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Conquest of Darkness
by
Management of the Stars

★★★★★★★★★★★★★★★★

Dr. Robert S. Wiseman.

Army Night Vision
February 1954 to July 1981

Martin Marietta Electronics, Information & Missiles Group
July 1981 to Present

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Expansion of Dowd Memorial Lecture
National IRIS Symposium
June 18, 1991

Conquest of Darkness Logo on Cover Page
by Myron W. Klein
Photographs courtesy of U.S. Army Night Vision Laboratory

Send information for additions to the history of Night Vision to
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Abstract

This text was presented as the Thomas B. Dowd Memorial Lecture for the 1991 national Infrared Information Symposium (IRIS). The history of Army Night Vision from World War II to 1972 proves how the right organization with talented people and proper support can succeed. This presentation not only illustrates the growth of image intensifier technology and families of equipment, but the key events and stars that made it all happen. Described are the management techniques used and how to organize for effective research, development, engineering, and production programs; the evolution of the Far Infrared Common Module program is described; and how the Night Vision Laboratory was unique.

ENGINEER RESEARCH & DEVELOPMENT LABORATORIES

Extract from Organization Chart Dated 21 January 1954
Revised: 1 February 1954

ELECTRICAL ENGINEERING DEPARTMENT
Oscar P Cleaver, Chief GS-15 Elec Engr
Charles F Cashell, Asst Chief GS-14 Elec Engr

ADMINISTRATIVE
J.M. Kees, Chief GS-11 Admin Asst
H.M. Helcamp GS-5 Secretary

PHYSICS RESEARCH LABORATORY *

PHYSICS RESEARCH
Georg Hass, Chief GS-14 Phys

Allan F Bradford GS-11 Phys
W Oshinsky GS-11 Phys
Jack B Ramsey GS-11 Phys-O
William J Cancell GS- 9 Phys
J E Waylonis GS- 7 Phys
William Erbe GS- 7 Tech
Pvt R F Roundtree Military

FAR INFRARED BRANCH *
Werner K Weihe, Chief GS-14 Phys
Sarah E Herr GS-3 C-typ

GENERAL RESEARCH SECTION
Andrew T Ireland GS-12 E E
Joseph Finberg GS- 6 Tech

COMPONENTS SECTION
Geo E.Brown, Ch GS-13 Phys
Bernard Chasnov GS-12 E E
Andrew McCulloch GS- 9 Phys

SYSTEMS SECTION
John N Hamilton, Ch GS-13 E E
Robt W Meservey GS-12 Phys
Morris H Arck GS-11 E E
Lloyd D Harrell GS- 9 E E
Lewis A Dixon GS- 9 Tech
Arthur c Tieman GS- 7 E E
Charles R Layne GS- 7 Phys
Lonie L Foshee GS- 7 Phys
Rita Cavelet GS- 3 C-typ

HIGH FREQUENCY RESEARCH
(Werner K Weihe) GS-14 Phys
Manford Gale GS-12 El Sci
R Gang GS-11 El Sci
E McDermott GS- 9 El Sci
Rudolph Thonen GS- 5 E E

NIGHT VISION EQUIPMENT BRANCH *
Benjamin Goldberg, Chief GS-13 Phys
Lewis M Brittle GS- 7 Adm Asst
Marguerite Hyer GS-4 Clk-Steno

RESEARCH & PHOTOMETRIC SECTION
Robert S Wiseman, Chief GS-11 Elec Engr
Myron W Klein GS-12 Phys
Stanley M Segal GS-11 Phys-Opt
John Johnson GS- 9 Phys-Opt
Earl Beinz GS- 5 Tech
SGT J T Sayer Military

ILLUMINATION SECTION
John A Bartelt, Chief GS-13 Phys
Capt Claude Orr Military
John C Boggs GS-11 Elec Engr
Andrew W Patteson GS- 9 Phys-Opt
Kendall Cooper GS- 9 Elec Engr
SFC Robert A Sonnett Military

NEAR INFRARED SECTION
Donald J Looft, Chief GS-12 Elec Engr
Malcolm W Fitzgerald GS-11 G-Engr
Harry G Johnson GS-11 Elec Engr
Edward E Firth GS- 9 Elec Engr
Charles F Freeman GS- 9 Elec Engr
V B Williams GS- 7 Phys
Carlyle D Charlton GS-7 Phys
Jack R Hildreth GS- 6 Engr Aide
Issadore Kessler GS- 6 Engr Aide
Larry E Hyer GS- 5 Tech
Marian L Kurash GS- 3 Clk-steno
Lt Wm H Olson Military
SGT H H Riffle Military
PFC J D Divilbiss Military
Pvt R A Ross Military

MINE DETECTION BRANCH
L O Goff, Chief GS-14 E E
S Eddington GS-7 Adm Asst
M L Cunningham GS-4 C-steno

GENERAL RESEARCH SECTION
Wilbert W Tool GS-13 Phys
+4

ELECTRONICS LABORATORY
Chandler Stewart GS-13 E-Sci
+5

PORTABLE EQUIPMENT SECTION
Charles Hoover GS-13 E E
+13

VEHICULAR EQUIPMENT SECTION
John W Cox GS-13 G-Eng
7

INSTRUMENT SHOP
Dennis Lugar GS- 9 Inst Mkr
+3

ELECTRIC POWER BRANCH
J W McGarrity, Chief GS-14 E E
W C Collier GS-7 Adm A
Yvonne Stallard GS-4 C-steno

RESEARCH & DESIGN SECTION
David Ginsberg GS-13 E E
+4

LABORATORY SECTION
Edward Prada GS-11 E E
+17

EQUIPMENT DEVELOPMENT SECTION
Clifford J Spilker GS-13 E E
12

PRODUCTION ADVISORY MAINTENANCE & LIASON SECTION
A J Van den Berg GS-12 E E
+1

ALLOCATION, CIVILIAN	130
EMPLOYEES, CIVILIAN	126
VACANCIES, CIVILIAN	4
OFFICERS	2
ENLISTED MEN	15
CONSULTANTS	3

Consultants
Dr. Fred W. Paul
Dr. Alexander Smakula
Dr. Francis T. Byrne

* These three organizations were transferred to the Army Electronics Command & became the NIGHT VISION LABORATORY on 2 Nov 1965.

I have dusted off some old slides that most of you have never seen before to illustrate the many objectives of this presentation:

1) Tell the history of the Army's night vision activity from World War II until 1967 and the beginning of far infrared (FIR) common module activity
2) Recognize the trailblazers of the 1950s and early 1960s
3) Reveal "behind-the-scenes" turning points
4) Describe how today's management trends were instilled in the heritage of Night Vision management in the 1950s and 1960s
5) Explain what made the Night Vision Laboratory "different"
6) Provide insight into organizing research, development, and engineering elements for success.

Figure 1. "Z" Type NIR Binoculars – Late 1940s

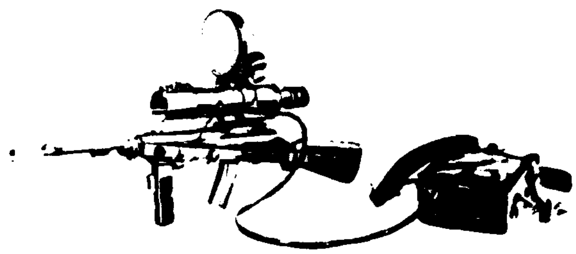

Figure 2. NIR Sniperscope – Early 1950s

World War II to 1954

Fort Belvoir, VA
★ Oscar P. Cleaver

Oscar is an early star in Night Vision history. At the beginning of World War II, he was a pioneer in blackout lighting at Westinghouse. The Corps of Engineers needed such an expert and offered him the position of Chief of the Electrical Department in the Corps of Engineers Engineer Research & Development Laboratory (ERDL).

In addition to blackout lighting, Oscar's group began experimenting with a near infrared (NIR) image tube viewer for driving vehicles. Because the image tubes and optics were so large, a "Z" configuration was used for better balance (Figure 1). Since they were not very practical, an NIR sniperscope was developed (Figure 2) and this was followed in the 1950s with a family of NIR systems, including tank periscopes.

The Corps of Engineers had responsibility for the 60-inch carbon arc antiaircraft searchlight. In order to help aim the searchlight at enemy aircraft, his group was attempting to develop a far infrared (FIR) pointing system. When the Signal Corps demonstrated radar that could do this and "see" through clouds and weather, the effort was redirected toward other night vision applications. The 60-inch searchlight was mounted on a truck and used for battlefield illumination (Figure 3).

In the early 1950s, ERDL had three Night Vision organizations with each competitively marketing

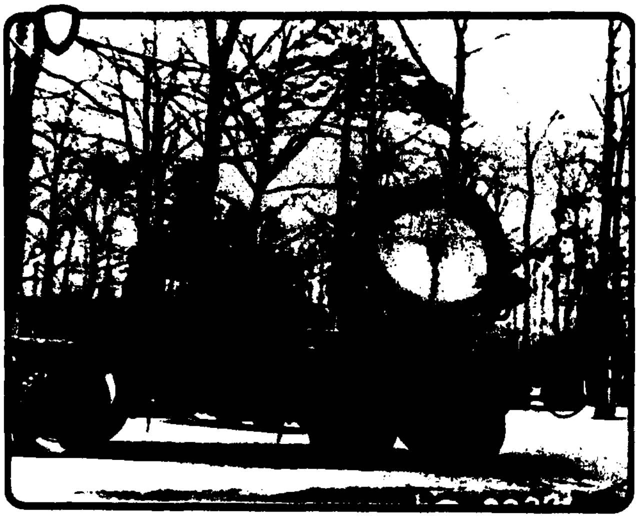

Figure 3. 60-inch Searchlight – Early 1950s

its own technology: visible illumination, NIR, and FIR. The searchlight people argued that their solution was the best since it illuminated the battlefield and the soldiers were not encumbered with electro-optical devices. NIR people argued that the enemy could see the searchlights, but that their system was invisible to the unaided eye. FIR people argued that their system was completely passive and would be available in just a few years. They fought each other in budget battles at the Pentagon. There was no systems integration plan defining the system that would best suit the Army's needs. Image intensifiers (II) came along in the late 1950s to add a fourth technology to replace NIR systems.

There were continuous conflicts with the Signal Corps, who thought that radar was the answer to all problems and NIR and FIR should belong to them because it was considered "electronics". There were equally fierce battles with the Ordnance Corps, who classified it as fire control – their area of responsibility. These fights kept us on our toes well into the 1960s.

Electrical Department – February 1954
★ Oscar P. Cleaver, Chief
★ Charles F. Cashell, Assistant Chief
★ Benjamin Goldberg, Chief
★ Donald J. Looft
★ John Bartelt
★ Dr. Robert S. Wiseman

In 1954, Oscar named Ben Goldberg as Chief of the Night Vision Equipment Branch with both searchlight and NIR responsibilities. Don Looft was Chief of the NIR section responsible for system development and production. John Bartelt was Chief of the Illumination section, but it was absorbed into the NIR section within a little more than a year, which settled one of the internal conflicts.

