NIKON AND THE SPONSORSHIP OF JAPAN'S OPTICAL INDUSTRY BY THE IMPERIAL JAPANESE NAVY, 1923-1945

by

JEFFREY WILLIAM SCOTT ALEXANDER

Hons. B.A., Brock University, 1995

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

(Department of History)

We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

August 2001

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the head of my department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of HISTORY

The University of British Columbia
Vancouver, Canada

Date AUGUST 14 / 2001

DE-6 (2/88)

ABSTRACT

This thesis examines the development of Japan's optical industry during the 1920s, 1930s, and through the immediate post-World War Two era, placing particular emphasis upon the support given to emergent optical firms by the Imperial Japanese Navy (IJN). The author seeks to trace IJN support for optical munitions development back to the Washington Naval Limitation Treaty of 1922 and the subsequent London Naval Treaty of 1930 – arguing that the root of Japan's early optical research and development initiatives is to be found in Japan's compensatory Naval Supplementary Bill of 1930. Faced with the limitation of both the number and size of its capital and auxiliary warships after 1930, the IJN sought to divert the remainder of its ship construction budget toward the fullest development of experimental weapons and related systems. This changing attitude toward maximizing auxiliary technologies in lieu of additional vessels gave a significant boost to such companies as *Nippon Kogaku Kogyo Kabushiki Kaisha* – which came to be known in the post-war era as Nikon.

Through an investigation of Nikon's own company histories and the U.S. Navy Technical Mission to Japan, 1945, the operational and technical growth of companies such as Nikon, Fuji, Canon, and Minolta are examined. Critical technical advances made in the furtherance of IJN projects such as optical glass manufacturing, aerial camera design, infrared imaging, rangefinder production and periscope lens coating techniques are shown to be at the heart of Japan's optical design and manufacturing successes in the post-war occupation period. In building upon its significant wartime technical breakthroughs and mass-production processes, Nikon was able to capture post-war consumer optical markets both at home and abroad by the late 1950s. That chain of events is herein demonstrated to have originated with the emphasis placed by the IJN upon developing auxiliary and experimental weapons technologies following the London Naval Treaty of 1930.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

I wish to acknowledge the assistance of the following:

Dr. Christopher Howe, for his advice regarding the published Nikon company histories; Edward J. Low, for his excellent IJN web site and his kind referral to the U.S. Navy Operational Archives; the staff of U.S. Navy Operational Archives at the Washington Naval Yard; Kurihara Yuka, Namita Yoko, and Kawakami Masako, for their patient assistance with the Japanese text – especially the names; and the Department of History at the University of British Columbia.

DEDICATION

For my family, with thanks for all of their support.

I) Introduction

This paper will explore several aspects of Japan's optical design and manufacturing industry both prior to and during World War Two in an effort to trace the continuum of Japan's technological development as it carried on into the post-war era. It will be argued that the financial and motivational support of the Imperial Japanese Navy (IJN) for research and design initiatives involving experimental weapons and related military hardware was the primary driving force behind Japan's overall technological progress made in the field of optical engineering. Furthermore, it will be demonstrated that the IJN's investments in optical munitions production laid much of the foundation for Japan's post-war optical industry – enabling the emergent companies to capitalize directly upon designs theretofore produced strictly for use by the armed forces. As a result, companies such as *Nikon*, *Fuji*, *Canon*, and *Minolta* were able to retool in the earliest stages of the occupation and begin directing their designs and manufacturing processes toward the swift capture of civilian consumer markets. The IJN's support, in turn, will be shown to have originated with the advent of the naval limitation conferences in 1922 and 1930, after which time Japan's government made determined efforts to promote compensatory naval R&D initiatives in the form of the Naval Supplementary Bill of 1930. As a specific model for examining this phenomenon, the innovations made in the field of optical weapons design undertaken by the *Nippon Kogaku Kabushiki Kaisha*, or Japan Optical Engineering Company, will be examined together with those of related optical firms in order to trace their growth and post-war metamorphoses. As the foundation upon which the post-war *Nikon* Company was able to rapidly construct its successful, modern commercial enterprise, the support given and demands made by the

IJN will be seen as the most significant accelerator of *Nikon's* technical and productive capabilities. It will also be demonstrated that although the investments made by the IJN in these military research projects were the primary force that carried such technological understanding forward into the post-war era, Japan's defeat in World War Two did not interrupt the process. While the source of technological incentive was indeed changed radically, the continuum of Japan's technical progress nevertheless remained unbroken.

II) Early Efforts and the Emergence of *Nippon Kogaku*

As a primary source of this technological incentive, we must first examine the effects of the First World War and the resultant naval limitation treaties upon the IJN command and its attitude toward *jikyujisoku*; or the goal of achieving self-sufficiency in critical materials. To this end, Japan had by 1906 already established an optical research laboratory in Tokyo, and in 1909 a repair facility was further established in order to service optical weapons belonging to the Japanese army.[1] Combined with the experience gained in maintaining instruments such as field binoculars and cameras, the facility also began producing telescopes and microscopes for a variety of applications. Shortly thereafter, production expanded to include prisms for binoculars and even lenses for photographic cameras.[2] By the outbreak of the First World War in Europe, however, the question of self-sufficiency in optical munitions had yet to be seriously considered. Japan's armed forces were almost entirely dependent upon overseas suppliers of optical

[1] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi / 50-nenshi henshu senmon inkai henshu *Japan Optical Engineering Company - 50th Anniversary Company* History (Tokyo: Nihon Kogaku Kogyo, 1967) p. 56.
[2] Ibid. p. 56.

weapons, and this supply was sharply limited during the war as the combatant powers suspended their exports of munitions in general.[3]

The significance of this over-dependence upon foreign suppliers was not lost upon the navy, which made serious efforts after 1915 to address the problem of domestic production of both optical glass and optical munitions. In 1918 navy researchers at the Tsukiji Arsenal, south of Tokyo, began to produce seven types of optical glass in quantities of up to 300 kilogram melts in an effort to compensate for the interruption of German imports – theretofore Japan's primary supplier.[4] Subsequently, the *Nippon Kogaku Kogyo Kabushiki Kaisha* was founded in Tokyo on July 25th, 1917 as an optical weapons instrument shop in order to meet the needs of the IJN. The company began with ¥2,000,000 in operating capital, and was formed through the consolidation of three smaller firms: *Iwaki Glass Seisaku-sho*, *Fujii Lens Seizo-sho*, and the optical division of *Tokyo Keiki Seisaku-sho*.[5] The *Iwaki Glass Seisaku-sho* had been operating since 1881, and had designed 60 cm and 75 cm searchlights for the IJN in 1914 and 1917 respectively.[6] Wada Kahei, the head of *Keiki Seisaku-sho*, was selected during the incorporation to stand as the combined firm's first president.[7] The newly consolidated company began with some 200 employees and produced optical equipment primarily for scientific, military, and industrial uses - remaining virtually unknown to domestic and international consumer

---

[3] Aoki Shosaburo. "Kogaku heiki kogyo no kaiko." (*Recollections of Optical Weapons Manufacture*) Kaiso no Nihon Kaigun – Suikokai hen (*The Japanese Navy Recollected*) (Tokyo: Hara Shobo, 1985) p. 437.

[4] Grimes, C.G. Captain, USN, ed. "Japanese Optics" U.S. Naval Technical Mission to Japan – Series X: Miscellaneous Targets – Report X-05 (Washington D.C.: U.S. Government Printing Office, U.S. Naval History Division, 1945) p. 9.

[5] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi pp. 58-59.

[6] Ibid. p. 58.

[7] Ibid. p. 57.

markets until after 1945.[8] *Nippon Kogaku* based most of its early optical engineering projects squarely upon German designs, and in July of 1919 the company invited eight German technicians to work for the fledgling optical firm on a five-year contract. These engineers arrived in January 1921 and began introducing German designs and manufacturing processes into *Nippon Kogaku's* production line, giving the company a development pattern that paralleled the highly successful German optical firms Leitz and Zeiss.[9] The company set about producing a wide array of precision optical instruments such as telescopes, microscopes, binoculars, range finders and surveying equipment, until operations were halted following the Great Kanto Earthquake on September 1st 1923.

In recognition of the company's critical importance to the supply of optical munitions for the IJN, the Japanese Navy Ministry immediately arranged for the reconstruction and reorganization of *Nippon Kogaku* following the earthquake.[10] Until that time, its research had been directed largely toward the refinement of optical glass manufacture, "mainly in an effort to duplicate German glass and to gain control of optical constants which appear to vary markedly from melt to melt."[11] Although the earthquake destroyed much of the company's manufacturing plant, the swift intervention of the Navy Ministry enabled *Nippon Kogaku* to rebuild its production facilities at Oimachi, Tokyo and to continue with its research and manufacture of optical glass by the middle of October 1923.

Despite the commitment and the financing extended by the navy, the remainder of the 1920s proved to be very challenging for *Nippon Kogaku.* The company hovered on the brink of insolvency for much of the decade, due in large part to the slowdown in

---

[8] "A Short History of Nippon Kogaku Japan." Nikon Historical Society 04/09/2001. <http://www.nikonhs.org/history.html>

[9] Ibid.

[10] "Japanese Optics" U.S. Naval Technical Mission to Japan p. 9.

[11] Ibid. p. 9.

naval construction following the Washington Naval Conference of 1921. The naval limitations agreed to by the chief signatories – Great Britain, the United States and Japan – placed a respective 5:5:3 ratio on capital ship tonnage in an effort prevent a dangerous and costly naval arms race. The resulting Washington Naval Treaty of 1922 naturally had a depressing effect upon Japan's shipbuilding industry, and affiliated munitions suppliers such as *Nippon Kogaku* suffered in turn. On a technical level, however, the company actually made great strides during the 1920s because both the army and navy munitions research facilities had also been destroyed in the earthquake. Consequently, many talented military engineers and research projects were assigned to *Nippon Kogaku* during its reorganization, expanding both the number of technicians on staff and the breadth of the company's research capabilities.[12] Financial difficulties notwithstanding, this enhanced role after 1923 as both a military supplier and as an affiliated research and design arm of the IJN would be of particular importance to the company's future.

