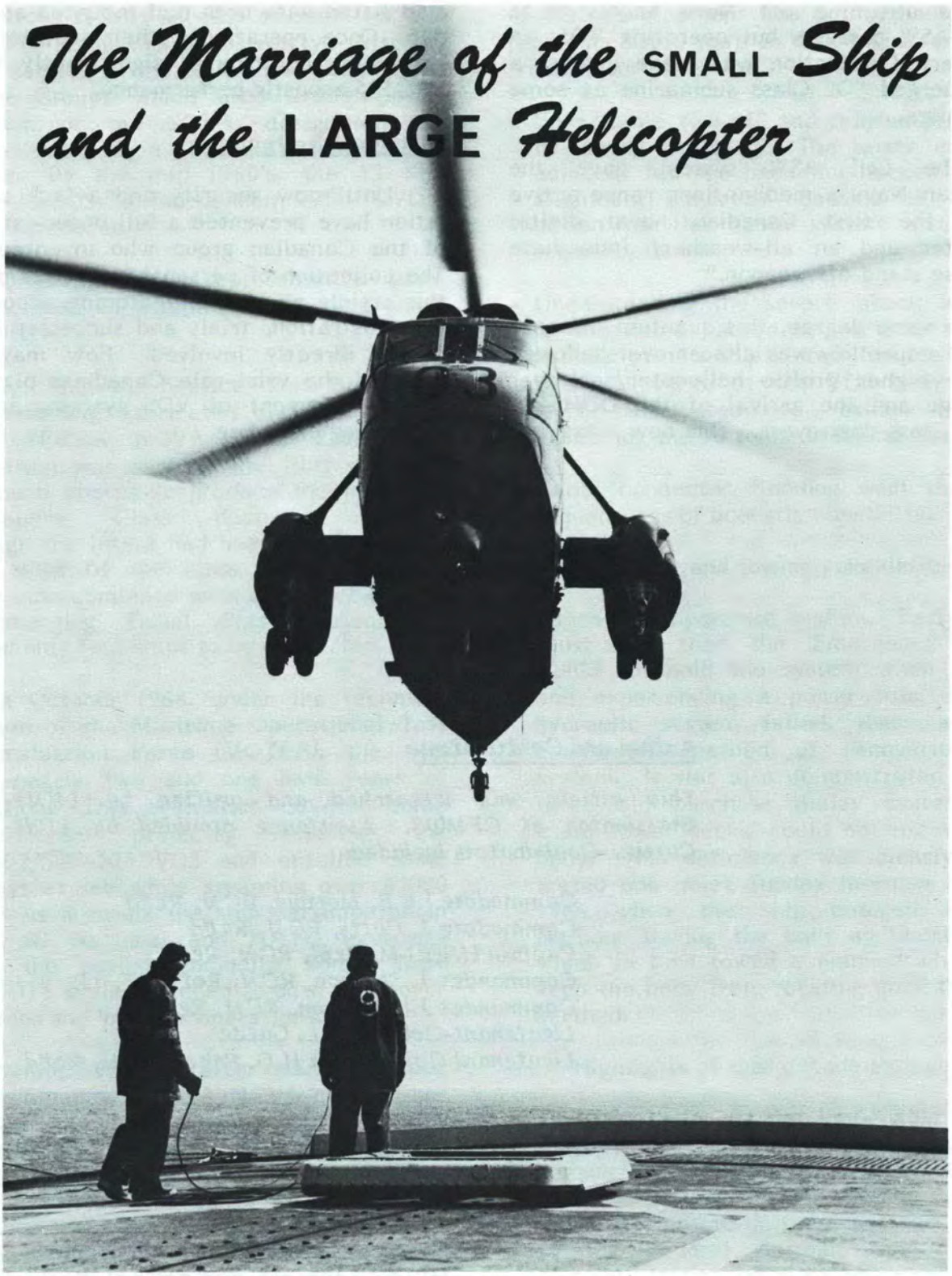
The Marriage of the SMALL *Ship and the* LARGE *Helicopter*



Large helicopters on small ships! Many Navies operate helicopters from destroyer/frigate size ships; however, only Canada operates SeaKing-size helicopters from destroyer-size decks and has been doing so for over twenty years. The ability to do this is the result of the efforts of a group of dedicated individuals faced with a problem to solve some thirty years ago.