Oscar had the vision to establish a research program for this branch and I was hired as Chief of the Research & Photometric section. Oscar wasn't sure whether the research effort would survive, but he knew there would always be searchlights to photometer.

FIR, which was under Dr. Werner Weihe, was separate and still in competition with the promise of the ultimate passive system that was just around the corner if detector and window problems could be solved. Charles F. Cashell, Oscar's technical assistant, was outstanding with the details of technical specifications and contracts. They complemented each other and made a perfect team with Oscar interfacing on the outside and Charlie managing the details on the inside.

Research & Photometric Section
February 1954
★ Dr. Robert S. Wiseman, Chief
★ John Johnson
★ Myron W. (Mike) Klein
★ Stanley M. Segal
★ Earl Bienz
★ SGT J. T. Sayer

My research group consisted of John, who was responsible for optics and what developed into "visionics" – system performance analysis; Mike, who was in charge of image tubes; Stan, for light sources; and Earl and SGT Sayer, the technicians. There were no laboratory facilities, just space in the old 60-inch mirror coating facility, Building 327, where the plating tanks had been left in place and covered with decking. We had a budget of $200,000 (about $950,000 in 1991 dollars) to cover salaries, contracts, laboratory equipment, and all other expenses. Thus, we were forced to plan in order to make every dollar count. We practiced "zero-based budgeting" before it became fashionable.

Our focus was to conduct research that would pay off with most benefit to the soldier in the field - not "basic research," not "the making of a better image tube," nor the desire to "be recognized as the best laboratory." Our emphasis was on the individual soldier while others concentrated on large weapon systems. This distinction established the foundation for all that followed.

Night Vision Objective

Our basic Night Vision objective was: "... the Conquest of Darkness so that the individual soldier can observe, move, fight, and work at night by using an image that he can interpret without specialist training and to which he can immediately respond."

The soldier had several problems with the NIR equipment: each piece weighed too much; range was limited; and it was detectable by the enemy. Our research objectives were to increase image tube sensitivity and develop a source better matched to the NIR to reduce battery weight. Approaches were to improve the S-1 infrared photocathode, find an electro-optical design to give more gain, and replace the carbon arc and tungsten sources with something more efficient. Cost was an issue because large quantities were needed. Research was done by contract; components were tested, prototype systems were designed and built in house, and Advanced and Engineering Development Systems were done on contract.

Concurrent Engineering

Don Looft was responsible for both equipment development and production. We had "concurrent engineering", but in 1957, ERDL consolidated all the different production engineering activities of Night Vision, Electric Power, Bridging, and Combat Engineer Vehicles, etc., into the Applications Engineering dcpartment. This was done to "standardize the size of arrow heads and drawings," and "improve the quality of production documents." Such standardization could have been legislated and monitored from a staff position, but there was no way to legislate and monitor critical technology interchanges.

The organizational and physical separation destroyed communication and coordinated planning between development and production. At first, Night Vision production engineers and their activities kept in touch because Don Looft transferred to be the Branch Chief for Electrical Products in this new department, but this informal relationship was soon lost when Don transferred to be Chief of the Electric Power Research and Development branch. We lost the benefits of mutual support.

1954 - 1957

Cascade Image Tube

★ Richard Stoudenheimer, RCA
★ Al Sommer, RCA

The Germans had worked on a cascade image tube in World War II. Based on an analysis by John Johnson in 1953, this was the best approach.

A contract was awarded to RCA for research on an NIR, two-stage cascade image tube (Figure 4). Dick Stoudenheimer, RCA, used a thin glass window between two image tubes, and because the S-1 NIR photocathode was difficult to make, we let him use a visible photocathode in early experiments. He used the new multialkali photocathode just developed at RCA by Al Sommer.

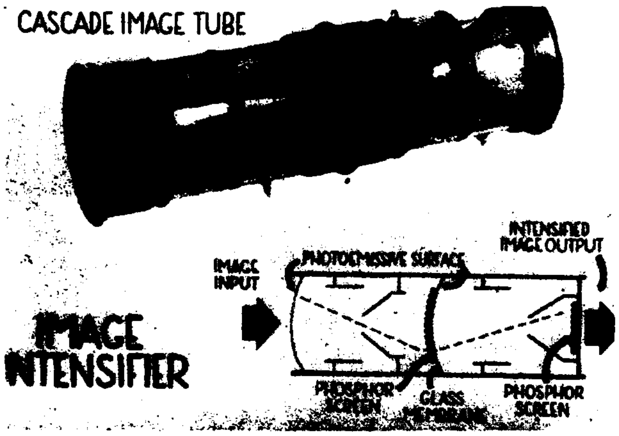

Figure 4. Two-Stage Cascade Image Tube

When we tested it in 1957 (Figure 5), everyone was surprised to find that without its own light source but under low level illumination from the moon, stars, and night sky, it outperformed a pair of 7x50 binoculars, which an earlier RCA publication had claimed the limit.

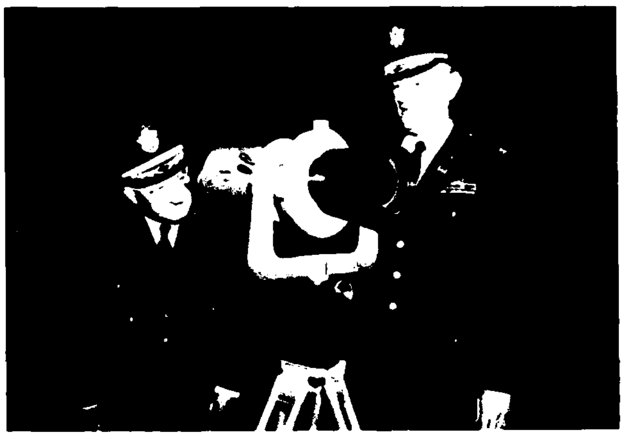

Figure 5. Two-Stage Cascade Tube Viewer (General Tulley, Colonel Davidson)

Plans were immediately readjusted. Objectives shifted from a better NIR system to exploiting image intensification because it better suited the soldier's needs. It was passive and much lighter.

Since the image orthicon provided storage capability plus other signal processing flexibility, we developed an image intensifier orthicon in order to have a vehicle from which to learn more about image intensifier performance in the field (Figure 6). This work led to the development of Night Vision Remote Viewing Systems for both ground and airborne applications. It was called a "remote view" night vision system so as to not conflict with the Signal Corps' charter for television.

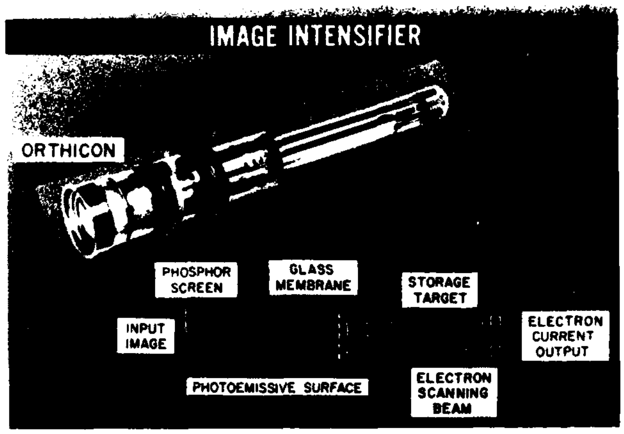

Figure 6. Image Intensifier Orthicon

Although the two-stage cascade tube proved the feasibility of image intensifiers for military use, there were problems. The gain was limited and the output image upside down. Optical inversion added unacceptable weight. A third electrostatic stage gave more gain and reinverted the image, but the tube grew to 17 inches long and 3.5 inches in diameter to maintain adequate edge resolution. It proved the practicality of image intensification (Figure 7). Yield was low because all three stages had to be built into a unified assembly and three good cathodes formed. AEC also supported the development of this three-stage tube. A viewer was made using this tube and became the work horse for early demonstrations (Figure 8). However, it was too big for military applications.

ITT

★ Richard Orthuber
★ Harold Baker
★ George Papp

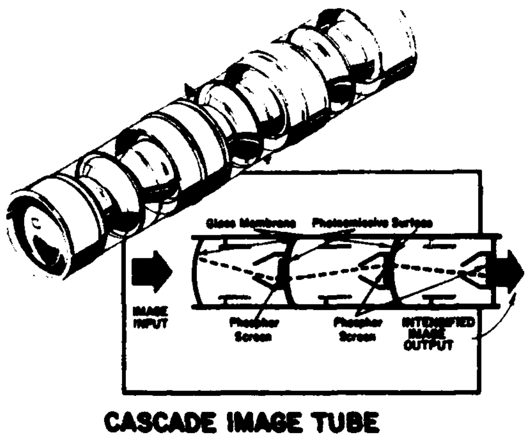

Figure 7. Three-Stage Cascade Image Intensifier Tube

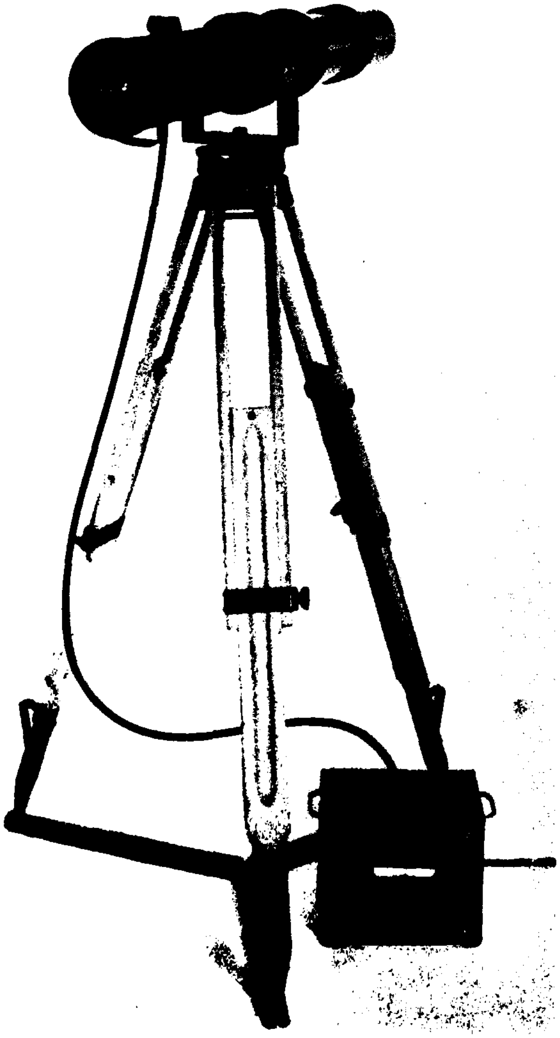

Figure 8. Three-Stage Viewer

Westinghouse
★ Gerhart Goetz
★ James Hall
★ A. E. Anderson
★ M. Wachtel
★ D. D. Doughty

Machlett Laboratories
★ Sam Yanagisawa
★ C. D. Robbins
★ S.A. Ward

GE, Schenectady

Bendix, Baltimore

Other techniques for image intensification were also investigated in order to find a shorter tube. ITT worked on a magnetic focused image converter tube. An early attempt with a demagnification tube did not produce enough gain (Figure 9). Westinghouse tried a thin film secondary emission tube with magnetic focus (Figure 10). Its work was sponsored not only by us, but by the Air Force, AEC, and Carnegie Institution of Washington. The tube was shorter, but had too many problems for Army applications. Machlett Laboratories worked on a light scan tube. GE and Bendix also tried other tube designs. None of these approaches was satisfactory for military applications.