III) *Nippon Kogaku* and the Naval Limitation Experiment

The series of events that followed would be key not merely to *Nippon Kogaku's* expansion and economic turnaround after the financially depressed 1920s, but also to the rapid growth of its overall design and manufacturing capabilities. This reversal of fortune began with the London Naval Conference in the spring of 1930 – the outcome of which was assessed by the IJN to be a disastrous strategic setback and a threat to Japan's maritime security in the western Pacific.[13] At the conference, Japan's negotiators had acted upon the orders of the Prime Minister and agreed to the American proposal of

[12] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi p. 62.
[13] Kobayashi, Tatsuo. "The London Naval Treaty, 1930" (Tiedemann, Arthur E., trans.) Morrow,

a less than 10:10:7 ratio in auxiliary vessel tonnage vis-à-vis Great Britain and the United States. Because the objections of the Navy Ministry had not been heeded, Japan's Supreme War Councillors were initially inclined to support the navy in its insistence that the government's action had violated the navy's right of supreme command.[14] Through a series of deft political maneuvers and the conclusion of a semantic compromise, however, Prime Minister Hamaguchi and Foreign Minister Shidehara were able to persuade the Council to agree to the three-power treaty without further investigation of the views of the Navy Ministry. While the Prime Minister had evidently vindicated the principle of civilian leadership, this victory was tempered by the tacit agreement of the government not to claim that the treaty had been ratified on constitutional grounds.

In exchange for its silence and its allowance of the treaty to be ratified by the Diet on "strictly procedural grounds", the navy fully expected that the government would deliver on its promise of a compensatory naval spending bill in order to maximize the fleet's technological capabilities in lieu of additional vessels.[15] Through a cross-examination of the correspondence between navy figures as they reflected upon the significance of the treaty, the genesis of their determination to seek a supplementary naval spending program becomes apparent. As the controversy over the proposed American compromise offer reached the ears of the Supreme War Councillors on March 26th, Admiral Okada Keisuke warned the Vice Minister of the Navy, Yamanashi Katsunoshin, as follows:

James William (ed.) Japan Erupts: The London Naval Conference and the Manchurian Incident, 1928-1932 (New York, NY: Columbia University Press, 1984) p. 43.

[14] Crowley, James B. Japan's Quest for Autonomy: National Security and Foreign Policy, 1930-1938 (Princeton, NJ: Princeton University Press, 1966) pp. 72-73.

[15] Ibid. p. 68.

> We will have to swallow the delegates' plan. But only on the condition that we make the government promise measures to offset the deficiencies we feel the American plan imposes on us... We must force the government to put its consent to these measures in the form of a cabinet memorandum.[16]

Yamanishi, in turn, sought the approval of Prime Minister Hamaguchi, Foreign Minister Shidehara, and Finance Minister Inoue for the recommendations he proposed in order to offset the limitations of the treaty. He wrote (italics are added):

> To mitigate the difficulties in implementing national defense plans that will inevitably arise as a result of the arms limitation agreement, there must be improvements both in materiel and in technical skills. With regard to materiel, the following must be borne in mind: the maintenance and improvement of the capabilities of our existing vessels; full provision for air power; *the promotion and development of experimental research installations*, the improvement of defense facilities; the full provision of special types of surface vessels; the maintenance of construction skills and productive capacity... With regard to the improvement of technical skills, the following must be borne in mind: the improvement of various educational facilities; *the rigorous implementation of every kind of training exercise*... In the past there has been a tendency to hold such appropriations tightly down in order to divert money to ship construction.[17]

In spite of the objections of the navy and the reluctant approval of the Supreme War Council, the minutes of the March 26th Council meeting reflect the willingness of

[16] Kobayashi, Tatsuo. "The London Naval Treaty, 1930" p. 43.
[17] Ibid. op cit. p. 44.

Admiral Kato to respect the will of the government. In the document generated by the Council, entitled *Future Policy*, this attitude is clearly illustrated as follows:

> Even though the government does not heed the navy's policy (or rather, strictly speaking, the opinions of officers attending various discussions), the naval agencies have, of course, no right to go beyond the proper boundaries of state and military matters. They will, of course, follow official regulations and do the best they can within the limits set by government policy.[18]

At the same time, however, the obedience of the navy was tempered by a conscious determination to maximize the defensive capabilities not limited by the agreement. Upon hearing of the government's decision to accept the terms of the American offer, Fleet Admiral Togo reflected positively on the situation with these words (italics are added):

> Since the matter has been definitely decided, we have to go along with it. Now that things have reached this stage, it's silly to grumble. In this situation we must work to unify the navy. In a cheerful spirit we must develop harmony and cooperation among all ranks. We must pour our energy into three things: *the provision of materiel*, improving morale, *and rigorously training our personnel.* It is important to raise our quality, to concentrate with religious dedication upon the intrinsic mission of the navy.[19]

By July 1930 the discussion of a naval supplementary program began in earnest, and Navy Minister Takarabe noted that its composition would ultimately depend upon the

[18] Ibid. op cit. p. 42.
[19] Ibid. op cit. p. 47.

state of the government's finances. On July 22nd, Takarabe reported to the Supreme War Council as follows:

> If there are shortcomings in the military strength needed to support and implement the operational plans drawn up in conformity with national defense policy, as Navy Minister I will, of course, consult fully with the Navy Chief of Staff and make the best possible effort to ensure that compensations are made for such shortcomings.[20]

The Supreme War Council, in turn, seized upon this opportunity to exploit the Navy Minister's compensatory promise. At its July 23rd meeting it voted unanimously to submit the following report to the emperor, which read, in part (italics are added):

> ...If the present treaty should come into existence, we must, until 1937, adopt the countermeasures listed below in order to hold these shortcomings to a minimum.
>
> 1. Complete utilization of the strength allotted under the agreement; the maintenance and improvement of the capabilities of existing vessels; full development of the categories of vessels upon which no limitations are placed by the treaty.
> 2. Full provision of the air strength necessary to support and implement operational plans.
> 3. Improvement of defense facilities; *full development of experimental research agencies*; improvement of educational facilities; rigorous implementation of every kind

[20] Ibid. op cit. p. 103.

of training exercise; improvement and full development of personnel, *materiel*, amphibious equipment, etc.[21]

Clearly the Council was not prepared to sit idly by and allow the government to ratify an objectionable treaty without making demands for suitable countermeasures. The specificity of the report illustrates the lengths to which the navy was prepared to go in its efforts to maintain its strategic advantage over the United States in the western Pacific. Rooted in this diplomatic setback are the navy's determined efforts to acquire sufficient technological capabilities to compensate for its perceived inferiority in tonnage. The third point of the Council's report highlights the navy's top priorities with reference to future defence spending initiatives: the development of experimental weapons and the expansion of related training exercises. As the political basis for the Navy Supplemental Program passed by the Diet on November 11th 1930, these recommendations point to the London Naval Treaty as the agent responsible for the acceleration and diversification of Japan's vast military research and development initiatives of the 1930s. The supplemental program allocated ¥20,000,000 for the modernization of capital and auxiliary vessels, and nearly ¥20,000,000 more for maintenance and the improvement of technical skills (see appendix I).[22] Added to these figures was nearly ¥250,000,000 for the ship replacement and construction that was allowed by treaty, all of which meant business for *Nippon Kogaku*. The final version of the supplementary bill ultimately reduced the previous appropriation of ¥508,000,000 for naval construction from 1931 to 1936 by a margin of ¥134,000,000. While this savings was earmarked for tax reduction, maintaining strategic advantage under the terms of the treaty necessitated that a greater

[21] Ibid. op cit. p. 105.
[22] Mayer-Oakes, Thomas Francis (ed.). Fragile Victory: Prince Saionji and the 1930 London Treaty Issue

proportion of the monies saved be funnelled specifically into auxiliary technology research.

The company's expansion throughout the 1930s was fuelled by a combination of the growth in naval construction and an expansion of its product line to include photographic lenses. The latter component was based upon ongoing research conducted by one of the company's German engineers, Heinrich Ahurt, who had extended his stay at *Nippon Kogaku* until 1928. Following his departure, the photographic lens project was taken over by one of his understudies, Sunayama Kakuno, who improved upon Ahurt's 500-millimetre f/4.8 prototype lens in 1929 and named the final product "Trimar".[23] In the same year Sunayama added a second model, a 12 mm f/4.0 lens named "Anytar", based upon a similar lens produced by Zeiss.[24] As the company's photographic lens design and manufacturing projects became more sophisticated, its role as an optical supply firm became increasingly diversified. With the debut of its 75 mm, 105 mm, 120 mm, and 180 mm *Nikkor* lenses in 1932, *Nippon Kogaku* began to supply other Japanese optical manufacturing firms with the lenses needed to produce cameras.[25] Thus began the process by which the selection of *Nippon Kogaku* by the IJN as its chief supplier of optical munitions would serve, in turn, to fuel the overall growth of Japan's optical industry. In an effort to trace this evolutionary process through the critical years after 1941, however, we must first examine the early development of Japan's other major optical firms.

---

from the Memoirs of Baron Harada Kumao (Detroit, MI: Wayne State University Press, 1968) Appendix III C. p. 311.

[23] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi p. 108.

[24] Ibid. p. 108.

[25] Ibid. p. 109.

IV) Related Japanese Optical Manufacturers

In 1928, an entrepreneur who had become enchanted with cameras and recognized the potential market for domestically produced optical equipment, Tashima Kazuo, established the *Nichi-Doku Shashin Shokai*, or the Japan-Germany Camera Company. The corporate name was changed in 1931 to *Molta Goshi Kaisha*, and again to *Chiyoda Kogaku Seiko Kabushiki Kaisha* after the company began photographic lens production in 1937.[26] These lenses went by the brand name *Rokkor*, and it was one of these lenses that was first used on an aerial camera produced by the company in 1940.[27] In July 1942 the corporation founded the *Itami* Optical Glass Company near Kobe upon the orders of the IJN – a development pattern that will be seen to repeat itself as the navy pressed for self-sufficiency in optical munitions after 1941. Following World War Two, the company would change its corporate name to the Minolta Camera Co., Ltd.

In November of 1933, entrepreneurs Yoshida Goro and Uchida Saburo founded the *Seiki Kogaku Kenkyusho*, or Precision Optical Instruments Laboratory. In its first year the firm produced an imitation "Leica II" prototype 35 mm camera named the *Kwanon*, and the name given to the final production model was "Hansa Canon".[28] When this camera debuted in 1935 it was Japan's first 35 mm rangefinder camera with a focal plane shutter, but like all Canon cameras made before WWII, it was fitted with a *Nikkor* lens manufactured by *Nippon Kogaku*.[29] The performance of the camera and the early success of *Seiki Kogaku* were dependent, therefore, upon the optical glass and lens manufacturing capabilities of *Nippon Kogaku*, which was fuelled ultimately by the support of the IJN. In

[26] "A Short History of Nippon Kogaku Japan." Nikon Historical Society
[27] Ibid.