The Beginnings

The ASW helicopter emerged from the normal pendulum of advantages gained and lost applicable to all forms of warfare. By the mid-1950's submarines were capable of diving deeper, running faster and attacking from greater ranges. The advent of the nuclear age in the form of the USS NAUTILUS, with its high speed and virtual limitless endurance, saw the pendulum swing hard over, away from the surface ship as the best ASW vehicle. The helicopter, with its mobility and speed, its relative invulnerability to submarine attack, and its dipping sonar capable of being lowered deep into the submarine's environment was an appealing solution to a growing problem. Dipping helicopters were being flown from aircraft carriers at this time, but their full potential would not be realized until they could be operated from small deck ships.

The RCN had earlier recognized the potential of the small ship - helo union. A memo from SO (Fuel) Operations Division to DOD suggested that "some of the Canadian frigates under construction should be completed as anti-submarine helicopter carriers." This memo was dated 23 January 1943.

In the mid-1950's, a committee in NHQ (Naval Headquarters Ottawa) was examining methods whereby the new St. Laurent and Restigouche Classes of destroyers could be given a weapons system capable of countering the nuclear submarine. Some of the areas under consideration included ship launched guided missile torpedoes capable of attacking at long range and the possibility of operating ASW helicopters from destroyers. Also under investigation by the same committee was the concept of the open ocean hydrofoil with a variable depth or towed array sonar. Each of these projects involved indepth studies including trials in the tactical trainer at the Joint Maritime Warfare School Halifax.

The missile idea was eliminated due to problems associated with accurately putting a weapon on a fast, deep target at long range. The hydrofoil concept was deemed to have merit and it was decided to continue with the studies. Its major drawback, which showed up in the JMWS tactical trainer trials, was that because of the hydrofoil's noise, the submarine always knew where the hydrofoil was and so could avoid it. The helicopter seemed to be the best prospect because:

* It was (at the time) immune to counter attack by the submarine.
* Its movements could not be easily predicted by the submarine.
* It could carry more than one weapon.
* Its quick reaction meant that at short notice several helos could join up to work together on one contact.
* It could operate in all weather, day and night.
* It could operate at long range from the mother ship.
* With the destroyer acting as a Command Post, the anti-submarine battle could be fought at long range, never letting the ship become exposed to the submarine's weapons.

The Aircraft

As a result of these studies, the Director of Naval Air, Commander G.C. Edwards, was authorized to commence trials on the feasibility and implications of placing a large helicopter on a small ship. The Department of Defence opened the competition and responses were received from: Doman, Kaman, Sikorsky, Vertol, Bristol and Westland. Of the proposals received only two, the Kaman HU2K and the Sikorsky S-58 (HSS-1) emerged as being at all suitable. However the "look ahead" indicated that the sensor/weapon package required and the performance capabilities necessary for the projected role proved to be too great for even these two finalists. Attention turned to a new aircraft, the S-61 (HSS-2) Sea King. This aircraft was at the time undergoing early testing prior to its introduction

into the USN as a carrier-borne ASW vehicle. Although the SeaKing was a larger helicopter than originally planned for, it was eventually selected for the following reasons:

* It had an automatic hover capability.

* It was a proven all-weather, day-night aircraft.