1958

Mosaic Fabrications, Inc.
★ J. W. (Will) Hicks

During an Optical Society meeting in New York, John Johnson heard a presentation on fiber optics and decided that this was the solution to our three-stage cascade image tube problem. Use of a fiber-optic interface instead of the thin flat glass film would result in a smaller tube since the surfaces of the fiber-optic plates could be shaped to match the electrostatic focal planes (Figure 11). At the conference, he

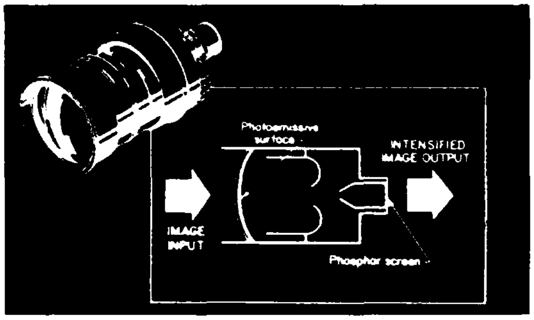

Figure 9. Demag-nification Tube

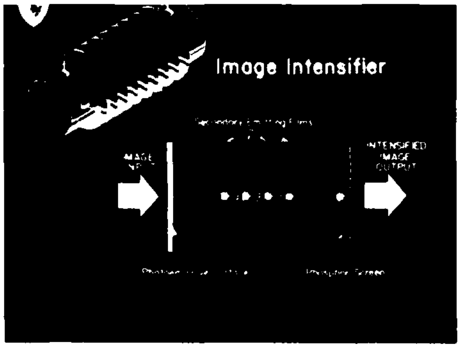

Figure 10. Thin Film Secondary Emission Tube

discussed this idea with American Optical people. Although they were not interested in such a venture, they referred him to J. W. (Will) Hicks, who had recently left them to form Mosaic Fabrications, Inc.

John talked to Will and peaked his interest. He went on to became one of the keys to the success of the Night Vision program. Will began as a truly small business, operating out of his garage, pulling the glass fibers by winding them around a drum attached to the axle of a jacked-up car. First, Will proved that he could make the fiber-optics vacuum tight. Then, Johnny calculated the tradeoffs needed for obtaining resolution, minimizing crosstalk, and optimizing transmission; and Will modified the fiber diameter and adjusted the darkness and thickness of the cladding as required. His development of the fiber-optic plates made the three-stage cascade image tube useful to the military.

Warfare Vision Branch

In the summer of 1958, Ben Goldberg transferred to manage Mine Detection and I took

INTENSIFIER TUBE

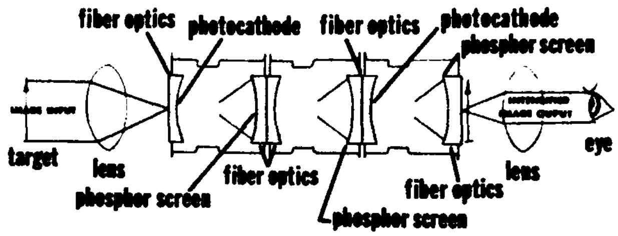

Figure 11. Three-Stage Cascade Tube with Fiber Optics Coupling

over management of the Branch. We changed its name to the Warfare Vision Branch to emphasize the ultimate objective of our work and decrease emphasis on identification of specific technology and equipment. Of course, the Army medical people did not like the word "vision" in our name since that was their area of responsibility.

The total Branch budget of $600,000 ($2.6 million in 1991 dollars) covered research as well as lighting and NIR systems development including:

1) Floodlighting kits, NIR beacon, and a light glide angle indicator to establish safe landing approach for aircraft
2) 30-inch carbon arc searchlight (Figure 12) to replace the 60-inch searchlight
3) NIR/visible tank kit consisting of:
   - Tungsten searchlight with NIR shutters to change from visible to NIR (Figure 13)
   - Gunner's and commander's NIR/ visible periscopes (Figure 14)
   - Commander's hand-held NIR binoculars (Figure 15) for open hatch viewing
   - Driver's NIR periscope
4) Helmet-mounted NIR binoculars (Figure 16) used with NIR filtered lights for driving and manual tasks
5) NIR image metascope (Figure 17) for detecting the enemy's NIR sources and for closeup viewing with its own NIR source

6) Lighter weight NIR weapons sight (Figure 18) to replace the heavy sniperscope.

The Branch was also developing a pulse-gated infrared ranging and detection device that would provide range finding for surveying (this was before lasers).

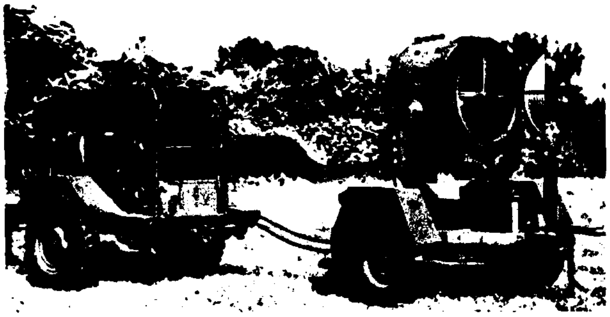

Figure 12. 30-Inch Searchlight

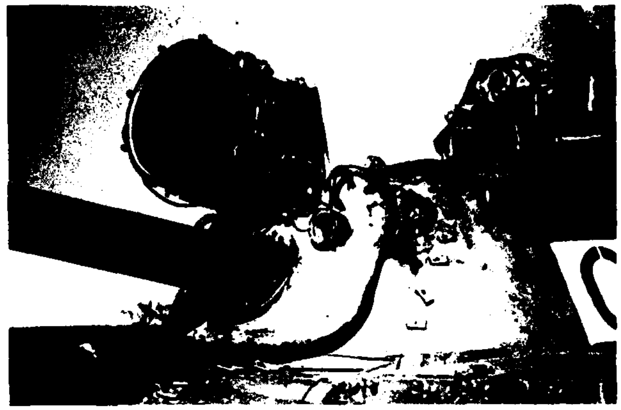

Figure 13. Tank Tungsten NIR/Visible Searchlight

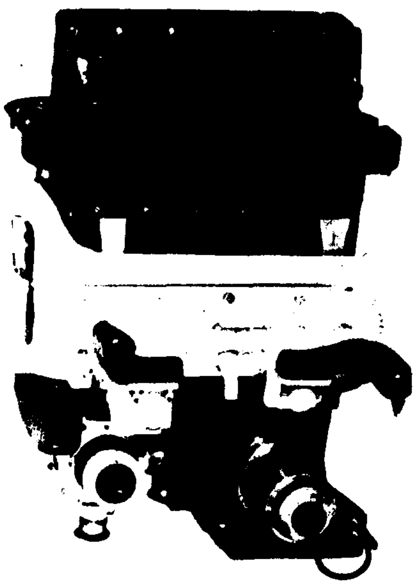

Figure 14. Tank NIR/ Visible Periscope

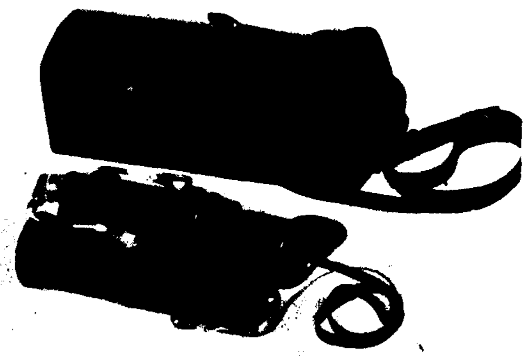

Figure 15. Tank Commanders Handheld IR Binoculars

Figure 16. Helmet-Mounted NIR Binoculars

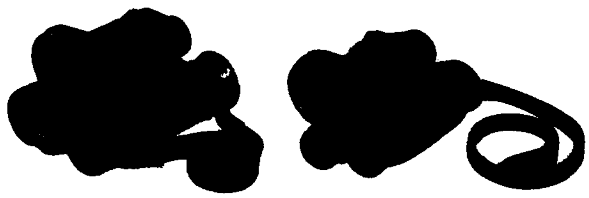

Figure 17. NIR Image Metascope

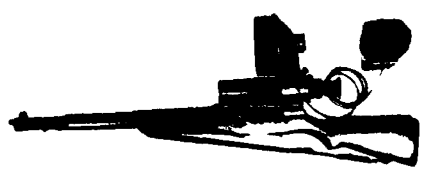

Figure 18. NIR Weapons Sight

Visionics
★ John Johnson

At that time, not much was known about translating field requirements into technical needs for resolution, contrast, and gain. In 1950, Howard Coleman at the University of Texas suggested to Ben Goldberg the use of line pairs as a means to evaluate sniperscope performance. Howard had used this technique in his atmospheric optics studies. Dr. Richard Blackwell, Project Michigan, was building a terrain board and studying the problem, but we could not wait.

In 1957-1958, anxious to have some guidelines for our own research, John Johnson expanded on the line pair concept and conducted some fundamental tests with in-house observers matching thresholds of seeing scale model targets, silhouette targets, blobs of equal area, and resolution patterns under varying conditions on his optical bench. He determined the number of line-pairs across a target for detection, orientation, recognition, and identification (Figure 19). It provided the basis for all our research and development activities.

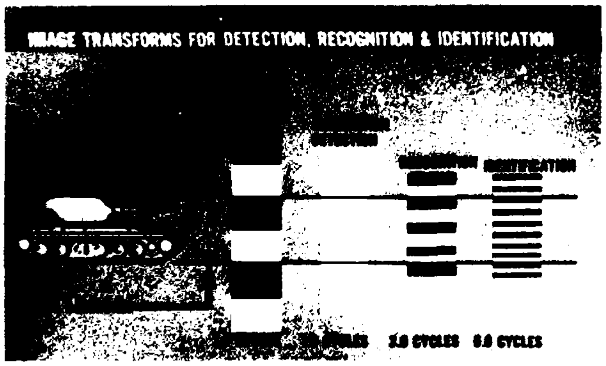

Figure 19. Johnson Criteria

His results were presented at our first Image Intensifier Symposium, 6-7 October 1958. The real significance of his work was not recognized until almost five years later and is recognized as the Johnson Criteria, which have been widely used ever since.