[28] Ibid.
[29] Ibid.

1937, Uchida Saburo incorporated the company under the name of *Seiki Kogaku Kogyo Kabushiki Kaisha*, and this date has since been listed as the time of Canon Inc.'s official founding.[30]

Finally, we turn to the company that would most closely rival *Nippon Kogaku* in both its production of optical glass and its receipt of support from the navy – the *Fuji* Photo Film Company. *Fuji* was originally incorporated in 1934 as a manufacturer of photosensitized film materials such as roll films, motion picture films, X-ray films, and photosensitive papers.[31] The company had two manufacturing plants; one in Ashigara that was originally constructed and equipped by the Dai-Nippon Celluloid Company, and a second in Odawara that was first established to aid its sister plant in the production of photographic chemicals (see appendices II and III).[32] In an effort to increase overall glass production after 1942, the Odawara plant also began to produce optical glass for binocular and camera lenses on the orders of the navy.

V) The American Perspective

The degree to which these primary optical companies were cultivated and fostered by IJN support was documented by the United States Navy during its extensive investigation of Japan's naval manufacturing and organizational structures after 1945. This investigative mission, which spanned over 185 subjects in seven targeted areas, was labelled collectively the U.S. Navy Technical Mission to Japan: Reports 1945-1946. The purpose of the mission was:

---

[30] Ibid.
[31] "Japanese Optics" U.S. Naval Technical Mission to Japan p. 43.
[32] Ibid. p. 9.

> ...to survey all Japanese scientific and technological developments of interest to the Navy and Marine Corps in the Japanese Islands of KYUSHU, SHIKOKU, HONSHU, HOKKAIDO; in China; and in Korea south of latitude 38°N. This involved the seizure of intelligence material, its examination and study, the interrogation of personnel, and finally, the preparation of reports which would appraise the technological status of the Japanese Navy and Japanese industry.[33]

With respect to Japan's optical industry, the introduction of report X-05, entitled "Japanese Optics", emphasizes the wholly exploitative nature of the investigation headed by Lieutenant Commander G.Z. Dimitroff, USNR. It simply states:

> The aim of this investigation was to exploit optical developments in Japan from the standpoint of research and manufacture and their application to instruments for naval or military use. This was accomplished by a study of:
>
> 1. The Glass Making Industry...
>   a. Methods of manufacture
>   b. Types of glass developed
>   c. Information received by the Japanese from Germany
>   d. Research laboratories or institutions
>   e. Type of raw material
>   f. Special ingredients or substitutions
> 2. Optical Designs
>   a. Research in physical optics
>   b. Methods of computation of optical systems

[33] Grimes, C.G. (ed.) U.S. Naval Technical Mission to Japan – History of Mission (USN: December, 1945) p. 1.

3. Application of Light and the Optical Arrangements to Special Fields

The introduction is followed by an exhaustive review of the state of Japan's optical design and manufacturing capabilities, with a particular emphasis placed upon the chemical formulations involved in optical glass production. Coupled with the review, however, is a forensic accounting of *Nippon Kogaku's* operations, as well as a detailed review of the plants operated by the *Fuji* Photo Film Company at Ashigara and Odawara. Together with numerous interviews conducted with various company directors and design engineers, the report paints a clear, concise picture of the influence of the IJN upon Japan's overall technical growth in the field of optics. The summary of the report reads as follows:

> On the basis of study of the targets listed and examination of material left intact, the development of optics in Japan can be summarized as follows:
>
> 1. In the past five years Japan has made a phenomenal growth in optical glass manufacture.
> 2. Japan has at present, fairly modern and efficient optical factories.
> 3. No spectacular optical developments have been made in Japan, but rather adaptations and modifications have been made of the optical systems used in German and U.S. instruments.
> 4. Japan has capable scientific personnel who understand modern optical requirements and are cognizant of the shortcomings in the Japanese processes of glass manufacture.
> 5. The Japanese exhibited a tendency toward large size (aperture) visual optical instruments, particularly in the field of binocular telescopes (80, 120, 150 mm

apertures). This tendency may represent a futile attempt to offset deficiencies in their radar development.[34]

The first section of the report outlines the early development of Japan's optical industry, and begins by noting that "during the war of 1917-18, Japan found herself, much like other countries, completely dependent for optical glass upon imports from Germany."[35] After tracing the reorganization of *Nippon Kogaku* following the Great Kanto Earthquake and its expansion under the wing of the Navy Ministry, the report focuses primarily upon the efforts of the company to meet the navy's stringent demands for optical glass and munitions. After interviewing *Nippon Kogaku's* directors, the report concluded that after the company was chosen in 1942 to be the primary producer of optical munitions for the IJN:

> ...there occurred a great expansion in glass production. This was carried out, according to Nippon Optical officials, under governmental pressure. New buildings, optical shops, machine shops, etc., were started.[36]

Thus by 1942 the locus of control over *Nippon Kogaku's* key logistical decisions lay with the Navy Ministry and its efforts to satisfy the needs of the IJN. Through an examination of the company's official fiftieth-anniversary history, entitled *Gojunen no ayumi*, the overwhelming influence of the navy over *Nikon's* early growth becomes visible on both technical and productive levels. Virtually all of the company's technical achievements were rooted in specific demands made by the armed forces, and in particular the navy, for specialized optical munitions. The engineering challenges posed by these demands were considerable, and they generated a wide variety of research

[34] "Japanese Optics" U.S. Naval Technical Mission to Japan p. 1.
[35] Ibid. p. 9.

projects aimed both at solving the inconsistencies faced by the company in its production of optical glass, and the improvement of technical proficiency in its design and manufacturing processes. A review of these engineering projects and their related challenges will illustrate the manner in which the demands of the IJN furthered *Nippon Kogaku's* overall technical capabilities.

VI) *Nippon Kogaku's* Evolving Design and Production Challenges

i) Cameras

Of primary importance to *Nikon's* post-war development is the company's initial interest in the design and manufacture of cameras. It must be noted, however, that *Nippon Kogaku* was initially founded as an optical firm, and not as a camera manufacturer. Until the 1930s, its production line was limited to telescopes, microscopes, surveying equipment, and a variety of optical measuring devices of use to science and industry.[37] As noted above, the company's research into photographic lens production was largely an effort to duplicate existing German designs and to become a supplier of lenses to camera manufacturers. With the advent of the London Naval Conference of 1930 and the Naval Supplementary Bill of the same year, however, the navy began to put pressure on *Nippon Kogaku* to begin designing cameras for reconnaissance aircraft. According to the company's own history, the IJN had theretofore depended entirely upon the import of aerial reconnaissance photographic equipment from France.[38] After 1930, the company's researchers were encouraged to develop a series of simple prototype cameras to satisfy the navy's demands for increased self-sufficiency in the field of aerial

---

[36] Ibid. p. 9.
[37] "A Short History of Nippon Kogaku Japan." Nikon Historical Society

photography. The first models ranged from 700 mm to 1200 mm in focal length and were characterized as simple, unsophisticated structures.[39] Following this project *Nippon Kogaku* began to manufacture a range of artillery cameras for land use, a project that was its first foray into the production of photographic munitions.[40] Despite these rudimentary beginnings, however, the significance of the company's early efforts in the field of camera manufacturing is rooted in the *source* of the incentive to pioneer such designs. *Nikon* states categorically "...it was primarily in response to the demands of the navy that [*Nippon Kogaku*] took up camera research."[41] As a result, the seeds of the company's post-war design and manufacturing focus were sewn by the navy's plan to reduce its dependence upon foreign suppliers of vital photographic equipment. This forced realignment of *Nikon's* manufacturing priorities would ultimately lay the foundations for its success in post-war camera production.

From these early beginnings, *Nippon Kogaku* went on to produce a variety of increasingly sophisticated cameras for a wide range of military uses. After 1932, the designs had become "authentic, full scale" aerial and land-based cameras, and each constituted another level of technological achievement for the company in its efforts to meet the navy's demands.[42] In the field of reconnaissance photography, the first small aerial camera to be mass-produced featured a 180 mm Tessar-type infrared lens and a focal plane shutter. The mechanism was sealed in a housing measuring 13 by 18 cm, but these overall dimensions were still considered too large for effective aerial use. Consequently an even smaller design was produced, which featured a 75 mm Tessar-type

---

[38] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi p. 67.
[39] Ibid. p. 67.
[40] Ibid. p. 67.
[41] Ibid. p. 67.
[42] Ibid. p. 67.

infrared lens and a spring-driven motor inside a "Brownie" style housing.[43] Cameras were the most complex and intricate designs produced by the firm to that date, and they represented a determined step forward in the miniaturization of its optical instruments. Added to the design challenges presented by demands for smaller and smaller optical components, the need for mechanisms such as motors, spindles, gears and shutters further forced the company to broaden its design and manufacturing focus. With the diversification of *Nippon Kogaku's* product line came the addition of a new factory at Hoyama, and together with the aerial cameras came a series of designs for land reconnaissance cameras featuring telephoto lenses. The first was a three-metre upright periscope-style camera on a tripod mount, which was later followed by a similar two-metre version in 1939. In the same year a pair of massive five-metre telephoto cameras were also produced that required flatbed trucks to transport. According to *Nippon Kogaku's* company history, these five-metre models were most extensively employed during the "incident" at Nomonhan versus the Russian army in 1939.[44]

ii) Range Finders

With the increasing demands being made by the military for optical devices capable of "seeing" extreme distances or in specific dimensions, *Nippon Kogaku's* research was also directed toward the development of adequate gun cameras, bombsights, wide-angle lenses, and even infra-red imaging devices.[45] Among the most technically demanding of these projects was the creation of optical rangefinders, or fire-control directors for the first IJN capital vessels to be built in Japan. In an era before computer-enhanced imaging systems, assessing the range to a target required warships to employ a variety of

[43] Ibid. p. 67.
[44] Ibid. p. 67.

purely optical instruments. These devices produced a 'stereo' optical image of a target for a vessel's fire-control command centre, which together with corrections for the target's course and speed would enable the *shagekiban*, or fire-control computer, to calculate accurate gunsight values for the turret.[46] These instruments operated in the same manner as a person's two eyes when determining depth: the more distant the target, the further apart the two optical images were required to be in order to accurately assess its range. Before the advent of computer-assisted imaging, targets at great distances naturally necessitated proportional increases in the scale of the optical equipment needed to view them. As the various instruments grew in scale, so too did their individual optical components, or 'elements', such as lenses and prisms. Larger and more ambitious element designs, in turn, fuelled the proportional expansion of the firm's production facilities and equipment.