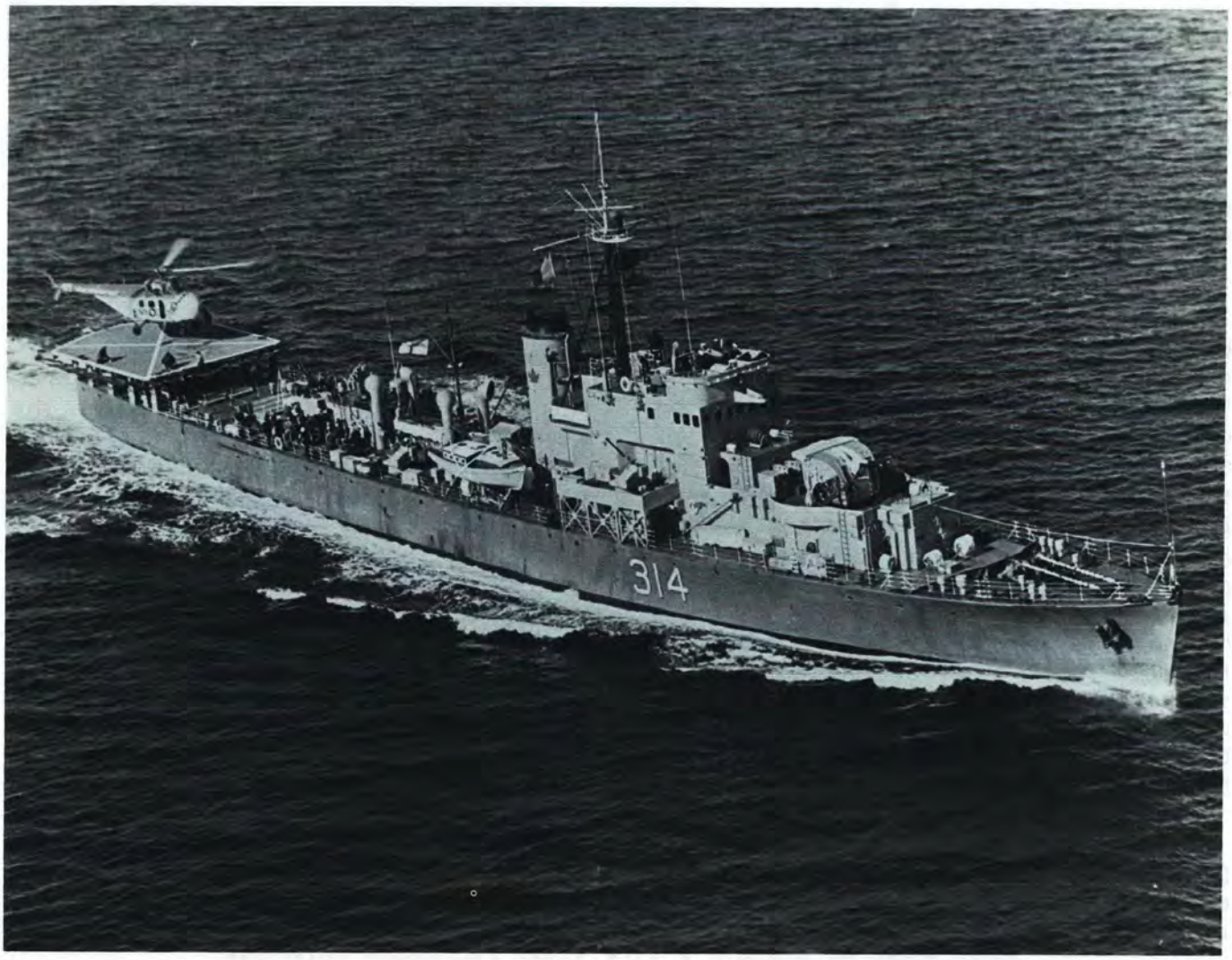
* It contained the latest in sophisticated dipping sonar and integrated weapons systems.

* It had high speed and long endurance.

* It had a boat hull, for use in emergency ditchings.

Trials Onboard HMCS BUCKINGHAM and HMCS OTTAWA

The ship-aircraft interface trials began in September of 1956. These were not meant to be operational ASW trials, but rather careful walks in a previously unexplored 'no man's land'. The ship chosen was a Prestonian Class frigate, HMCS BUCKINGHAM, under the command of LCdr Tom Connors. A steel deck was built by HMC Dockyard in Halifax and fitted aft over BUCKINGHAM's mortar wells. The first "helicopter platform trials" were conducted in Bedford Basin by LCdr Rod Bays and LCdr John Laurie flying a Sikorsky S-55 (HO4S-3) from HU-21 Squadron Shearwater.



The Real Beginnings

First Landings

Trials continued with the BUCKINGHAM and her HO4S helicopter for the remainder of the year. These trials progressed from the Basin to the Harbour Approaches to the Bay of Fundy and down the coast to Portland, Boston and Bermuda. Sea trials were considered very important to the project and required BUCKINGHAM to spend a great deal of time away. LCdr Connors commented in his 'Report of Proceedings' for December that "BUCKINGHAM's longest period in home port during the year was from 21 to 31 December 1956."