Imperial College of Science, London University
★ Professor J. D. McGee

In November 1958, I toured Europe to research what others in the industry were doing. Professor McGee was conducting research on a variety of image tubes, including a channel image intensifier. Channel intensifiers were not practical because the channels could not be made small enough to get good resolution. I was impressed that his college students were making photocathodes and prototype tubes in rustic laboratory facilities. We had not considered it feasible for us to do such work in house, but seeing Professor Magee's activity initiated thoughts of what could be done in our in-house facilities if we had the funds.

Observatoire d'Paris
★ Professor A. Lallemand

A visit to Professor Lallemand set the stage for future events. He made a photocathode in a glass bulb, tested it, inserted it in a telescope, evacuated the chamber containing the bulb and photographic film, and broke the bulb to allow the photoelectrons to impinge onto photographic film. He lost the vacuum when he changed the film and had to replace the photocathode frequently, but he had overcome the poor yield problem caused by photocathode uncertainties – a good idea for future use.

Corps of Engineers Headquarters
★ Clifford Spilker

Based on demonstrations of the cascade tube, the Corps of Engineers responded by increasing our budget from $600,000 to $1.8 million in 1959. Cliff Spilker was the action officer at Headquarters who provided support and kept the books well into the late 1960s. His noninterference support was a major factor in our success. Those in charge of the R&D budget deserve a lot of credit for supporting these night vision efforts although they did not actually support the Corps main line of activity, e.g., combat vehicles, bridging, and electric power. Further, they supported us in constant battles with the Ordnance Corps, who tried to stop our "fire control" activity, and with the Signal Corps, who tried to stop our "electronics" activity.

1958 - 1960

By 1960, the Branch had 32 stars, the foundation for the development of the image intensifier families of Night Vision equipment and searchlights (Table 1).

Table 1. 1958 – 1960 Stars

Warfare Vision Branch	
★ Robert Wiseman	
★ Marge Hyer	
★ Joyce Holland	
Visionics	Light Sources
★ John Johnson	★ Stan Segal
★ Joe Bunor	★ Steve Gibson
★ Gil Burroughs	★ Art Dauray
★ Earl Bienz	★ John Schmidtlein
★ Alan Dobras	
	Developments
II Research	★ Bucky C. Freeman
★ Mike Klein	(Components)
★ Wilbur Liebson	★ Isadore Kessler
★ Ernie Meredith	★ Russ Vass
★ Neil Swanson	★ Clarence Johnson
★ Jim Parton	★ Grady Stowe
★ John Moody	(Systems)
★ Bill Jarvis	★ Charlie Charlton
★ M. Twiford	★ Ken Cooper
★ Audry Newton	★ Harrie Johnson
	★ Ed Sheehan
	★ Jack Hildreth
	★ Larry Hyer

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Friends

Since Army funding was limited, we became entrepreneurs and convinced scientists in other organizations to invest in our contracts. From 1954 to 1957, we received more money from the Air Force, Navy, AEC, astronomers, and others than we did from the Army. We managed the contracts and distributed copies of the intensifier tube research to the sponsors.

Mike Klein and Jim Parton took the Image Intensifier Orthicon system to Mount Palomar for Bill Baum to try on the 36-inch telescope. One of the astronomers remarked that they had accumulated more data in that one night than in three months using conventional methods.

Now that the budget had been increased, we brought the community together and took stock of the state of the art in image intensifiers. We held the first Image Intensifier Symposium on 6-7 October 1958. In addition to the industrial tube developers, there were papers on:

Astronomy
- ★ Dr. W. A. Hiltner, Yerkes Observatory;
- ★ Professor Lallemand, Observatoire d'Paris
- ★ Dr. Radames K. H. Gebel, Wright Air Development Center
- ★ Dr. John S. Hall, Lowell Observatory

Nuclear Physics
- ★ Dr. George T. Reynolds, Princeton University

Radiology
- ★ Lee B. Lusted, MD, University of Rochester
- ★ J. J. Van der Sande, Old Delft Optical Company

University Research
- ★ Professor J. D. McGee, Imperial College of Science, London University

The second Image Intensifier Symposium was held in October 1961, which set the precedence for the current Night Operations Symposia.

The Night Vision Team

The Branch learned to work as a team. The individual stars came together by recognizing and relying on each other's talents. They developed mutual respect and interdependence, which made for an unbeatable team. Each participated and contributed to the overall goal. This is now called "high performance work environment."

There were a lot of informal strategy sessions. The needs were still considerably bigger than the new budget. Planning was done by those responsible for the work, and plans were drawn on the blackboard and flip charts. There were no formally documented plans, but all knew where we were going and how their efforts fit into the big picture. All were dedicated and true believers in our product being of key benefit to the soldier.

Another key activity was frequent night demonstrations and field tests in which all participated. This gave the researchers and developers practical experience on what it was like to operate in darkness and experience field problems from the soldiers' points of view. It motivated us all, and the vertical integration structure enabled the Branch to focus needed talent on critical problems.

1961

Institute for Defense Analysis
★ Lucien Biberman

John Johnson expanded his visionics activities and developed an objective method of measurement of modular transfer function (MTF). He began experiments dealing with field problems such as search and atmospheric effects. Luke Biberman started his involvement with our Night Vision activities. He provided valuable stimulation by his observations and challenges that kept us on our toes and striving for a better understanding of the factors affecting system performance under field conditions.

Systems Evaluation
★ Jack Hildreth
★ Larry Hyer
★ Warren Robinson
★ Paul Travesky
★ Jack Lee
★ Bill Metz
★ Jimmy Clodfelter

To have objective testing and provide technical feedback, the Systems Evaluation section was formed under Jack Hildreth. Jack's team of experts were able to evaluate the systems from a soldiers' and TECOM point of view. They also provided essential design assistance to the developers and technology objectives to the researchers. The Systems Evaluation people developed excellent relationships with the users in the field and supported many exercises as well as activities in Vietnam and other critical operational areas. This kept the Branch in tune with the needs of the soldier. They were the conscience of the organization.

Office of Chief of Research and Development (OCRD)
Department of the Army
★ COL Gordon A. Schraeder

A major event in 1961 was when COL Schraeder became the Night Vision Action Officer at OCRD. During his orientation, we fascinated him with our present and future dreams. He arranged for LTG Arthur G. Trudeau, Chief, Research & Development for the Army, to come to a night demonstration where he saw the image intensifier prototype equipment in action and saw white wooden models of our dreams. COL Schraeder was a crusader and a champion to our programs.

Limited War Study
★ Dr. Luis Alvarez

President Kennedy had directed the Army to do a study on how to fight a limited war. The noted Dr. Luis Alvarez was the chairman. The committee conducted its investigation and came to the following conclusions:

1) Night Vision was critical to the Army in fighting limited warfare.
2) The Army did not have a program to satisfy this need.
3) The Army should be buying industry items off the shelf.

COL Schraeder intercepted the report and alerted Dr. Alvarez that LTG Trudeau had recently visited the Army's Warfare Vision Branch, but the report had ignored this activity. COL Schraeder also told him that the Warfare Vision Branch had ideas for other nonfunded activities. COL Schraeder arranged for Dr. Alvarez to meet with me the day prior to briefing LTG Trudeau.

Johnny and I briefed Dr. Alvarez on what we were doing and where we wanted to go but couldn't because of our limited $1.6 million budget. Dr. Alvarez turned to MG Power, LTG Trudeau's deputy, and told him that this was exactly the program the Department of the Army needed and questioned why the Army wasn't supporting us. MG Power instructed me to lay out the details and return to brief LTG Trudeau. Dr. Alvarez advised that if we knew five approaches to problem solving, we should initiate all five for a year or two, then narrow it down to two or three.

★ John Johnson
★ Mike Klein
★ Bucky Freeman
★ Stan Segal
★ Carlyle (Charlie) Charlton

We spent that weekend laying out our plan. Although there were no formal military documents to support this effort, this was not a serious handicap since we had been well indoctrinated into the soldier's needs (Figure 20).

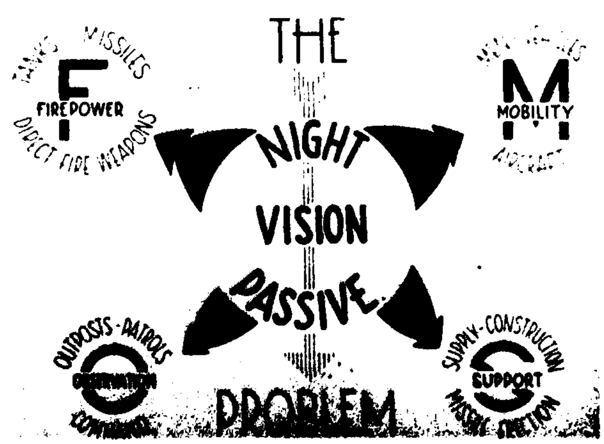

Figure 20. Limited War Briefing – 1961

We conceived that the Army needed systems as soon as possible (within two years), even though they were too large, too heavy, and overall not perfect; hence, the first generation of image intensifier systems was born (Figure 21). In order to expedite development, minimize cost, and simplify logistical support, commonality was the rule.

There would be a Small Starlight Scope (Figure 22) used as an individual weapon or as a handheld viewer. The same 25 mm cascade intensifier tube, power supply, and body would be used with larger optics and a different reticle for a crew served sight.

PROGRAM GOALS for 1ST GENERATION EQUIPMENT

OBSERVATION FIREPOWER MOBILITY SUPPORT

ARMORED VEHICLE DEVICES
WEAPON SIGHTS
OBSERVATION SCOPES
REMOTE VIEW OBSERVATION SYSTEM

COMPLETED FY 1964

Figure 21. First Generation Image Intensifier Program

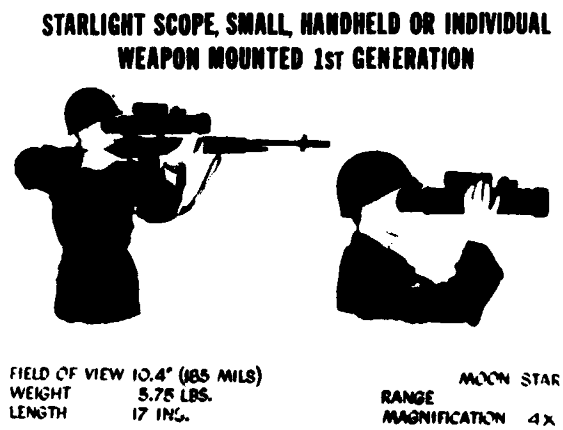

Figure 22. First Generation Small Starlight Scope

There would be a Night Observation Device, Medium Range (Figure 23) , that would be passive and use a 40 mm cascade intensifier tube. A viewer with the same type tube but with an NIR photocathode and light source would be used for the Night Observation Device, Long Range.

Simultaneously, there would be research to solve the problems that would allow smaller, lighter, and better systems; hence, the second generation family with type classification three to five years later (Figure 24). This family was illustrated by the use of white wooden models. The second generation, Small Starlight Scope, was smaller, lighter, and provided the desired viewing range (Figure 25). Similarly, there was a second-generation starlight scope for crew served weapons. Using the same tube, there were also Hand-Held Starlight Binoculars (Figure 26) and second-generation Night Observation Devices, Medium and Long Ranges (Figure 27).