Following the arrival of the British-made battlecruiser *Kongo* in 1913, which featured rangefinders produced by maker Barr & Stroud, the IJN began to design comparable fire-control optics for future vessels.[47] *Kongo* was the last of the IJN's capital ships to be built outside Japan, and during its construction by Vickers & Sons, a series of three sister keels was laid in Japanese naval yards at Yokosuka, Nagasaki, and Kobe.[48] Over the next ten years, IJN optical researchers at the Tsukiji Arsenal made considerable progress in the field of optical engineering, but their efforts were reduced to ashes in the earthquake and fire of 1923. From this point forward, the IJN came to rely on private domestic

---

[45] Ibid. p. 68.
[46] Evans, David C. & Peattie, Mark R. Kaigun: Strategy, Tactics, and Technology in the Imperial Japanese Navy, 1887-1941 (Annapolis, MD: Naval Institute Press, 1997) p. 253.
[47] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi p.. 179.
[48] Jentschura, Hansgeorg & Jung, Dieter & Mickel, Peter. (Preston, Antony & Brown, J.D., trans.) Warships of the Imperial Japanese Navy, 1869-1945 (Annapolis, MD: Naval Institute Press, 1977) p. 35.

manufacturers for the satisfaction of its optical requirements, not the least of which included rangefinders. The optical fire-control contracts awarded to *Nippon Kogaku* by the IJN would stretch the company's technical capabilities to their limits and necessitate the expansion of its research team to include a wider cast of experts in the field of optics. As *Nippon Kogaku's* product line diversified, a committee was established to set specifications for the standardization of products and the minimization of variation in optical constants. This committee included professors from Tokyo Imperial University, the Tokyo University of Technology, Kyoto University, and the Osaka Industry Laboratory.[49] While their efforts were directed toward the management of production standards, however, the scale of the navy's optical requirements continued to grow proportionally with its expansion in naval construction through 1941.

As the complexities of calculating accurate firing solutions for heavier naval artillery came to be better understood by the British, American and Japanese navies in the interwar period, the need for precise optics became more critical. The basic rangefinder designs produced by *Nippon Kogaku* were grouped into two categories – low-angle and high-angle directors. The former consisted of four types: ranging from 2 metre to 4.5 metres in length, while the latter category consisted of several types ranging between 1.5 and 15 metres long.[50] The largest of the high-angle directors were produced especially for the *Yamato* class of superbattleships, plans for which were drawn up after the failure of the second London Naval Limitation Conference in 1936. Each of these 70,000-ton vessels was designed to feature three 18.1-inch turrets, and represented the firm determination of the IJN to outrange all other navies. Superlative artillery, however, also

[49] "Japanese Optics" U.S. Naval Technical Mission to Japan p. 27.
[50] Low, J. Edward. "Directors" Mechanisms of Imperial Japanese Navy Warships in 3-D 04/29/2001

necessitated superlative fire-control optics, and *Nippon Kogaku* was therefore tasked with the production of eight 15-metre rangefinders capable of providing images of targets at distances of over 35 kilometres.[51] One of the finished devices were affixed to each of the three main turrets aboard both the *Yamato* and the *Musashi* battleships, with a fourth installed on their forward fire-control towers. The creation of these massive instruments involved such a high degree of engineering precision that the standard of accuracy in their prism construction was 60 times greater than that which had been applied to conventional projects.[52] In addition, there were 10-metre rangefinders installed on the ships' after fire-control towers, and 7.5-metre versions on each of their secondary turrets.[53] *Nippon Kogaku* had not only set new design standards when it had furnished the IJN's flagship *Yamato* with the optics necessary to fight, it had also raised dramatically the technological capability of the Japanese optical industry as a whole. The failure of the naval limitation treaty system and the ambition of the IJN to outclass its opponents had stretched *Nippon Kogaku's* design and manufacturing abilities further than ever before.

iii) Periscopes and Lens Coatings

Added to the company's accomplishments in rangefinder production were similar successes made in the field of periscope manufacturing. *Nippon Kogaku's* first periscope was produced in 1918, and had an overall length of seven metres.[54] Following the First World War, the company began to produce periscopes based upon German designs,

---

<http://www.ijn.dreamhost.com/Directors/Directors.htm>

[51] Evans, David C. & Peattie, Mark R. Kaigun: Strategy, Tactics, and Technology in the Imperial Japanese Navy, 1887-1941 (Annapolis, MD: Naval Institute Press, 1997) p. 262.

[52] Howe, Christopher. The Origins of Japanese Trade Supremacy: Development and Technology in Asia from 1540 to the Pacific War (London, UK: Hurst & Company, 1996) p. 305.

[53] Hansgeorg et al. Warships of the Imperial Japanese Navy, 1869-1945 p. 39.

[54] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi p. 180.

manufacturing between 50 and 60 units between 1920 and 1922.[55] By the mid 1920s, German technicians were hired by the company to aid in the development of new models, and records indicate that by the beginning of the Showa period, large numbers of 9-metre and 10-metre periscopes were being produced.[56] Added to these models, which were featured aboard most first and second-class IJN submarines, was a series of smaller periscopes for use aboard the navy's vaunted *kaiten*, or midget submarines. The questionable effectiveness of these one to five-man submersibles notwithstanding, *Nippon Kogaku* was called upon to make working periscopes for the over 300 units that were produced across their various classes (see appendix IV).[57]

Added to the optical engineering of the periscopes themselves was an ongoing effort made by *Nippon Kogaku* to increase the transparency of their glass surfaces. The standard 10-metre periscope produced by the company featured 33 individual optical elements (see appendix V), and its complexity resulted in dramatic light losses.[58] In the interest of maintaining their strategic advantage, Japanese submarine commanders wished to use their periscopes at dawn and in the low light of early evening, but the initial inferiority of the optics prevented them from doing so without difficulty. These commanders placed great pressure on the navy and on *Nippon Kogaku* to improve the performance of their periscopes under low light conditions, and the company responded by initiating research into new lens coating techniques aimed at increasing their transparency. According to the investigators in the U.S. Navy technical mission:

> ...two methods were found for "coating" glass surfaces:
>
> 1. The chemical method, in which the glass was treated with nitric acid.

[55] Ibid. p. 180.
[56] Ibid. p. 180.

2. The evaporation method, in which cryolite is evaporated and deposited upon the glass surface, in vacuum. After treatment, the glass is baked at 150°C for one hour for durability.[59]

These procedures were evidently conducted at the *Nippon Kogaku's* optical factory at Yokosuka, in coordination with the navy's submarine base at Nagaura Harbour. During their analysis of the plant, the U.S. Navy investigators noted: "Evidence was found that lens coatings had been carried on" and recorded that "a few samples of apparently experimental coatings and coating material were obtained."[60] Such experimental work demonstrated the kinds of subsidiary technologies generated by the company's efforts to deliver on IJN optical contracts. As engineers sought new ways to solve these kinds of design problems, a host of secondary investigations was inevitably added to their ongoing studies in the field of glass production. These new tasks included: experimental methods of glass annealing, the four-stage grinding and polishing of both lenses and prisms, and a variety of efforts to enhance night viewing with the aid of lens coatings and filters.[61] The company's efforts in the field of experimental periscope lens coatings would be of particular importance in the post-war period as such coatings were later found to have a variety of optical applications. Periscope production too continued after the war, and *Nikon* manufactured instruments for construction surveying, as well as a series of 10 metre periscopes for use in the railcar maintenance bays of the *shinkansen*, or bullet-train railway line.[62]

---

[57] Hansgeorg et al. Warships of the Imperial Japanese Navy, 1869-1945 pp. 184-185.
[58] Howe, Christopher. The Origins of Japanese Trade Supremacy p. 306.
[59] "Japanese Optics" U.S. Naval Technical Mission to Japan p. 31.
[60] Ibid. p. 5.
[61] Ibid. p. 30.

iv) Night-Vision Technologies

While *Nikon* would continue to produce periscopes after the war, research into night-vision technology was prohibited by the United States after 1945. Until the end of the war, however, *Nippon Kogaku* pursued a variety of projects designed to aid the IJN in its prosecution of nighttime surface combat. These included the development of powerful binoculars with unusually large 21 cm lenses that had superb light-gathering capabilities, as well as 12 cm and 5 cm models. The last of these was named the "Nova"-type, and each pair was fitted with detachable night-vision enhancing filters designed to better refract and capture available starlight and moonlight. Combined with the navy's considerable training in night-combat maneuvers and its development of parachute-suspended star shells, these advanced optics put the IJN far ahead of its rivals in its readiness for night surface engagements.[63] While U.S. naval war-gaming at Newport during the 1930s led the Americans to underestimate the value of night-combat readiness (with costly results in 1942), radar did indeed prove to be the superior technology, and it soon rendered the IJN's night-vision optics tactically obsolete.[64]

VII) *Nippon Kogaku's* Corporate Development

Attention must also be paid to *Nippon Kogaku's* financial and logistical development from its rapid expansion in the late 1930s to its suspension of operations in August 1945. The influence of the Navy Ministry over the company's growth and the diversification of its research and manufacturing initiatives was of paramount importance to the Japanese optical industry overall. The investments made by the navy in *Nippon Kogaku* provided

[62] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi p. 180.
[63] Evans & Peattie. Kaigun, p. 275.

not only the required incentive to develop these technical capabilities domestically, but also the capital needed to support such a dramatic expansion in operations. At the time of its founding in 1917, *Nippon Kogaku* had approximately 200 employees and a single manufacturing plant, but by the end of the war it employed 25,000 workers at 24 different facilities.[65] Clearly this dramatic growth could not have been fuelled by naval contracts alone, and indeed the navy's influence was crucial to the procurement of additional bank loans at key points in the company's development. Following the passage of the National General Mobilization Law in July 1938, the increased control of the government over production, wages, and labour enabled the military to pressure *Nippon Kogaku* to boost the production of optical weapons. In the same year, a navy investigation determined that the company would have to increase its annual output between five and six times to ¥6,000,000 per year.[66] Under the weight of such demands, *Nippon Kogaku's* financing by the *Mitsubishi Ginko* was becoming inadequate, and consequently the company was granted approval by the navy to begin receiving loans from the Japan Industrial Bank (*Nihon Kogyo Ginko*) in 1939. In October of that year, the company was furnished with a preliminary loan of ¥5,000,000, which was followed shortly thereafter by an additional ¥10,000,000 for the further expansion of its facilities and the purchase of new equipment.[67] As the company continued to grow it underwent a period of corporate and managerial restructuring as new manufacturing plants were opened in Totsuka in 1940 and Kawasaki in 1941. Finally, with the outbreak of war against the United States, *Nippon Kogaku* was chosen to be the navy's chief supplier of optical weapons, necessitating the appropriation of an additional ¥50,000,000 loan in

---

[64] Ibid. p. 578.
[65] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi, p. 72.