BUCKINGHAM with her helicopter platform and HO4S helicopter were unique, and very much the objects of interest and curiousity to all who saw them. Senior naval officers quickly became "routine" visitors in every port and at sea. During one series of trials off Halifax and while operating in company with HMCS MAGNIFICENT, Captain(N) A.B. Fraser-Harris, MAGNIFICENT's Commanding Officer, took part in the trials and piloted the aircraft through three landing sequences.

While the trials were generally acknowledged as proceeding satisfactorily, some serious problems were noted. Primarily, the undercarriage of the HO4S could not stand up to the constant strain imparted to it by the rolling and pitching of the destroyer's deck. A different/larger helicopter was required if the trials were to continue. The RCN received, on loan from the RCAF, an S-58 helicopter and a pilot who would join LCdr Bill Frayn for the next stage of testing, the heavy weather trials. The flight deck was removed from BUCKINGHAM, modified and fitted to HMCS OTTAWA in preparation for the next phase. OTTAWA and her comparatively larger helo with its better and stronger undercarriage arrangement set out in pursuit of "heavy weather". They found it! Upon her return from her solo voyage to England and back, OTTAWA gave the S-58 back to the RCAF with such a bad case of salt water corrosion that rumour has it that the helo never flew again.

RCAF At Sea

From the RCN's point of view, at least, the trial was a success, and the report concluded:

- that a large helicopter can operate from a small ship in heavy weather;

- that a hangar is essential for maintenance and shelter;

- that a quick release and rapid securing device is essential; and

- that mechanical assistance in deck handling the aircraft was required. (Note: There were no hangars. The difficulties in straightening and traversing the aircraft had not yet been encountered. It is a credit to the ingenuity and foresightedness of the project team members that the problem, with all its implications, was identified at that time. The USN, more than twenty years later in upgrading its newer ships with larger helicopters (LAMPS III) wrestled with the very same problems and settled on the Canadian conceived, designed, and built Beartrap and traversing system as the solution.)

The Navy Of The Day!

During the whole of this ASW helicopter development and evaluation process (circa 1956-62), a number of major considerations were interwoven. A partial list includes:

* search and selection for a suitable aircraft

* design and configuration of the flight deck and hangar

* design of a rapid securing/quick release/ traversing system

* planning the personnel organization of air squadrons and ships

* shipborne flying trials

* development of technical and operating manuals, and operational procedures

Perhaps, now is the time to take note of the organization of the RCN in those days. At that time, through its training programs and personnel policies, there existed a total integration of naval aviation within the navy. Operational crews had extensive naval experience at sea both as aviation sub-specialists and as ships officers. In the technical arm of the Naval Air Service, the maintenance personnel had the knowledge and experience of operating and maintaining aircraft in the confining and demanding conditions of the aircraft carriers. Operational decisions, design specifications, authority for modifications and changes for naval aircraft, all were the responsibility of the Naval Air Directorate. The staff of the Directorate was made up of officers with hands-on naval experience; indeed, many senior staff had been ship commanders. On a personal note, I recall my father, who was then in the RCN as an Electrician (Air), as having successive postings to the Fighter Squadron VF-870, the cruiser HMCS QUEBEC, and "L" Division, HMCS Stadacona. It was that kind of Navy! This commonality of background experience and future expectations on both the air and surface sides lent a cohesiveness to the project which prevented it from bogging down. Consequently, the RCN was able to develop a ship/helicopter system which was to be a leader to all other Navies.

During this period, close contact was maintained with both the USN and the RN, each being concerned with the progress of the others. The RN had developed an aircraft securing method consisting of a wire mesh grid of steel cable suspended about six inches above the deck. Upon landing a harpoon shaped probe on the underside of the aircraft penetrated the mesh. The flukes on the probe attached themselves to the wires and thus secured the aircraft to the deck. The grid was sufficiently large enough that the helicopter could be flown onto it when landing. In the meantime the USN was working with unmanned drone helicopters. They were experimenting with a constant tension winch as an aid in keeping the drone over the deck in preparation for landing. The engineers working on the Canadian project had been convinced for some time that some form of constant tension cable system was needed for centering assistance during hovering and landing. Their idea had progressed to the point of tests involving an aircraft and a tractor. A cable attached to the bottom of the aircraft, fed through a series of snatch blocks, ended upon a reel on the back of the tractor. While the helicopter moved backward, forward, left, and right, experimenting with the flight aspects of the centering effect of the cable at various angles, the tractor moved back and forth simulating the movement of a ship's deck. Interest in the USN system was understandably high. Following the "tractor trials", LCdr Don Cruickshank spent some time at sea in the USS HAZELWOOD observing their operation with the drone and the constant tension winch system. On his return he confirmed that the previous thinking was correct and with that the constant tension winch principle was adopted. The problem of having to accurately and consistently land a very large helicopter on a tiny piece of flight deck was solved; however, the problems of securing it and moving it about the deck remained.