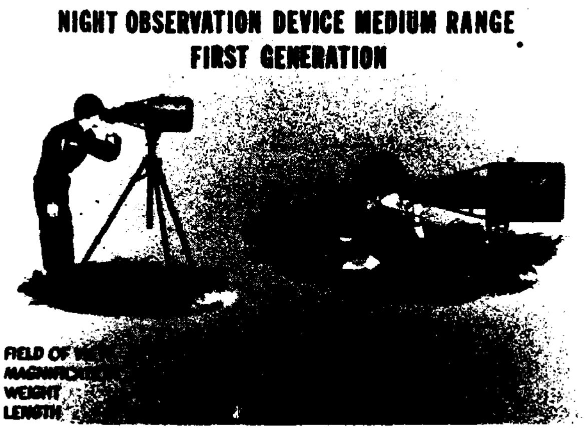

Figure 23. First Generation Image Intensifier Program

BY FY 1967

2ND GENERATION EQUIPMENT

CRITICAL COMPONENTS

WAFER IMAGE INTENSIFIER TUBE
SPECIAL OPTICS — LASER ILLUMINATOR

MAJOR TASKS

PHOTOCATHODES — PHOSPHORS
MICRO CHANNELS — SECONDARY EMISSION SURFACES
WAFER-TUBE MULTIPLE APPROACHES
LASERS

FUNDING (MILLIONS)

	FISCAL YEARS 1962	1963	1964	1965	1966	1967
RESEARCH	27	23	26	22	20	C
COMPONENTS	02	03	12	13	14	04
EQUIPMENT	C	03	07	12	16	11
TOTAL	29	29	45	47	50	15

(FOR OFFICIAL USE ONLY)

Figure 24. Second Generation Image Intensifier Program

Figure 25. Second Generation Small Starlight Scope

Figure 26. Second Generation Night Observation Device

Figure 27. Second Generation Handheld Binoculars

The smaller second generation intensifier tube would permit building head-mounted Night Vision Goggles (Figure 28), which could be used for driving and many other tasks. Although helicopters had been flown experimentally with the old NIR helmet-mounted binoculars, restrictions made it impractical. These passive goggles would provide this capability under high levels of illumination. It would take another generation photocathode to really make the use of the goggles widespread for aircraft night operations. Simultaneously, there was to be research that would lead to a third generation of night vision devices.

We had a three-phase plan with multiple approaches to exploit our ideas for IIs to provide passive operation using the light from the night sky, stars, moon, and other stray radiation. All bases were covered. When we totalled the cost, we were stunned to see an annual budget of $7 million over 7 years (Table 2). It did not seem feasible to increase our $1.6 million budget by $6.2 million instantaneously, but we had followed Dr. Alvarez's instructions and couldn't find anything that should be eliminated.

Management had always given me complete freedom in my dealings with Army Headquarters. Mr. Cleaver and ERDL management had let me go forth without review. As long as I kept Cliff Spilker informed of where I was going and what the results were, he kept the Headquarters from interfering. However, with this big of an impact, I thought it wise to go through channels to let everyone know what I was about to tell LTG Trudeau.

Mr. Cleaver thought it impossible, but let me go on to the Corps of Engineers Headquarters. Mr. Bill New, Chief Scientist, thought that I was out on cloud nine, but he let me go on without any changes. At OCRD, I found myself alone with COL Schraeder and a room full of generals and colonels assembled for my presentation. Afterward, they could not understand why we had not been supported all along.

Figure 28. Second Generation Night Vision Goggles

Table 2. Budget for Night Vision Limited War Program

Passive Night Vision
Required Funding
($ Millions)

FY	1st Gen	2nd Gen	3rd Gen	Total
62	2.7	2.9	0.6	6.2
63	4.0	2.9	1.2	8.1
64	0.8	4.5	2.2	7.5
65		4.7	2.2	6.9
66		5.0	2.5	7.5
67		1.5	5.8	7.3
68			7.2	7.2
Total	7.5	21.5	21.7	50.7

G108-0340-02

OCRD, DA
★ LTG Arthur G. Trudeau

Special Forces
★ COL Donald Blackburn

A few of the key officers were in the room when I briefed LTG Trudeau. After he heard our three generation plan, he asked for comments and everyone agreed that we should be supported. He agreed but said that because of his reprogramming limits he could only add $5 million to our $1.6 million budget for FY62.

Since it would take some time to reprogram funds, he instructed us to go ahead and start the paperwork for the new contracts and he would have the funding to us by the time the contracts were ready to go on the street. COL Blackburn, Special Forces promised to get us $1 million the next week and he did.

Since we needed more manpower, LTG Trudeau alerted the manpower people to increase our authorization ceiling. He got the Corps of Engineers to send an architect to start plans for the new Building 357. And, he arranged for me to go to CONARC to tell them what it was we were going to do for them so that they could support this effort with formal requirements.

1961 - 1965

CONARC/CDC

★ MGen VanNatta
★ Major Werhle
★ Major Badger
★ Major Ellis
★ Major West

At CONARC, I expected to brief MG VanNatta, but instead, I faced an auditorium full of CONARC officers. After my briefing, MG VanNatta told his officers that he was fully behind the plan and that it was their job to prepare the military requirement documents to support it.

CONARC helped with contract requirements and was party to tradeoffs such as magnification, field of view, and reticle patterns. They wrote the user requirement documents simultaneously with our contract development. The CONARC/CDC/TRADOC team players were key to the success of the program.

1961

★ Mike Klein
★ John Johnson
★ Bucky Freeman
★ Stan Segal
★ Jack Hildreth

The success of the Image Intensifier program was due to the contributions of many stars, both in house and on contract (see Table 3). In 1961, Mike became my deputy and John managed both the Image Intensifier research effort and visionics. Bucky Freeman led the tube and system developments and Stan continued with light sources. Jack Hildreth led the systems evaluation, which provided an objective evaluation of our product. Many stars have been added.

Table 3. 1961 Galaxy

Warfare Vision Branch

★ Robert Wiseman
★ Mike Klein
★ John Adamitis
★ Helen Donahue
★ Howie Edberg
★ Marge Hyer
★ Joyce Holland

Visionics

★ John Johnson
  ★ Joe Bunor
  ★ Gil Burroughs
  ★ Earl Bienz
  ★ Alan Dobras

II Research

★ John Johnson
  ★ Bill Liebson
  ★ Ernie Meredith
  ★ Neil Swanson
  ★ Jim Parton
  ★ John Moody
  ★ Bill Jarvis
  ★ M. Twiford
  ★ Audry Newton
  ★ Alvin Schnitzler
  ★ Walt Lawson
  ★ John Leslie
  ★ Carl Thomas
  ★ Stan Carts
  ★ Herb Stahl
  ★ Joe Kervitsky
  ★ Kenny Kaldenbach
  ★ Harry McQuary

Light Sources

  ★ Stan Segal
  ★ Steve Gibson
  ★ Art Dauray
  ★ John Schmidtlein
  ★ Art Hook

Developments

★ Bucky Freeman

(Components)

  ★ Isadore Kessler
  ★ Russ Vass
  ★ Clarence Johnson
  ★ Grady Stowe
  ★ Carl Hoover
  ★ John Perample
  ★ Ron Colangelo

(Systems)

  ★ Charlie Charlton
  ★ Ken Cooper
  ★ Harrie Johnson
  ★ Ed Sheehan
  ★ Jim Updegraff
  ★ Joe Carter
  ★ Dave Anderson
  ★ John Yanagi
  ★ Ronald Uhler
  ★ Bob Stone
  ★ Tom Moore
  ★ C. Deane

Systems Evaluation

★ Jack Hildreth
★ Larry Hyer
★ Paul Travesky
★ Warren Robinson
★ Bill Metz
★ Jack Lee
★ Jimmy Clodfelter

G108-0340-03

First-Generation Fiber Optics Cascade Image Intensifier Tube

The key to success was the cascade image intensifier tube. (This was one of the first practical uses for fiber optics.)

In accordance with Dr. Alvarez's guidance, we used multiple approaches. In addition to RCA who was developing the fiber-optic cascade tube, we added Westinghouse, CBS (Bernie Linden), Rauland (Wilfrid Niklas), and at the last minute, Machlett Laboratories. Fiber optics were developed by Mosaic Fabrications (Will Hicks) and Chicago Aerial.

We awarded separate contracts for the various components and managed their development, use, and integration with monthly meetings in which the various contractors described their progress and problems. Explicit direction was not given to the contractors, but they were able to proceed using the knowledge and experience gained by others.

Machlett Laboratories

★ Sam Yanagisawa

Sam Yanagisawa led the group at Machlett and was the most successful in developing the cascade tube. Charlie Robbins and Marty Rome were also at Machlett. Sam is certainly one of the stars responsible for the success of the first generation.

Even though the production engineers had been separated from us, we were still concerned about the producibility of our product. In the conventional way of making image tubes, all the parts were assembled and evacuated, and then the three photocathodes were formed by evaporating the elements onto the three photocathode face plates. This is called a photocathode internally processed (PIP) tube (Figure 29). If any of the photocathodes failed, the tube was scrapped or disassembled with loss of parts.

Figure 29. PIP Image Intensive Tube

Recalling my visit to Professor Lallemand in 1958, Machlett was given the challenge of developing a manufacturing process that allowed the photocathode to be formed on the face plate, tested, and moved in a vacuum to be assembled with the rest of the tube parts. Machlett was successful in making the Externally Processed Image Converter (EPIC) tube (Figure 30). Each stage was made separately, photocathodes were formed, and good stages assembled into the complete three-stage cascade tube. This significantly increased the yield and reduced cost.

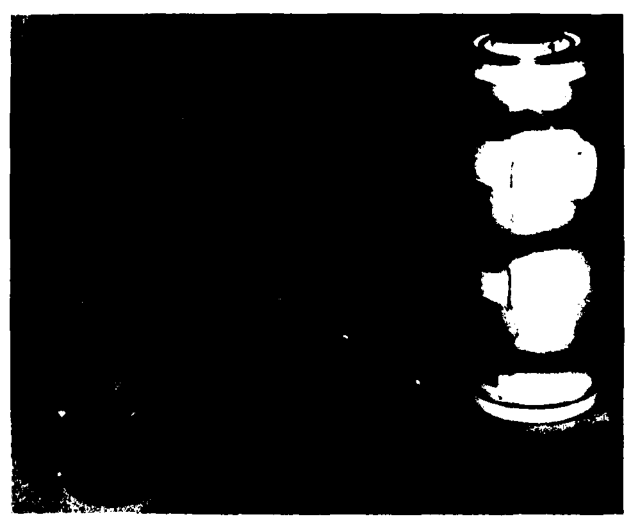

Figure 30. EPIC Image Intensifier Tube

Other Stars

★ Ledge Kastner, LK Engineering

There were many problems to be solved and many contractors made key contributions. For example, although the tube was a success when operated with a laboratory power supply, there was a major problem when it was connected to a small power supply from a military viewer. There could be no voltage across the fiber-optic interfaces, and the voltage distribution for each stage must remain constant. Originally, voltages changed as current load varied. This small but critical problem was solved by Ledge Kastner when he used the Cockcroft-Walton design for the voltage divider.