July of 1942.[68] When the company's vast expansion prompted the reform of its manufacturing systems, mass-production techniques were adopted in order to compensate for the paucity of skilled labour experienced during the war. Despite the company's continued expansion, however, the measure of operational control exercised by its directors declined dramatically. With the creation of the Munitions Ministry in September 1943 and the subsequent passage of the Munitions Supply Company Act in the same year, *Nippon Kogaku* became increasingly beholden to the navy's "impossible" production goals and ill-conceived emergency measures.[69]

VIII) Approaching the Nadir

U.S. successes in the Pacific War against Japanese shipping had by late 1944 sharply curtailed Japan's supply of raw materials, and by 1945 *Nippon Kogaku's* production facilities had begun to suffer the effects of American bombing raids. The response of the navy to these threats from the air was to move many vital optical research and production plants underground into caves or even to relocate them to Manchuria.[70] The U.S. Navy technical mission discovered several such ad hoc manufacturing facilities in various stages of completion during their investigation of Japan's wartime optical industry. Their final report highlights some of the more desperate measures undertaken as follows:

> Optical factory at ZUSHI – This factory manufactured mechanical parts for midget submarines. Extensive caves had been dug into the hills, which appeared

---

[66] Ibid. p. 71.
[67] Ibid. p. 71.
[68] Ibid. p. 71.
[69] Ibid. p. 72.
[70] "Japanese Optics" U.S. Naval Technical Mission to Japan, p. 9.

> to be soft shale, and machines had been moved in, but no work had actually been done in the caves. One of the tunnels in the caves was designated for glass annealing, but was not completed. Machines and equipment for about 400 employees were provided. Plans called for enlargement to about double this size.[71]

In some cases, optical firms were ordered to relocate entire manufacturing plants in an effort to hide them or put them out of the range of U.S. bombers. The U.S. Navy report notes that shortly after constructing a series of new factories in 1942, *Nippon Kogaku* was ordered by the Navy Ministry to move them further inland. The report states:

> No sooner were they completed than the company was ordered to move the machinery to plants in the interior of Japan. Shortly afterwards, this order was rescinded. Later it was expected that the plants would be moved to Manchuria. In fact, some of the equipment (film coating machines) of the Fuji Optical and Photographic plants in ASHIGARA was sent to Manchuria, but was lost when the ships carrying it were sunk.[72]

Fuji's sister plant in Odawara fared no better, for its role as a producer of optical glass qualified it too as an industrial target for U.S. air strikes. It is noted in the report that "the plant increased its production to 30 tons of optical glass per year and was still expanding when it was bombed on 14 August 1945" – the date of Japan's surrender.[73] Based upon interviews with the company's directors conducted by the US Navy after the war, the plant's ultimate expected production capacity had been 120 to 150 tons of glass

---

[71] Ibid. p. 5.
[72] Ibid. p. 9.
[73] Ibid. p. 9.

per year.[74] Additionally, the company had begun construction of a new plant for the production of materials for safety glass in July 1943, but it was not completed before Japan's surrender in August 1945. Other factories too, such as the optical research laboratory of the First Air Technical Branch Arsenal at Kanazawa, did not escape the air raids. The U.S. Navy report noted:

> The greater part of the buildings had been destroyed by bombing, and most of the equipment had been removed to KOMARIYA, near OSAKA. A display room contained some binoculars, bomb sights, and gun cameras and many signs indicating the places where lenses, torpedo cameras, Navy binoculars, sights, and other material had been arranged for display.[75]

During the first few months after August 1945, many such post mortem reports were written about the status of Japan's optical industry, and U.S. Navy investigators collected samples of every device, material, and document relevant to its progress. Among these items were samples of dozens of types of optical glass, together with samples of the indigenous clay, feldspar, kaolin, etc., used in their manufacture. Ultimately this list of materials and equipment, including binoculars, bombsights, periscopes, gun sights, sextants, etc., was shipped to the U.S. Navy Ordnance Investigation Laboratory at Indiana Head, Maryland for further analysis (see appendix VI).[76] Exhaustive studies were made of the physical properties and chemical compositions of the optical glass produced by *Nippon Kogaku* and *Fuji*, and further forensic accounting by the U.S. Navy investigators would yield a comprehensive list of every optical firm to which that glass

[74] Ibid. p. 9.
[75] Ibid. p. 5.
[76] Ibid. p. 33.

was sold between 1941 and 1945 (see appendix VII).[77] During those years, the *Fuji* optical company alone sold over 158,000 kg of optical glass to 19 domestic optical device manufacturers, while retaining another 1,400 kg for the production of lenses in its own manufacturing plants.[78] At the same time, *Nippon Kogaku's* operations had managed to produce over 5,000,000 kg of optical glass in 41 different types – and fully 98 percent of its sales were to the Japanese armed forces.[79] The investments made by the IJN and the Navy Ministry in these two firms had enabled a geometric expansion of Japan's optical industry with respect to productivity and technical proficiency. A report issued in 1944 by the U.S. War Department entitled "Handbook on Japan's Military Forces" described captured Japanese optics as "outstanding".[80]

IX) Post-Mortem and Reorganization Under the U.S. Occupation

Following Japan's surrender, *Nippon Kogaku's* operations were halted and its plants remained idle while the U.S. occupation authorities (SCAP) considered how the company should be reorganized. Unlike *Fuji's* manufacturing plants, which had employed a mere 2,100 workers during the war, *Nippon Kogaku's* massive operations had kept 25,000 employees on its payroll, and in the absence of military contracts, a sharp reduction of its workforce was inevitable. In the case of *Fuji*, SCAP allowed the company to continue on producing photosensitive materials with little reorganization because its manufacturing base was determined to be adequate for the production targets chosen. (These targets varied little from those set during the war era, and as such the number of employees

[77] Ibid. p. 21.
[78] Ibid. p. 21.
[79] Ibid. p. 25.
[80] Howe, Christopher. The Origins of Japanese Trade Supremacy p. 306.

retained was not drastically curtailed during the reorganization.[81]) *Nippon Kogaku*, on the other hand, was slated to resume only limited operations as the producer of optical equipment for the civilian consumer market – an exercise in which it had had virtually no experience. Undeterred by the layoffs that had cut its workforce to a mere 1,725 employees, the firm's directors set about coordinating a series of 15 working groups to examine its potential manufacturing options.

These groups were essentially tasked with the creation of a product line that would enable the company to employ its considerable technical skill to the continued production of existing designs. Four key innovations made by *Nippon Kogaku* during its years as an optical munitions supplier would later prove to be of paramount importance to the company's post-war manufacturing success.[82] Firstly, the experience gained in the production of prisms for periscopes and rangefinders was to be of crucial significance. *Nikon* would later find itself in a position of leadership during the revolution of the photography world by the reflex camera – of which prisms were the vital component. Secondly, the innovative lens coatings designed for submarine periscopes were later found to improve the performance of photographic lenses. Coatings that utilized as few as four elements were able to increase the transparency of the glass and reduce light loss, thereby improving the overall performance of the optics.[83] Thirdly, the company's own wartime systems of mass-production for such items as binoculars provided the experience needed to begin producing instruments in higher volumes. Finally, the early experimentation that had been conducted by the company into the rudimentary

[81] "Japanese Optics" U.S. Naval Technical Mission to Japan, p. 52.
[82] Howe, Christopher. The Origins of Japanese Trade Supremacy p. 306.
[83] Ibid. p. 306.

integration of optics, electronics, and mechanical devices would enable it to continue on as a pioneer in that field.[84]

While most of these key considerations were not yet evident to the company's 15 working groups in the fall of 1945, their aim was to pinpoint *Nippon Kogaku's* strengths as an optical manufacturer and assess their potential value to the civilian market. They were tasked, however, with the evaluation of over 70 possible designs, including cameras, telescopes, surveying equipment, projectors, clocks, spindles, lights, calculators, and even surgical equipment.[85] The groups began making their assessments on September 1st 1945, and by September 20th they had selected 38 of the designs as the most eligible candidates. The most successful items chosen for production were the binoculars previously designed for the use of Japan's military forces during the war – models that featured names such as "Galileo", "Nova", and "Orion".[86] Many of these wartime-issue binoculars had already become highly sought-after trophies of U.S. Naval officers, and American servicemen continued to be the company's most eager customers after production resumed in April 1946.[87] By that date, a mere eight months since the end of the war, the company began manufacturing a line of products that included: camera lenses, five types of binoculars, a pocket telescope, a microscope, a water level, land-use and astronomical telescopes, and several types of spectrographs.[88]

---

[84] Ibid. p. 306.
[85] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi, p. 77.
[86] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi, p. 72.
[87] Samuels, Richard J. Rich Nation, Strong Army: National Security and the Technological Transformation of Japan (Ithaca, NY: Cornell University Press, 1994) p. 308 and;
Morrison, S.E. History of United States Naval Operations in World War Two (Boston, MA: Little, Brown, 1947-1964) vol. 3, p. 24. in Howe, Christopher. The Origins of Japanese Trade Supremacy p. 306.
[88] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi, p. 77.