The Beartrap

The securing and traversing problems were both separate and conjoined. Therefore it was decided to tackle them together. The project team set down two basic requirements. They were that the system must be capable of securing the aircraft to the deck as soon as possible after landing and manoeuvring the aircraft into, and out of, the hangar.

They began by looking at moving the securing device in and out of the hangar. They were convinced that external devices, such as winches or mules, should not be used. It must be self propelled. They quickly devised a system with an electrically powered dolly mounted in a track beneath the deck which could move fore and aft and bring the securing device on deck with it. Contractors confirmed the feasi-

bility of the idea. The second part of the problem, attaching the aircraft to the securing device, proved a little more difficult.

As previously mentioned, the RN was experimenting with a wire mesh grid and harpoon. The obvious first step was to try to incorporate the RN's wire mesh into the moveable dolly. The major shortcoming of this arrangement quickly became apparent. It was absolutely essential that if the aircraft (remember, we are talking about the 10 ton SeaKing) was to fit into the hangar it must be perfectly centred in the traversing device. With the assistance of the constant tension centering wire (later referred to as the "haul-down" cable) the aircraft was capable of landing close to the centre of the flight deck, but there could still be a displacement of up to two feet, and/or the tail would be off centre.

A third requirement reared its head, difficult to engineer yet absolutely essential. The "system" had to be capable of centering the aircraft after it had landed and prior to moving it forward into the hangar. A circular rotating framework was considered but the limitations of the wire mesh grid and the elaborate mechanics required made the idea impractical. At this apparent impasse, they, as it was told to me, "stepped back, took a breath, and returned to basics". In fact what happened was that Cdr John Frank (at that time Director of Aircraft Design and Development at NHQ) brought in his son's meccano set and they went to work on the problem. Before long the concept of four powered rails mounted inside a square frame and moving parallel to the sides was developed. A working model was built and presented to Fairey Aviation of Canada Ltd with instructions to submit a proposal for the construction of a prototype. The "Beartrap" was conceived and born in precisely this manner. It is indeed indicative of the engineering expertise of this group that the Beartrap rapid securing and traversing system continues in service in many Navies today virtually unchanged from that which they designed over twenty years ago.

"Hands Off" Traversing In and Out of the Hangar

The Ship

In the meantime, HMCS ASSINIBOINE had been selected as the prototype DDH and was in Esquimalt undergoing a major conversion which included the addition of a hangar, flight deck, and associated fittings and spaces. One of the critical factors which contributed to the overall success of this entire venture lies in the characteristics of the St. Laurent Class. She was, at that time, the finest state of the art destroyer escort and although not designed with helicopters in mind, she might well have been. Her built-in stability meant that she could take in stride the extra top weight of helicopter, hangar and flight deck. Her high freeboard offered a spacious, uncluttered platform where helicopter operations could be conducted free from all but the worst conditions of sea and spray. The basic rightness of design and her ability to accommodate new generations of equipment and weapons have made this Canadian designed and built class of ship one of the most outstanding of all time.

As the conversion was nearing completion, ASSINIBOINE (under the command of Cdr Walter Blandy) eagerly awaited the arrival of her first helicopter. They would have to postpone the marriage a little longer, however, because what was being shipped from Halifax via CN Rail was not a SeaKing. It was, in fact, a carefully built "dummy" helicopter made out of cement blocks. It had an accurately positioned SeaKing undercarriage and probe plus a centre of gravity that was within half an inch horizontally and vertically of that of the real aircraft. Its weight could be varied in 1250 pound increments between 13000 and 18000 pounds. It was with this dummy aircraft that ASSINIBOINE set sail for Halifax in the fall of 1963, and under the careful eye of C2AT4 Tom Boyd conducted an extensive series of straightening and traversing trials, in ship motions of up to 12° of roll.