First Generation Image Intensifiers (1964-65)

★ Charlie Charlton
★ Bob Uhler
★ Ed Sheehan
★ Bob Stone
★ Roger Koren
★ Jim Updegraff
★ Jim Parton
★ Dave Helm
★ Howard Graves
★ Jim Hearn
★ Bobbie Bradshaw
★ Bill Jarvis
★ Isador Kessler
★ Grady Stowe
★ Carl Hover

The first generation family was developed within approximately two years. It provided the interim capability needed until the improved second generation family was developed. Following are the in-house stars responsible for establishing the requirements and directing the contract efforts.

Charlie Charlton and Bob Uhler developed the Small Starlight Scope (SSS) (Figure 31), and the Night Vision Sight for Crew Served Weapons (NVS, CSW) (Figure 32). Image intensifier tube, power supply, and housing were identical with only changes in optics, reticles, and mounting brackets for the different weapons.

Ed Sheehan and Bob Stone developed the Night Observation Device, Medium Range (NOD, MR) (Figure 33). Roger Koren helped get it into production.

Figure 31. First Generation Small Starlight Scope

Figure 32. First Generation Crew Served Weapons Sight

Figure 33. First Generation NOD, Medium Range

One of the problems encountered in the field with all of the first systems was that the spill light from the phosphor lit up the soldiers face. Bob Stone deserves special credit for adapting a bathroom plunger flap idea to the eye shield used on all image intensifier systems to block out the light from the phosphor until the flap is opened by pressing it in by the forehead.

Jim Updegraff was responsible for the NOD, LR 1 1/2 generation, which was similar to the NOD, MR, but used an NIR photocathode and an auxiliary invisible light source to extend the range (Figure 34).

Figure 34. First Generation NOD, Long Range

Jim Parton, Dave Helm, Howard Graves, Jim Hearn, Bobbie Bradshaw, and Bill Jarvis developed the remote view tubes and systems. These were made for ground observation and placed in pods and mounted on helicopters in Vietnam as shown in Figure 35.

Figure 35. Tank Xenon Searchlight

The image intensifier tubes, Figures 29 and 30, and power supplies were developed by Bucky Freeman's organization with particular accolades to Isadore Kessler, Grady Stowe, and Carl Hoover.

Light Sources
★ Stan Segal
★ Steve Gibson
★ Art Dauray
★ John Schmidtlein
Searchlights
★ Ed Sheehan
★ Tom Moore
★ Jack Lee
★ Don Merritt
★ PFC Joe Morales
Reflectors
★ Bill Erbe
★ Alan Bradford

While image intensifiers were being developed, the light source problems were solved by Stan Segal and his group who worked with Hanovia and Duro Test and brought the xenon lamp out of the theatre and made it a military item. The 2.2 kW xenon lamp provided the much improved NIR visible xenon searchlights widely used on tanks, jeeps, and aircraft.

There were multiple approaches for a new NIR/visible tank searchlight: Strong Electric was developing a new carbon arc version; Westinghouse was developing a mercury arc; and GE a xenon arc version. The carbon arc and mercury arc versions were unsatisfactory. After GE's failure, development of the 2.2 kW xenon searchlight (Figure 36) was brought in house and developed for production using concurrent engineering with Stan Segal's group of Steve Gibson, Art Dauray, and John Schmidtlein improving the lamp, Ed Sheehan's group of Tom Moore and Jack Lee doing system design and management, and Don Merritt and PFC Joe Morales assisting from Production Engineering. The ERDL shops and drafting personnel provided assistance.

SEARCHLIGHT 2.2 KW IR VISIBLE

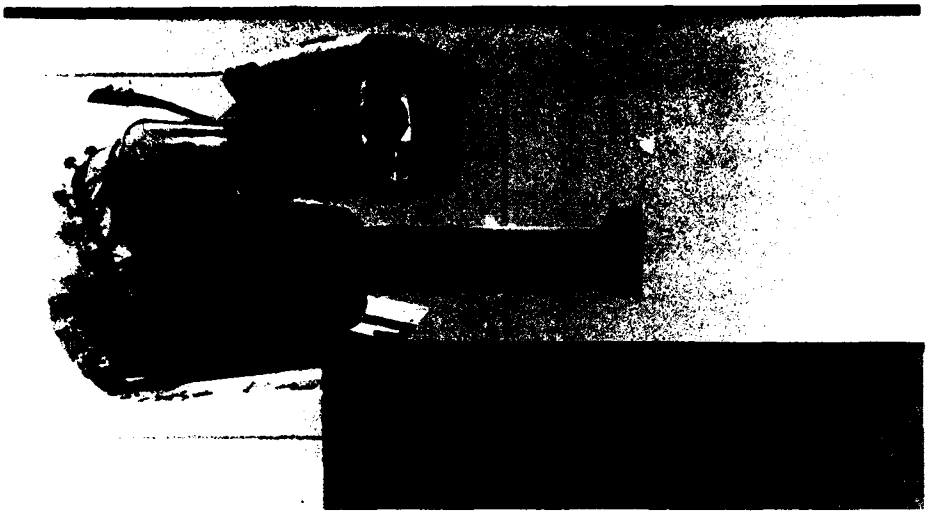

Figure 36. Tank Xenon Searchlight

The reflector was made in house by Bill Erbe and Alan Bradford from the Physics Research Branch. Lamps were obtained from Hanovia (Dr. Otto Lienhard and Dr. Kashmiry) and Duro Test (Dr. Tourret), filters from Metavac and heat exchangers from Train. The igniter for the lamp was built in-house by PFC Joe Morales. This development was particularly demanding because it was under the purview of the M60 tank program manager. This provided the organization with many valuable lessons learned since we had to do what a contractor normally has to do: design, fabrication, test, and documentation.

The searchlight was an approved requirement for the M60 tank and although COL Birney, Project Manager, didn't agree with having a searchlight on the tank, he always believed in strict adherence to requirements. The lamp had to start at -65° F from 18 to 24V. The low voltage was required for "silent watch" with the engine not running. Of course, if the searchlight was operated for any length of time, they would never be able to start the tank engine. Then, it had to stand fording under five feet of water with a five-knot current. We eventually solved these problems and passed the tests, but there were numerous failures with other parts of the tank, especially at -65°F temperatures and fording streams.

It was our first exposure to working with a project manager. COL Birney insisted upon complete attention to detail, and by doing all of the systems integration and documentation in house, our expectations for future contractor performances were raised. When the searchlight went to the Army's Test & Evaluation Command (TECOM), it passed with flying colors, and COL Birney had no choice but to accept it. Thanks to COL Birney for insisting on perfection and setting high standards.

Transition from Development to Production

As we neared completion of development of the first generation image intensifier systems in 1964, one of my major concerns was how to get the Application Engineering department on board and push this new family of systems into production. Since 1957, it had grown apart from the development activity. While we were developing this new family of passive image intensifiers, they were working on product improvements to the NIR weapon sight, which would soon be obsolete. I could not get their attention focused on the new problems that they would be fa ng with the image intensifiers. COL Schraeder shared my concern, and he encouraged LTG Betts, CRD, to write a letter to AMC suggesting all production engineering be put under my control as a Program Manager. Since it was presumptious to tell AMC who to appoint, my name was left out of the letter. Since AMC only had "Project Managers," they thought the title "Program Manager" was used in error, and they established a Project Manager.

Project Manager, Night Vision
★ COL John Schremp

AMC designated COL John Schremp as Project Manager for Night Vision. This was fortuitous since a military program manager was just what we needed to introduce this first generation family into Vietnam and create a distribution and logistics system to support it.

The first generation was conceived just for such an eventuality as Vietnam. Although the equipment was heavier and bigger than ultimately desired, it performed better than advertised. It has been credited along with the helicopter as having a major effect on the way war is fought. It "took the night away from Charlie." During my visit to Vietnam, many comments were heard on how many lives this Night Vision equipment had saved by allowing our troops to observe the Viet Cong operation at night. It not only eliminated surprise attacks, but enabled our troops to take preemptive actions.

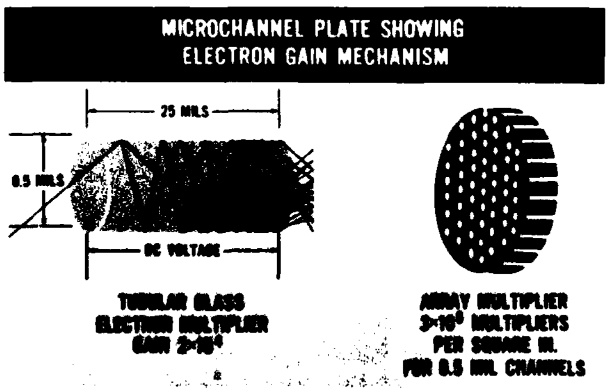

Figure 37. Microchannel Plate

Microchannel Intensifiers
★ John Johnson
★ Will Hicks
★ Professor Magee
★ Professor Lallemand

As planned, while developing the first generation family, research was being conducted on the second generation components. The second generation image intensifier family depended upon the development of a much smaller tube. The concept was based upon the ideas that I had picked up from Professors Magee and Lallemand on my trip in 1958.

Professors McGee, Bendix, and others had attempted to make channel image intensifiers but they were not practical. The channels had to be small and closely spaced so as to retain the image resolution (Figure 37). Again, John Johnson had the idea and Will Hicks executed it. John conceived that if the fiber cores could be etched out of a fiber-optic plate, the result would be a plate of microchannels that would be small enough to retain image resolution (Figure 38). How to get the secondary emission material on the walls of the microchannels was a problem for the future. When Johnny asked Will if it could be done, Will didn't see why not. When he returned in a couple of weeks, he had done it but could not clean out the residue left on the channel walls. Fortunately, this residue had secondary emission properties. Of course, there was a lot more work to do to optimize the microchannel, but it showed that we were on the right track.

Figure 38. Etched Fiber Optics

The next issue was how to make an image tube with a microchannel in it. We wanted a wafer tube with only a small gap between the microchannel plate and the photocathode on one end and the phosphor screen on the other (Figure 39). However, standard fabrication of image tubes with photocathodes internally processed was not feasible. For the microchannel tube, it was essential to use the external processing technique that Professor Lallemand had shown me in 1958, and that had been perfected by Machlett Laboratories for the first-generation EPIC tube.