In September 1945, *Nippon Kogaku's* Consumer Goods Production Subcommittee also proposed the production of a camera, and by November of that year the Camera and Projector Committee had started its investigation of the designs.[89] Engineers began working with designs for an 80 mm twin-lens reflex camera, as well as a small coupled-rangefinder camera with a focal plane shutter and an interchangeable lens that would use 35 mm film. The 80 mm TLR design was eventually abandoned, however, and the smaller model was selected and given the name "Nikorette".[90] Shortly thereafter, the abbreviated version of the company name, "Nikko", was changed to "Nikon", and when this name was applied to the firm's prototype 35 mm camera it became known as the "Nikon 1".[91] Twenty prototypes were ordered in 1946, and by early 1947 the first finished Nikon Camera model was exhibited within the company. In March of that year the company's new name was officially announced, and by October 1947 advertising of the first model Nikon had begun. Finally, in February 1948, the camera was released. *Fuji*, meanwhile, had established an optical manufacturing division known as the Fuji Photo Optical Co. Ltd. in 1944, and SCAP's post-war reorganization had allowed it to continue producing small amounts of optical glass. The continuation of operations at the Odawara lens production shop enabled its engineers to produce the company's first still camera, the Fujica-6, which was released in August 1948.[92]

Nikon's rapid development of its first 35 mm camera was not without its difficulties, which stemmed largely from the nationwide shortage of materials and the overall novelty

---

[89] Ito Mikio. "Archivist's Memo No. 1" Nikon Company 02/05/2001. <http://www.nikon.co.jp/main/eng/d-archives/memo/m01_e.htm>

[90] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi, p. 79.

[91] Ito Mikio. "Archivist's Memo No. 1"Nikon Company

[92] "Company History" Fuji Photo Optical Co. Ltd. 30/05/2001. <http://www.fujinon.co.jp/outline/out02.htm>

of the design. According to the Nikon company web site, the managing director of the project, Fuketa Masahiko, described the initial setbacks as follows (*archivist's translation*):

> For the designing department as well as production spot, everything was new and they were suffering from troubles and problems. It was, as it were, "to think while running." In retrospect, we were doing just the opposite of "Make haste slowly."[93]

X) The Lessons of Optical Munitions Production

The experience gained by *Nippon Kogaku* in its role as a wartime munitions supplier helped enable the emergent Nikon company to overcome its initial postwar difficulties and initiate production in a relatively short time frame. Added to its knowledge base in the fields of optical glass and photographic lens production, prior successes in lens coating left Nikon well positioned to enter the U.S. and European camera markets by 1950. In April 1946, a soft optical coating was applied to the surfaces of the lenses inside the barrels of its Nikkor lenses to improve the transmission of light through the instruments. Cryolite was initially used, as it had been during the war, but by 1948 the primary ingredient was changed to magnesium fluoride, and the anti-reflective coatings were substantially hardened.[94] Together these improvements enabled corrections to aberrations in the optics through the addition of more optical elements without compromising the transmission of light. The coatings also played a role in significantly reducing internal reflections or "flares", which improved the performance of the

[93] Ito Mikio. "Archivist's Memo No. 1" Nikon Company

[94] "History of Nikon Cameras" Nikon Company 02/05/2001. <http://www.nikon.co.jp/main/eng/d-archives/camera/history_e.htm>

company's large aperture and wide-angle lenses.[95] All told, these chemical coatings of the internal surfaces of Nikon's lenses were the key feature that enabled them to surpass German lenses in their optical performance after the war.[96] The continuum of Nikon's technological research had clearly not been broken by the company's crash transition to consumer production in 1945 and 1946. The firm was able to capitalize directly upon its successes in the war era and modify them to suit the needs of its new markets despite the nearly total evisceration of the company's manufacturing base.

By the mid-1950s, the superior quality of Nikon's photographic lenses and cameras came to be recognized worldwide.[97] The company points to the "sensation" created by the age of the "cameraman", from whom the readers of *Life* magazine received such dramatic shots of U.S. involvement in the Korean War.[98] When a Korean War correspondent for *Life* won the U.S. Camera Award in 1950, his Nikon camera equipment was described in the *New York Times*.[99] The article was read with interest by the chief of the economic and scientific section of SCAP, General W.F. Marquat, who responded in a letter to Nagaoka Masao, the president of Nikon:

> It was with extreme interest that I read the article in the *New York Times* of December 10, 1950 on the superior quality of the Nikon camera and the Nikkor lenses... It has been my contention that Japanese export industry should adjust itself to compete in the world markets on a basis of quality... The employees of

---

[95] Ibid.
[96] Howe, Christopher. The Origins of Japanese Trade Supremacy p. 306.
[97] Ibid. p. 306.
[98] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi, p. 83.
[99] Ibid. p. 83.

> Nippon Kogaku may take pride in making a substantial contribution toward the rebuilding of the economy of their country.[100]

Again in 1955, the *New York Times* reported on the substantial progress made by Japan's post-war optical industry:

> Production of high-grade precision lenses for cameras and other optical goods is winning Japan a new and profitable field of export trade. Three years ago the industry began a drive for a major share of world markets. It made rapid and sizeable gains in exports of low and medium-priced cameras, binoculars and microscopes, particularly in the United States, the largest market.[101]

The technological superiority of Nikon optical products was further confirmed when Nikon's optical glass, its camera design, and its various lenses were awarded the "Grand-Prix", "Gold", "Silver", and "Bronze" prizes at the 1958 World Expo in Brussels.[102]

XI) Conclusions

Nikon has described its growth as an optical munitions supplier as an episode of "increased wealth in technical efficiency", and cites its production of optics for the military as key to its emergence as a civilian manufacturer.[103] If not for the pressure from the military, it is unlikely that *Nippon Kogaku* would have diversified its product line to include reconnaissance aircraft cameras and military use cameras during the war. While post-war research was indeed required to fashion designs for civilian markets, the origins

---

[100] Nippon Kogaku Kogyo – Yonjunenshi *A 40-Year History of Nikon* (Tokyo: Nippon Kogaku Kogyo Kabushiki Kaisha, 1957) p. 291. in Samuels, Richard J. Rich Nation, Strong Army p. 308.
[101] *New York Times*, 3 October, 1955, in Samuels, Richard J. Rich Nation, Strong Army p. 308.
[102] "Nikon Portfolio: Brief History" Nikon Corporation 24/06/2001. <http://www.nikon.co.jp/main/eng/portfolio/history.htm>
[103] Nippon Kogaku Kogyo Kabushiki Kaisha - Gojunen no ayumi, p. 74.

of the company's understanding of camera production rests with the wartime demands made by the armed forces – and those of the IJN in particular. The foresight possessed by navy commanders at the time of the naval limitation treaty negotiations of 1922 and 1930 clearly enabled the navy to make broad compensatory plans for its cultivation of domestic technology manufacturers. For its provision of technological incentive and its intensification of the navy's animosity toward naval limitation agreements, the London Naval Treaty of 1930 stands as one of Japan's most significant pre-war diplomatic accomplishments. Furthermore, in tracing the roots of the extensive naval supplementary program back to the Supreme War Council's report to the emperor, the treaty can be seen to have accelerated and diversified several of Japan's military research and development initiatives of the 1930s. Given the determination of the navy both to achieve self-sufficiency in critical materials and to maximize the combat effectiveness of its voluntarily restricted fleet, Japan's optical industry was, among others, poised after 1930 to reap huge technological rewards. In the case of *Nippon Kogaku*, the effectiveness of the navy's campaign would carry a small Japanese optical manufacturer very far into the post-war era.

XII) Further Considerations

Among the questions and potential avenues of further investigation that arise from this analysis, several deserve particular attention. First of all, a determination is needed of the degree to which manufacturers in other critical industries experienced the same measure of support from the IJN as a result of Japan's experiment with voluntary naval limitation. Additionally, a wider focus might shed light on the way these manufacturers interacted with one another and with universities and government research institutions

during the prewar period. On another level, further questions are raised through this singular examination of the lengthy and comprehensive U.S. Naval Technical Mission to Japan. Of interest are both the political mandate underlying the conscious decision of the U.S. Navy to exploit Japan's industrial base, and the impact that exploitation had upon America's post-war technological development. Of parallel consideration are the efforts of the Japanese to prevent the post-war discovery of its most sensitive research projects, and/or the agreement of the United States not to publicize their existence.

BIBLIOGRAPHY

Aoki, Shosaburo. Kogaku heiki kogyo no kaiso (*Recollections of Optical Weapons Manufacture*) in, Suikokai. Kaiso no Nihon Kaigun (*The Japanese Navy Remembered*) Tokyo, Japan: Hara Shobo, 1985.

Evans, David C. & Peattie, Mark R. Kaigun: Strategy, Tactics, and Technology in the Imperial Japanese Navy, 1887-1941 Annapolis, MD: Naval Institute Press, 1997.

Fuji Photo Optical Co. Ltd. "Company History" Fuji Photo Optical Co. Ltd. 30/05/2001. <http://www.fujinon.co.jp/outline/ out02.htm>

Grimes, C.G. Captain, USN, ed. "Japanese Optics" U.S. Naval Technical Mission to Japan – Series X: Miscellaneous Targets – Report X-05 Washington D.C.: U.S. Government Printing Office, U.S. Naval History Division, 1945.

Grimes, C.G. Captain, USN, ed. U.S. Naval Technical Mission to Japan – History of Mission Washington D.C.: U.S. Government Printing Office, U.S. Naval History Division, 1946.

Ito Mikio. "Archivist's Memo No. 1" Nikon Corporation. 02/05/2001. <http://www.nikon.co.jp/main/eng/d-archives/memo/m01_e.htm>

Jentschura, Hansgeorg & Jung, Deiter & Mickel, Peter. (Preston, Antony & Brown, J.D., trans.) Warships of the Imperial Japanese Navy, 1869-1945 Annapolis, MD: Naval Institute Press, 1977.

Howe, Christopher. The Origins of Japanese Trade Supremacy: Development and Technology in Asia from 1540 to the Pacific War London, UK: Hurst & Company, 1996.

Kobayashi, Tatsuo. *The London Naval Treaty, 1930* in, Morley, James William (ed.) Japan Erupts: The London Naval Conference and the Manchurian Incident, 1928-1932 New York, NY: Columbia University Press, 1984.

Low, J. Edward. "Directors" Mechanisms of Imperial Japanese Navy Warships in 3-D 04/29/2001. <http://www.ijn.dreamhost.com/Directors/Directors.htm>

Mayer-Oakes, Thomas Francis (ed.). Fragile Victory: Prince Saionji and the 1930 London Naval Treaty Issue from the Memoirs of Baron Harada Kumao (Detroit, MI: Wayne State University Press, 1968) pp. 17-18.