Once in Halifax, after some minor modifications, the flying trials commenced. The SeaKing was not yet operational but the

HMCS ASSINIBOINE and her VX-10 SeaKing

USN, very much interested in the project, arranged for the RCN to get one of their aircraft right off the production line. The aircraft was delivered to VX-10, the RCN's Test Development and Evaluation Squadron, for reconfiguration. In January of 1963 VX-10, under the command of LCdr Shel Rowell, had been directed to evaluate helicopter haul-down, rapid securing and deck handling systems for use in helicopter operations from destroyers. The VX-10 project team was formed with LCdr Peter Carlton handling the technical aspects and LCdr Joe Soznkowski as the project pilot. Flying and ground handling trials began immediately at Shearwater.

For the next two years the project continued simultaneously with the delivery of the aircraft for fleet use and the change-over to them from the HO4S. Flight trials, including "haul-down" and "free-deck" landings with and without the Beartrap, were progressing satisfactorily. Considerable problems were still being experienced in straightening and traversing the aircraft. LCdr Jim Atwood, the technical project officer in NHQ, redesigned the tail grid and this resolved some of the difficulties. A straightening problem arose quite unexpectedly out of "severe calm" conditions. Very briefly, straightening or centering, is accomplished in the following manner, the aircraft has landed, is shut down, and the probe is locked into the jaws of the Beartrap. The trap is traversed aft across two forward facing 60° chevrons. When the shuttles on the jaws come in contact with the chevrons, they are forced into the centre, carrying the jaws and thereby the probe and the aircraft with them. The LSO (Landing Safety Officer) who controlled this evolution used the roll of the deck to achieve two things. First, no matter which side of the trap the aircraft had landed in, the roll moved it "downhill" to the centre. Second, the roll was used to swing the tail to the centre, since the aircraft, once centred, had to then be perfectly aligned fore and aft in order to fit into the hangar. On the day in question the ship was at anchor in Bedford Basin. It was winter, there was a covering of frost on the flight deck, and it was flat calm. When they tried to straighten the aircraft, they found they couldn't do so. The combination of no roll and frost reduced the friction between the deck and the tires so that the aircraft simply skidded sideways - the tail would not swing. A number of possible solutions were discussed - from electrically heating the flight deck to having someone steer the tail around with a small powered tow bar. LCdr Craig Balsom sketched out the solution, literally on the back of a cigarette package. The result, which was engineered and installed in about two months, was tail-guide winches. This continuous loop concept with single point control, originally meant as an emergency back up system, is routinely used in all DDHs today.

By late 1967, numerous changes had gone on in both ship and aircraft. The final phase was the night/heavy weather trials, flown by LCdr Gerry Watson as the project pilot with Lt Bill Peterson providing the engineering input. Maturity had set in. HS-50 was designated a shore squadron and tasked with providing trained air detachments to DDHs. Tactics were drawn up at the Joint Maritime Warfare School by men like LCdr Ken Gibbs, a former CO of HS-50. With the decommissioning of BONAVENTURE, DDHs driven by Commanders with "my ship" - "my helicopter" backgrounds moved in to take up the slack.

This arranged marriage between a child bride ocean escort and her even younger groom helicopter proved to be a long and happy one in Canadian Naval Aviation. From ANNAPOLIS through the 280's to the upcoming CPF, all Canadian destroyers have been designed for this ship-helo team. All those who took part in those early days should recall with pride their involvement in this union. Their efforts brought about the birth of a new generation of naval airmen - TACCOs (Tactical Coordinators) and AESOs (Airborne Electronic Systems Operators) who are capable of conducting independent operations in a modern ASW theatre; and pilots who routinely place their 10 ton machines, still the largest of any Navy in this role, within 24 inches of the centre of a pitching, rolling and heaving deck in round-the-clock, all-weather conditions.

Author and Contributors

This article was researched and written by Captain C. Dalley of CFMWS. Capt Dalley has spent most of his twenty- three years of RCN/CF experience flying helicopters from the decks of ships ranging from carrier to destroyer size. He has logged over 3500 flying hours in the SeaKing, and more than 800 deck landings. Assistance provided by LCol A. Kerr, the Deputy Commandant CFMWS, and Maj J.A. Cox, a Staff Officer of CFMWS. Contributors included:

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