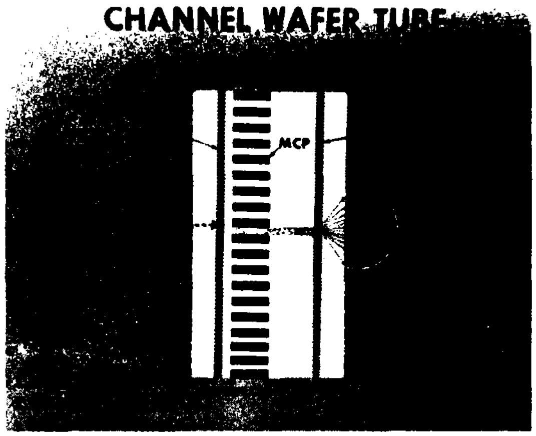

Figure 39. Wafer Intensifier

Combat Surveillance & Night Vision Management Study

★ Honorable Willis Hawkins, ASA (R&D)
★ General Frank Besson, CG, AMC

In 1964, Dr. Eugene Fubini, DDR&E, requested the Army develop a plan for strengthening the Combat Surveillance & Target Acquisition (CS&TA) activity at Fort Monmouth. As a result, in 1965, the Honorable Willis Hawkins, Assistant Secretary of Army (R&D) and General Frank Besson, CG, AMC, suggested that I transfer to become Director of the CS&TA Laboratory, which was part of the Electronics Command (ECOM). They also directed that a study be made of how Night Vision and CS&TA should be managed.

As a consequence, the Warfare Vision Branch, which I had led, was combined with the FIR Branch and Physics Research Branch to form the Night Vision Laboratory (NVL); and it was transferred to ECOM and placed under my management in combination with the CS&TA Lab. Key to the success of this management decision was that the Night Vision Laboratory was not physically moved but remained at Fort Belvoir while the CS&TA Lab remained at Fort Monmouth. It was recognized that movement of either would have caused personnel losses that would seriously impact performance.

Night Vision Laboratory Established – 2 November 1965

Ben Goldberg returned home to Night Vision from Mine Detection (Barrier & Intrusion Detection) Branch to become my deputy for Night Vision (Table 4). Mike Klein was the Associate Director and perpetuated the management philosophies developed over the years. John Johnson managed both the image intensifier and visionics technologies; Stan Segal, the light source technology; Dr. Werner Weihe, FIR; Dr. Georg Hass, physics research - thin film technology; Bucky, the advanced development component activity. Ed led the systems development activity that interfaced with the user and used whichever technology was appropriate for the application, and Jack managed the systems evaluation activities. The FIR group was rapidly assimilated and was imbued with the same esprit de corps as existed in the Warfare Vision Branch. Of special significance was the consolidation of all systems developments under Ed Sheehan. His group examined the military problem and selected the optimum technological solution. This allowed the Laboratory to present a consolidated/coordinated program of developments. They built many prototypes in house for evaluation. They accelerated engineering developments. This set the stage for the future.

Table 4. Night Vision Laboratory (Established 2 November 1965)

Night Vision Laboratory
- ★ Dr. Robert S. Wiseman, Director
- ★ Benjamin Goldberg, Deputy
- ★ Myron (Mike) Klein – Associate Director

Visionics & Image Intensifier
- ★ John Johnson

Far Infrared
- ★ Dr. Werner Weihe

Light Source
- ★ Stanley Segal

Thin Film
- ★ Dr. Georg Hass

Advanced Developments
- ★ Charles F. (Bucky) Freeman

Systems Development
- ★ Edward Sheehan

Systems Evaluation
- ★ Jack Hildreth

G108-0340-04

Army Night Vision Growth

In 1965, the total budget was $11.2 million and Night Vision activities had grown from their 1954 level (see Table 5).

Table 5. Army Night Vision History

	January 1954	December 1965
Warfare Vision	23	117
Far Infrared	17	23
Physics Research	7	10
Lab Subtotal	47	150
Funding	$1.0M	$11.2M
Drafting Security & Gen Admin	?	14
Lab Grand Total	47	164

G108-0340-05

When the long range plan was made for LTG Trudeau in 1961, it focused on image intensifiers and did not include FIR. In fact, care was taken not to overlap into their portion of the spectrum. Now with this reorganization, the FIR activities became integrated into the overall planning for Night Vision and use of FIR became a technology option for the systems engineers.

OCRD

★ COL Edwin S. Townsley

COL Edwin S. Townsley had taken over as the Night Vision Action Officer from COL Schraeder in 1964. He was equally effective in sponsoring the Night Vision cause at The Department of Army (DA) headquarters and was a bright star in the Night Vision history from 1964 through 1967. All of this growth could not have happened without these two champions of Night Vision at DA.

1966

SEA NITEOPS

★ MG Jack Guthrie, Director Developments, OCRD (Office Chief of Research & Development), Department of Army

One day in 1966 while in the Pentagon visiting COL Townsley, Ed said, "Come with me. General Guthrie wants to see us." MG Guthrie was trying to get funding for a new multisensor Mohawk program that was one of my CS&TA Lab programs monitored at OCRD by another action officer who was not having any success. The standard Mohawk had a downward-looking FIR scanning system that records data on film or a side-looking radar. The Intelligence community was interested in having a multisensor, real-time FIR system that could be operated with the radar. During 1966, several unsuccessful attempts were made to get funding for such a testbed. It was a delicate time since this was the Army's last fixed-wing asset, and there was fear that too much visibility of a real-time multisensor system might lose this airplane to the Air Force also.

Late in 1966, we had been working with MG Guthrie to develop the No Dark program to equip helicopters in Vietnam with night vision. MG Guthrie had the idea to combine the Special Mohawk and No Dark programs and add to them other night vision developments that could be completed within 2 years. Plans were to procure enough systems to support four battalions in Vietnam: one artillery battalion in an infantry division; one artillery battalion in an airmobile division; and two helicopter companies in an armored cavalry troop.

COL Townsley and I went to work interviewing Vietnam veterans who had returned to the Pentagon to determine what was needed. Then, we got with my NVL and CS&TA Lab to determine what was feasible to do within the time limit. Some of the items were accelerations of existing programs and other items were brand new. This was our first opportunity to exploit some of the FIR technology.

We named the program Southeast Asia Night Operations (SEA NITEOPS). It included a variety of systems:

1) Airborne: Airborne FLIR, Low-Light Level TV - INFANT, Pod Mounted LLL-TV, Night Vision Aerial Surveillance Device (II), Stabilized Night Sight (II), and Airborne Searchlights
2) Combat Vehicle: Tank FIR Target Indicator, Night Vision Image Intensifier Periscope, and Supplemental Vehicular Searchlight
3) Ground: Hand-Held Thermal Viewer, LLL-TV, Night Observation Device, Long-Range 1 1/2 Generation. (Near IR II), and Night Vision Goggles.

It began in mid-1967 with about $6 million. In 1968 it doubled the Night Vision basic budget of $20 million. All pitched in to expedite these developments, and many laboratory personnel went to the field and Vietnam to ensure that they worked as designed.

The special multisensor Mohawk became the Southeast Asia Mohawk Revision (SEAMORE). When briefed to Department of Defense headquarters, the SEAMORE was brushed over lightly so as not to create any controversy. Len Sullivan, however, singled it out to ask more details about it. When he learned that we needed a testbed to find out how to integrate the multisensors for a single operator, he thought that it was a great idea. Unfortunately, SEAMORE was the one program that never got funded because emphasis was shifted from surveillance to armed helicopters that could shoot at targets once they were located. Thus, radar and FLIR multisensor integration was delayed for 25 years.

Feb 1967 to Dec 1970

SEA NITEOPS
★ LTC Charles Lehner

Since there were many aircraft programs and introduction and support of the equipment was heavily a military activity, LTC Charles Lehner was made Project Manager, SEA NITEOPS.

The items fielded in Vietnam not only provided valuable information for future developments, but also provided significant military contributions for their limited quantities. It accelerated the second generation family of night vision image intensifiers, particularly goggles and established the role of FIR.

OCRD
★ COL Edward West
★ COL Harl Graham

In 1968, COL Townsley was succeeded by COL Edward West who had been involved with night vision earlier as a major at CONARC. When his tour was over, he was succeeded by COL Harl Graham.

1968

★ COL Arthur Surkamp, PM Night Vision
★ CPT James Tegnelia

COL Arthur Surkamp replaced COL Schremp in 1968. CPT James Tegnelia was an important player on his staff. Later, when assigned to Vietnam, Jim was able to help introduce the new SEA NITEOPS equipment into the field. When the major efforts of initial production and establishing support to the field was completed in 1970, COL Surkamp recommended that the Project Management Office be abolished since the Night Vision Laboratory did not need a PM's help.

NVL
★ Ben Goldberg, Director
★ Mike Klein
★ Don Looft

In August 1968, I was made Deputy to the CG of ECOM and responsible for all of the ECOM Laboratories (Table 6); Ben Goldberg was promoted to Director of the Night Vision Laboratory; and Mike Klein was Associate Director for Operations. In January of 1969, Don Looft returned home to Night Vision from Acting Technical Director, MERDC (nee ERDL) to be the Associate Director for Development.

There was a lot of activity: SEA NITEOPS; completion of second-generation image intensifier family; research on other advances in image intensifiers and light sources/lasers to help the soldier; and development starting on FIR systems. To effectively use the talent, the Laboratory formed teams using matrix management to multiplex its personnel for the different tasks.

Table 6. Night Vision Laboratory

★ MG W. Latta, CG, ECOM
★ Dr. Robert Wiseman, Dep to CG, ECOM for Labs

NVL
★ Ben Goldberg, Director
★ Don Looft, Associate Director for Developments
★ Mike Klein, Associate Director for Operations

Visionics and Image Intensifier
★ John Johnson

FIR
★ Dr. Werner Weihe

Light Sources
★ Stan Segal

Thin Film
★ Dr. Georg Hass

Advanced Developments
★ Bucky Freeman

Systems Development
★ Ed Sheehan

Systems Evaluation
★ John Hildreth

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1954 - 1966

FIR Key Personnel
★ Dr. Werner K. Weihe
★ George Brown
★ Pat J. Daly
★ Lonie Foshee
★ Jim Perry
★ Bill Sims
★ Bernie Chasnov
★ Gerry Bean
★ John Scully
★ Dr. Reinhart Ennulat
★ Milt Compton
★ Joe Finberg
★ Dr. Lou Cameron

Dr. Weihe deserves credit for his management of the FIR activities during the research phase. Most of their efforts had been on the search for detectors of military use. With the formation of NVL, the FIR systems development responsibility was transferred to the System Development area where the systems engineers could draw upon the technology that is optimum for the particular military application. There had been little system development until SEA NITEOPS. When they were integrated into the NVL, Dr. Weihe continued to lead the FIR technology activity until he retired in 1969 when Dr. Reinhart Ennulat took over. Lou Cameron, who joined in October 1966, went on to become the Director of NVL.

Post-1967

This document essentially concludes with the formation of the Night Vision Laboratory and the introduction of SEA NITEOPS. The history of FIR has not been included since much of that story has been told elsewhere. However, it is important to note the advent of the FIR common module activity.

Although the feasibility and desirability of FIR had been shown by SEA NITEOPS, the primary issue was cost. Each new FLIR developed for the Army and Air Force seemed to be different without any commonality to previous FLIRs. Although FIR offered advantages over image intensifiers, it was too costly for general Army use.