Nikon Historical Society. "A Short History of Nippon Kogaku Japan." Nikon Historical Society 04/09/2001. <http://www.nikonhs.org/history.html>

Nikon Corporation. "Nikon Portfolio: Brief History" Nikon Corporation 24/06/2001. <http://www.nikon.co.jp/main/eng/portfolio/history.htm>

Nikon Corporation. "Brief History of Nikon Cameras" Nikon Corporation 02/05/2001. <http://www.nikon.co.jp/main/eng/d-archives/camera/history_e.htm>

Nippon Kogaku Kogyo. Gojunen no ayumi / 50-nenshi Henshu Senmon Iinkai henshu (*50-year History of Nippon Kogaku*) Tokyo, Japan: Nihon Kogaku Kogyo, 1967.

Samuels, Richard J. "Rich Nation, Strong Army" – National Security and the Technological Transformation of Japan Ithaca, NY: Cornell University Press, 1994.

APPENDIX I

Table I – The Navy Supplemental Program, November 11, 1930 [104]

Ship construction (6-year program, 1931-36):

1. Cruiser, destroyer and submarine Replacement	¥227,080,000	Total
2. Construction in unlimited categories	20,000,000	¥247,080,000

Aviation replacement and expansion:

1. Activation of 14 Airgroups (8-year program, 1931-38)	¥46,340,000	
2. Maintenance of same (7-year program, 1932-38)	45,510,000	
3. Maintenance of carrier-plane Units	6,000,000	
4. Experimental aviation construction	4,250,000	¥102,100,000

Miscellaneous replenishment:

1. Modernization, re-construction of capital ships and auxiliaries (in addition to balance of ¥23,000,000 from previous appropriation), 1931-36	¥20,000,000	
2. Increase in special ship repair fund	5,000,000	
3. Costs incidental to maintenance of ship performance, improvement of training, and adjunct technical skills	19,950,000	¥44,950,000
		¥394,130,000

Ship Construction under the Supplemental Program:

1. Cruisers (6-inch 8,500 ton)	4 ships
2. Destroyers	9 ships
3. Submarines	12 ships
4. Vessels of other, unlimited categories	2 ships

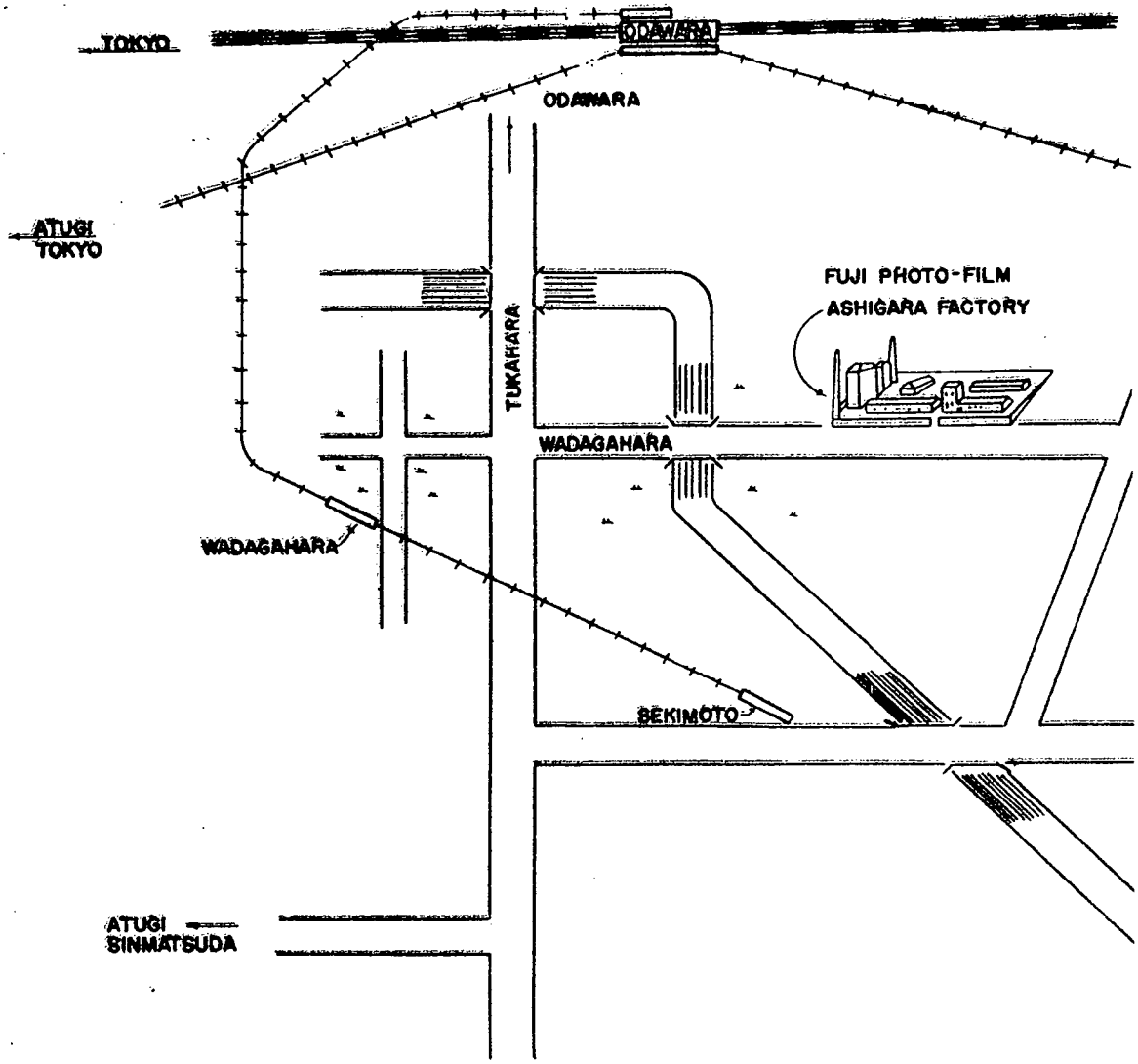
Sources of Funds for this Naval Supplementary Program:

- From the balance in the ¥508,000,000 ship construction fund, appropriated for 1931-36.	¥374,000,000
- From other sources, appropriated for 1937-39.	¥ 20,000,000
- There is, thus, a saving of ¥134 million from the ¥508 million appropriation to be allocated for tax reduction.	

[104] Mayer-Oakes, Thomas Francis (ed.). Fragile Victory: Prince Saionji and the 1930 London Treaty Issue

APPENDIX II

Figure I – Map of *Fuji* Film Company, Ashigara Manufacturing Plant [105]

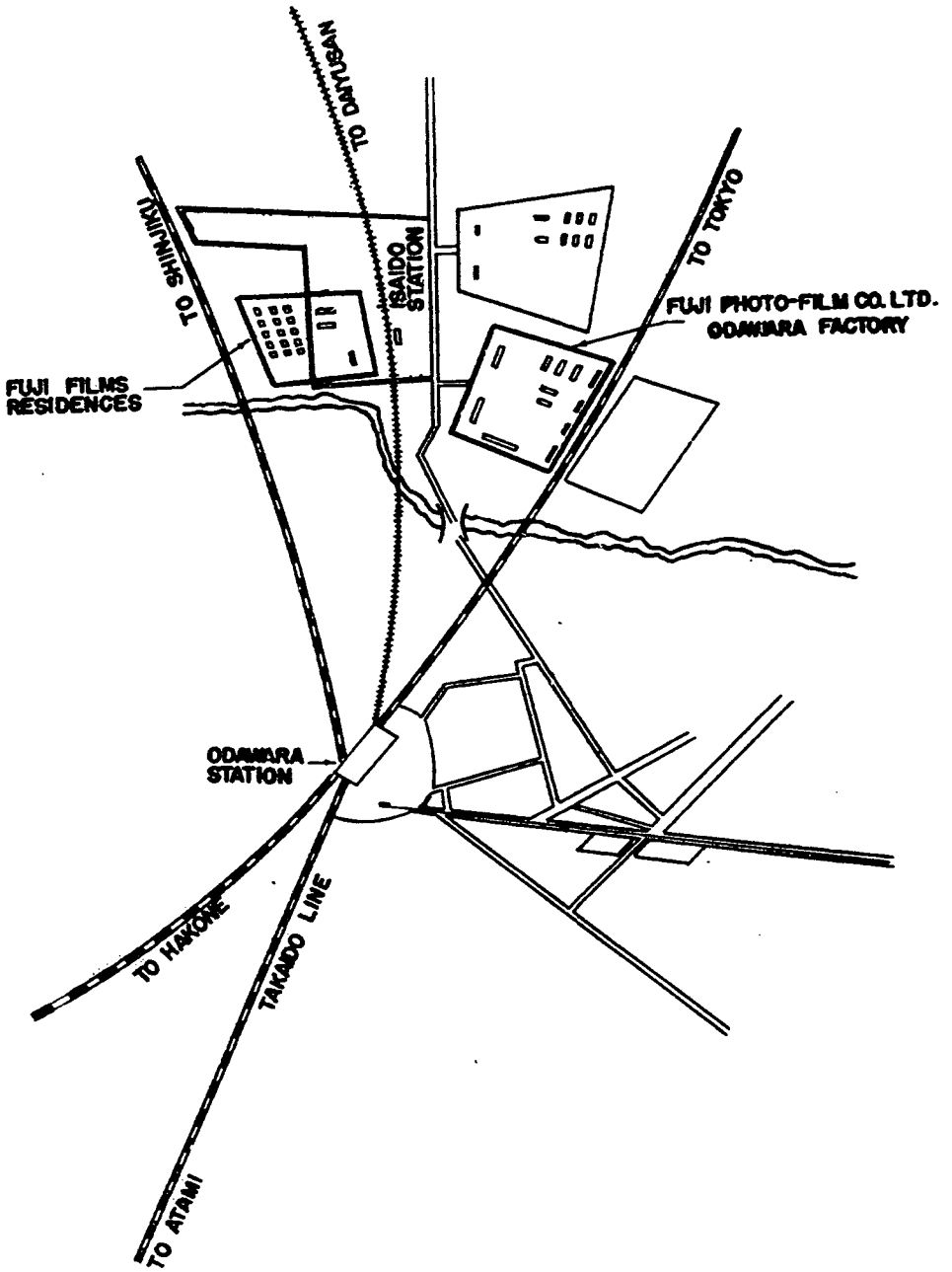


from the Memoirs of Baron Harada Kumao (Detroit, MI: Wayne State University Press, 1968) pp. 17-18

[105] "Japanese Optics" U.S. Naval Technical Mission to Japan, p. 56.

