras. To help find the answers, they turned to experts at Kodak's Health, Safety and Human Factors Laboratory.

Terry Faulkner, who headed up the Human Factors activities on the project, said the first step was to look at the print evaluation data base maintained by the Human Factors section. This computerized data base was started in 1976 to help provide a better understanding of how people use their cameras.

The data base contains some 50 bits of information on each of more than 30,000 prints. It includes, for example, data on whether a picture was taken indoors or outdoors, with or without flash, if there is a problem and the nature of that problem.

"From this data we knew that underexposure was the most frequent problem and that inadequate flash range was the leading cause of it," Terry said. "The data base allowed us not only to set priorities on the problems but to understand the circumstances under which they occurred. We could then concentrate on correcting them with the new system."

As the development process progressed, Human Factors was called on again to evaluate camera configurations. In a series of four preference tests, more than 250 people looked at 23 different cameras.

"For security reasons we used Kodak people, but we went to great lengths to get people who represented typical customers," Terry said.

In each experiment, six to nine models made in the KAD model shop were shown to volunteers. They had to rate models in terms of acceptability, place them in rank order for preference and explain why they liked or disliked each one.

"One thing we discovered was that people took more than one factor into consideration when rating cameras," he said. "They didn't like the pop-up flash that was on some of the cameras but many liked a cover handle."

As the Human Factors researchers focused in further on the cover handle, they discovered an almost even split between those who liked it and those who didn't. The ones who liked it felt the handle offered more protection for the lens or made the camera easier to hold, while the other group felt that it was just a bother.

"These opinions were held quite strongly, too," Terry said. "The result was that we decided to offer cameras with and without the cover handle."

Besides the preference experiments, six additional experiments were conducted to measure the effect of configuration on aspects of performance. Researchers looked at such things as the probability of a user putting a finger over the lens or flash and the vulnerability of the camera to camera shake.

The participants were told to pick up each camera and try taking a picture 10 times, both in the horizontal and vertical position.

"We discovered, for example, that a user's hands tend to take opposite but symmetrical positions on the camera," he said. "That meant that if the lens was directly opposite the shutter release, a finger might cover the lens."

A key objective for camera designers was to incorporate an electronic flash that would fire whenever it was needed without manual intervention. Because the flash system was so critical, Human Factors was asked to help evaluate several elements of its operation.

To be sure that the flash is always fully charged and ready to take a picture, three levels of protection were built into the cameras. First, there is a switch that turns on the flash when the lens cover is opened. Human Factors studies showed that most people close the lens cover when they put away their camera, Terry said, so when they reopen the cover to take a picture the flash will be automatically recharged.

To protect the smaller group that stores the camera with the lens cover open, a "wake up" switch was added to the shutter release. A light touch of the button will wake-up the camera and recharge the flash. Additional Human Factors experiments showed that most people touch the shutter release well before taking a picture, thus providing time for the recharge.

The third level of protection is for the very few people who leave the lens cover open and who don't touch the shutter release before taking a picture. In this situation, there is a slight delay between the time the button is depressed and the picture is taken to allow for topping off of the capacitor.

There also was some concern that a camera carried in a purse might be continuously activated by objects banging against the shutter button.

"We had the insides of one camera removed and replaced with a logging computer," Terry said. "Volunteers carried it in their purses for several days so we could see how many actuations it received. As a result of these tests, a small ridge was put around the button to help prevent accidental actuations."

Working closely with KP Photographic Technology, Human Factors helped set up and run a series of weekend home tests in which more than 400 employee volunteers used the cameras on weekends and later rated their results. Terry said the same volunteers also took home 110-size cameras to compare them with the new system.

In all, Human Factors conducted 36 experiments and tests on the new products. More than 1,400 employee volunteers took part.

***FLASH ASSEMBLY**–Eunice Cochran, KAD Electronic Assembly, solders a connection on the electronic flash subassembly.*

To Kodak Men and Women:

In 1888, Kodak founder George Eastman made amateur picture-taking a convenient reality with the invention of roll film and a small box camera. Nearly 100 years later, Kodak is introducing another new era in amateur photography.

Disc photography represents a fundamental change in film format. Just as Eastman's roll film revolutionized photography in his day, disc photography will have a profound impact on the photographic field as we know it today.

I know there is a special satisfaction for many of you in seeing these products publicly announced because you have contributed your skills and talents to their development. You can be proud of your accomplishments. It's been a job well done.

Walter Fallon

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