1971

FIR Common Module Study

★ Don Looft
★ Patrick Daly
★ James Perry
★ William Sims
★ Frank Shields
★ James Predham
★ William Grogg
★ Stuart Layman
★ Harold Orlando
★ Dennis Van Derlaske

In 1971, Don Looft decided to attack this cost problem. He assembled a group to find a way to reduce the cost so that FLIRs could be affordable for the Army. Pat Daly was the leader of this group. They developed the Universal Viewer concept, which led to the standardization of a set of common modules. This established the basis for the first generation of FLIRs for all three Service branches.

As a captain, Jim Tegnelia helped introduce the equipment in Vietnam, and later as a civilian, he was the first leader of the Common Module Development Team. Lou Cameron led the effort to fruition.

1972

Concurrent Engineering Restored

In 1972, the production engineers were placed under my management at ECOM Headquarters, where I was able to restore them to the management of the Director of NVL so they could fully resume concurrent engineering. At the end of 1972, the NVL had reached a strength of 399 civilians and 70 military, and there were too many stars to count — at least too many to put on one slide. In 1973, Ben Goldberg retired and Don Looft became the Director and led the future advances in Night Vision.

Over the Years

★ Edwin N. Myers
★ George Heilmeier, ODDR&E
★ Marvin Lasser, Chief Scientist, OCRD

Watching over these Night Vision activities from higher headquarters all of these years were friends like Ed Myers and Marv Lasser. They helped fight the budget battles, and most of all defended us from raids on our growing budget. At DoD, Ed was instrumental in erecting fences which prohibited the Army from reprogramming Night Vision funds. He and his supervisors like George Heilmeier and others certainly played an important role in letting the stars shine. And, Marv and others looked out for us at OCRD.

1950 - 1970

Night Vision Contractors

Although the Night Vision Laboratory did assemble components and build prototypes, the Advanced and Engineering Development models were built by contract. Most of the component and materials development were also performed by contract. The NVL would not have been successful without the equally dedicated support by the contractors (Table 7). We thank them for their many contributions, moral support, and participation. Those individuals mentioned by name are a token of all that should be recognized.

Table 7. Night Vision Contractors 1950 – 1970

Raytheon	RCA	Crouse Hinds
Texas Instruments	ITT	Strong Elec
Wollensak	Machlett	Hanovia
Varo	CBS	Duro Test
Polan	Westinghouse	Train
Perkin Elmer	Rauland	Gilfillan
EOS	GE	Metavac
Chrysler	Mosaic Fab	Magnavox
Farrand	Chicago Aerial	EMR Photo-El
B&H	Optics Tech	Varian
Kollsman	Bendix	Velonex
Hughes	Honeywell	L-K Elect
Avion	HP	TRW
Philips	Corning	Erie Tech
Aerojet	Itek	Venus Sci
Garret	Dumont	Victor

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What Made the Night Vision Laboratory Unique

The Night Vision team grew as a team (Table 8). There was continuity in management philosophy. It was vertically integrated with everyone dedicated to the goal of providing the soldier with the equipment needed in time at a reasonable cost. There was synergism between the research, development, and engineering. The researchers knew the importance of their work and its value to the soldier. The developers knew that what they designed not only had

Table 8. Management Continuity

	February 1954		January 1966		January 1972	
	Leader	Members on Team	Leader	Members on Team	Leader	Members on Team
HQS	Cleaver		Wiseman Goldberg Klein		Wiseman Goldberg Klein Looft	
FIR	Weihe	15	Weihe	22	Ennulat	39
Thin film	Hass	7	Hass	9	Cox	8
Visionics	Goldberg Wiseman J. Johnson		J. Johnson	7	J. Johnson	61
Intensifiers	Klein	1	J. Johnson	29	J. Johnson	58
Sources	Segal	1	Segal	11	Segal	29
Adv Devel (Components)	Looft	1	Freeman	27	Freeman	68
Sys Devel		20	Sheehan	20	Sheehan	113
Sys Eval		0	Hildreth	9	Hildreth	27
Admin & Sec	M. Hyer	1	Adamitis	7	Burke	26

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to perform, but had to be producible and logistically supportable. They planned for concurrent component developments to support their systems. The testers knew how to perform realistic tests.

The Laboratory supported more than fourteen project managers plus those for Night Vision and SEA NITEOPS. In the 1970s, more than 40 percent of the systems development funding came from them and other customers. The Laboratory had to be responsive and perform to meet schedules.

There was followup with Laboratory people assigned to the field: Europe, Korea, Vietnam, and wherever else the action was. This closed-loop feedback provided realism and a sense of ownership and urgency that stimulated all to do their best. The scientists and engineers were equally at home with the soldiers in the field, with their compatriots in industry, and with upper management because they understood the whole picture. They were able to respond to emergencies such as Vietnam, Panama, and Desert Storm. They came together to solve problems.

Scientists and engineers in industry were treated as part of the team. They responded with equal enthusiasm. Whenever we heard of a lead that might be beneficial to our program, we immediately made contact and either got that organization under contract or kept them in coordination.

The Laboratory project engineers were activists and provided leadership and constructive criticism in all areas. Staff meetings included all levels and ideas were critically analyzed with free technical exchange by all. People were recognized for their talents and performance, not by their degrees or positions. Some of the best leaders did not have advanced degrees. Some were highly qualified technicians. All views were examined, and the consensus reached was supported by all.

We all took risks to do what had never been done before. MG William Latta, CG of ECOM (1965-69) said he could feel electricity in the air whenever he visited the Night Vision Laboratory.

Vertically Integrated Program

There was an integrated, balanced program for both the near and future (Table 9). There was excitement, enthusiasm, fun, loyalty, and a galaxy of stars.

The Laboratory never gave up its concern about "concurrent engineering" even when the production engineers were separated from it in 1957.

Others recognized that our applied research was integral to our success, and we were able to hold on to our 6.1 programs when the Army Research Office was formed in the late 1950s. We were used by General Besson, CG, AMC, and Assistant Secretary (R&D) Hawkins as the model Laboratory to overcome the Sherwin Plan of the early 1960s when DoD proposed to split the Army Laboratories with 6.1 and 6.2 going into Institutes and 6.3 and 6.4 going into systems organizations. MG Latta protected it from decimation when it was transferred to ECOM, and attempts were made to make it just another ECOM laboratory by moving its 6.1 programs to the ECOM Institute of Exploratory Research and its 6.2 programs into the Electronic Components Laboratory. I hope that it can survive the latest attempt to destroy its unity by the proposed new Army Laboratory reorganization.

Leaders from 1972 - 1991

Due to time limitations, I have had to skip over many stars, particularly those that came after 1965. I only got to the beginning of the FIR common modules. Some people should be singled out for special mention because they illustrated another strength. Leadership grew up

Table 9. Night Vision Integrated Program
From Applied Research to Support of the Troops

	SEARCHLIGHTS & LASERS 50's 60's 70's 80's	NEAR INFRARED SYSTEMS 50's 60's 70's 80's
PRODUCTION & WITH TROOPS	1st Gen 60" S/L Carbon Tank S/L Tungsten 2nd Gen 30" S/L Carbon 3rd Gen Xenon 2.2 KW Tank S/L 30" S/L 1 KW Tank S/L 1st Gen Lasers Laser Range Finders Target Designators Aiming Light	1st Gen NIR Metascope Sniperscope 2nd Gen NIR Image Metascope NIR Weapons Sight Tank Periscopes Gunner, Cmdr, Driver HH Binoculars Helmet Binoculars
ENGINEERING DEVELOPMENT & ADVANCED DEVELOPMENT	2nd Gen S/L 3rd Gen S/L 1st Gen Lasers	2nd Gen NIR
COMPONENT DEVELOPMENT & APPLIED RESEARCH	Carbon Arc Xenon Arc Vortex Arc Reflectors . . . . Lasers	High Voltage Image Tubes NIR Filters Optical Design Power Supplies

	FAR INFRARED SYSTEMS 50's 60's 70's 80's	IMAGE INTENSIFIER SYSTEMS 50's 60's 70's 80's
PRODUCTION & WITH TROOPS	1st Gen FIR HH Thermal Viewer Tank Thermal Sight NOD, LR TOW Night Sight Dragon Night Sight Rifle Sight CSWS, TI A/B FLIRs	1st Gen SSS CSWS NOD,MR Tank Sights 2nd Gen NV Goggles Miniscope HH Binoculars SSS CSWS NOD,MR Tank Sights A/B Sights 3rd Gen NV Goggles Miniscope
ENGINEERING DEVELOPMENT & ADVANCED DEVELOPMENT	1st Gen F I R 2nd Gen F I R	1st Gen II 2nd Gen II 3rd Gen II
COMPONENT DEVELOPMENT & APPLIED RESEARCH	Detector Materials . . . . Linear Detectors Focal Plane Arrays FIR Window Materials Coolers	Photocathodes . . . . Intensifier Techniques Cascade Tubes Fiber Optics Microchannels Microchannel Tubes
	VISIONICS Static Search Environmental Models	VISIONICS Static Search Environmental Models . . . . . .

in the Laboratory and gained practical experience with the equipment and an understanding of the management philosophy practiced in the Laboratory.

Following Don Looft

★ **Ed Sheehan** was Director from May 1975 to June 1979.

★ **John Johnson** was Deputy Director from 1973 and Director from July 1979 to November 1980.

★ **Mike Klein** carried on the philosophy for many years.

★ **Bucky Freeman** is now the Chief Scientist.

★ **Bill Hawley** was the key person to establish working relationships with the other parts of the Electronics Command and to obtain its support for Night Vision Maintenance, Training, Materiel Management, and Procurement. He became the Deputy Director and represented the Laboratory in Korea.

★ **Larry Acchione** ran the first search effectiveness field tests at Warren Grove and became an Associate Director.

★ **Lou Cameron** came out of the FIR detector research team to take over the Common Module team and establish the standards. He later went into Systems Development, became Associate Director for Development and Engineering in 1976, and was Director for the Laboratory from November 1980 to October 1984.

★ **Paul Travesky** started in Systems Evaluation and moved through Systems Development and Systems Concepts to become Director in March 1985.

★ **Rudy Buser**, who was the leader of the Combat Surveillance and Target Acquisition Laser activity, moved this program to NVL, then became the current Director in 1990.

★ **Lester Mackay** led the Airborne Systems activity during SEA NITEOPS and is now an Associate Director.

★ **Doug Wood** was also in the Airborne Systems activity and is now the Deputy Director.

★ **Jim Ratches** carried on John Johnson's Visionics work to develop the Ratches model and is now an Associate Director.

As records dating prior to 1967 are extremely scarce and incomplete, any assistance in compiling the history of NVL would be greatly appreciated. Of particular value would be any information regarding personnel names and service dates and a chronological listing of various assignments and projects worked.

I have fond memories of my time spent as a member of the Night Vision team, and am eager to formally document its history. I look forward to the Center for Night Vision & Electro-Optics continuing the Conquest of Darkness by the Management of the Stars.