APPENDIX III

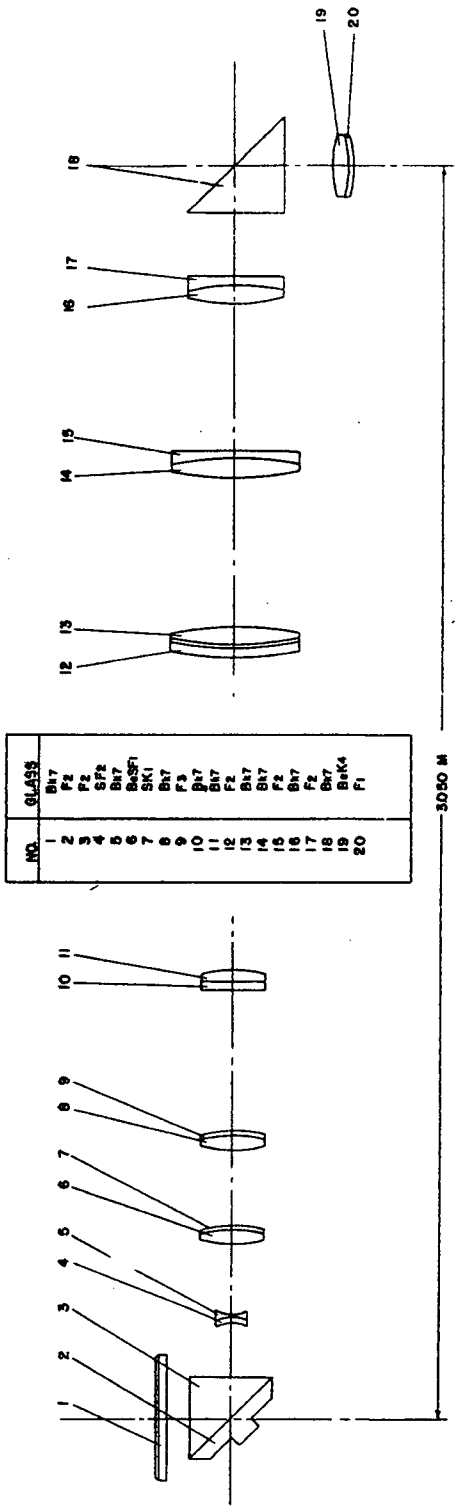
Figure II – Map of *Fuji* Film Company, Odawara Manufacturing Plant [106]



[106] "Japanese Optics" U.S. Naval Technical Mission to Japan, p. 49.

APPENDIX IV

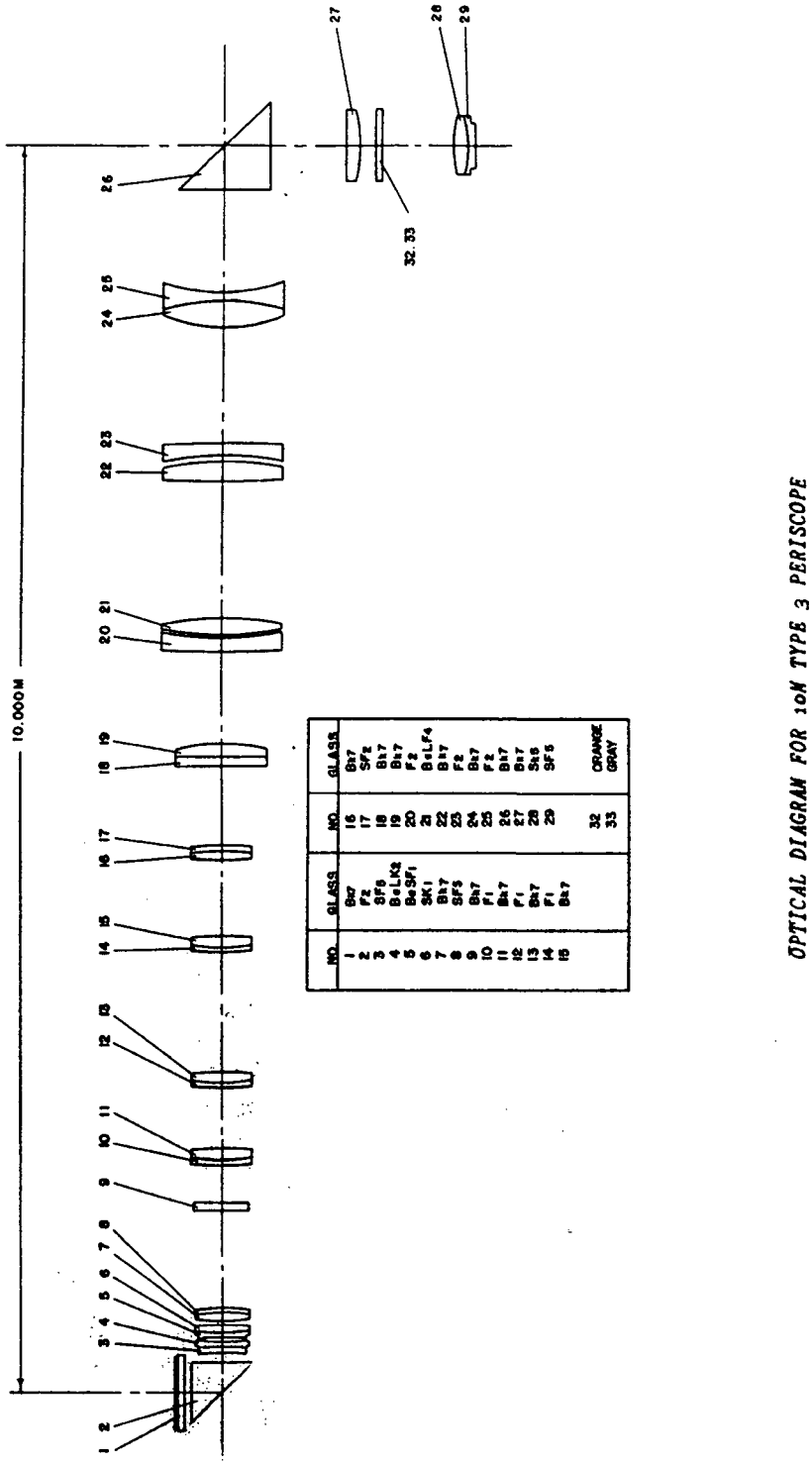
Figure III – Diagram of Midget Submarine Periscope [107]



[107] "Japanese Optics" U.S. Naval Technical Mission to Japan, p. 41

APPENDIX V

Figure IV – Diagram of 10-metre Periscope [108]



[108] "Japanese Optics" U.S. Naval Technical Mission to Japan, p. 42.

APPENDIX VI

Table II – Abbreviated List of Items Taken to Indiana Head, Maryland by USN, 1945 [109]

EQUIPMENT SHIPPED TO ORDNANCE INVESTIGATION LABORATORY, INDIANA HEAD, MARYLAND

NavTechJap Equipment No.	Item	No. Shipped
JE10-3101	Oiji Type machine gun sight	1
-3102	Type 95 gun bombsight	1
-3103	Type 2 Model 1 bombsight	1
-3105	Bubble sextant	2
-3106	Small drift meter	2
-3108	Type 97 drift meter mount	2
-3110	Bombsight bubble levels	1
-3112	Celestial navigation slide rule	4
-3113	Navigational plotting boards	2
-3114	Type IV gun bombsight	1
-3115	Type III gun bombsight	5
-3116	Celestial navigation calculator	2
-3118	12cm A.A. binocular tripods	4
-3119	Type 90 Model 5 bombsight	1
-3120	Drift meter for night use	1
-3121	Type 97 MK1 Model 4 drift meter	2
-3123	Canada balsam	2 Bottles
-3124	18cm binoculars	2
-3126	8cm binoculars	1
-3127	12cm binocular for Type 97 director	2
-3128	Spherical star maps	2 BX
JE10-4978(1-4)	Sextants	4
JE21-3114	Periscopes for suicide torpedoes	10 BX
-3105(1-3)	Stereoscope viewers	3
-3107(1-3)	Sextants	3
-3109-1	12cm spotting binoculars (tripod, mount)	1
-3101-1,2	12cm spotting binoculars	2
-3110	12cm A.A. binoculars	1
JE50-5035 & 5037	Sextants	2

[109] "Japanese Optics" U.S. Naval Technical Mission to Japan, p. 33.

APPENDIX VII

Table III – List of Firms to which *Fuji* Optical Glass was Sold, 1941-1945 [110]

Table II
LIST OF ALL FIRMS TO WHICH OPTICAL GLASS WAS SOLD BY FUJI OPTICAL CO., 1941 to 1945

(Unit: kg)

Firms	1941	1942	1943	1944	1945	Total
Tokyo Daiichi Rikugun Zoheisho	3,645	17,688	17,316	26,878	20,572	86,099
Fuji Shashin Koki			6,492	8,024	9,615	24,131
Tomioka Kogaku	883	9,766	9,084	50	400	20,183
Showa Kogaku (Inoue Kogaku)	265	1,330	2,533			4,128
Okada Kogaku		2,378	84		1,677	4,139
Seiki Kogaku			32	3,424	186	3,642
Nippon Taipu			1,612	530	500	2,642
Fuji Kogaku					2,231	2,231
Konishiroku Shashin Kogyo					1,906	1,906
Asahi Kogaku				260	1,074	1,334
Takachiho Kogaku					1,684	1,684
Shimazu Seisakusho		60	651		200	911
Tokyo Tokei (Tamagawa Koki)		707	185	1,074		1,966
Chiyoda Kogaku			15	1,292	617	1,924
Yamato Kogaku			1,721			1,721
Riden Kogaku			162			162
Total	4,793	31,929	39,887	41,532	40,662	158,803

Note: Amounts include products of the second and third class sold.

[110] "Japanese Optics" U.S. Naval Technical Mission to Japan, p. 21.