MIT Lincoln Laboratory Journal: Fifty Years of Radar

William P. Delaney & William W. Ward, (eds.)
Lincoln Laboratory, Lexington, MA
2000, Soft cover, 444 pages
ISSN 0896-4130

Many of our non-US readers may not be well-informed about the steps and work in radar development in the US after WW II to the present. Many of us know MIT by name and recall the famous Radiation Laboratory Series produced (luckily!) just after the battles ended. But the more recent technical history has been less in the "public domain." In an attempt to correct this, one of the key institutions in the field, the MIT Lincoln Laboratory two years ago produced a nice special issue of their regular publication. Although the document currently at hand is not a book in the strict sense, the size, shape, and editorial comprehensiveness of the *MIT Lincoln Laboratory Journal's Fifty-Year Anniversary Issue* (**12**, 2, 2000) justifies calling this text a book review.

This special issue of the Lincoln Laboratory Journal has fifteen individual technical chapters, a brief but interesting "outsider's view" written by professor Merrill I. Skolnik, a separate list of acronyms, and a comprehensive alphabetical index. The volume has 444 pages in A4 size, printed in two-column layout. Two distinguished scientists, having long careers at Lincoln, William P. Delaney and William W. Ward, certainly had hard times selecting the material to be included. Their approach has been to create an overview of work done during the past 50 years, and, at the same time, highlight those specific projects where Lincoln Laboratory once had (or still has) a unique fingerprint. One of the apparent reasons for this special journal is time. Those who still remember are not that many, and every year this particular group of people gets unavoidably smaller. Besides the editors themselves, more than 30 individuals have contributed directly to this compilation – the number of indirect contributions being (apparently) at least ten times that. The topics covered include an overview of radar development at Lincoln, early advances in aircraft detection, several items on early warning and UHF radars, three chapters about radars for ballistic missile defense or related research, one chapter is devoted to cruise missiles, and two sections on radar antennas – specifically discussing phased array technologies. One chapter is devoted to signal processing, and specialties, such as the tracking of satellites and planets, and advances in laser technology have their own sections, as well.

Illustrations are one of the strong points in this special issue. Their total amount is near one thousand and many seem to be previously unpublished material, at least not seen too often outside the US. Color has been used whenever possible – that is, if a good-quality color photograph was available from the early days – and many systems are described simultaneously through photographs and schematic drawings which should make reading very interesting for those who have not personally participated in the projects. Performance of once-developed equipment is shown as curves, radiation patterns, and as tabulated data, but also realistic radar plots have been included. Every chapter has a list of references (in some sections up to 40+ items), which greatly adds to the scientific value of this issue, because now an interested reader can easily find the detailed mathematical treatment behind a specific system. In fact, this anniversary issue contains no equations; it is entirely a systems-oriented presentation.

The special journal is arranged as separate chapters, which means that anyone interested in one thematic area can just select it and leave the rest, but the editors have managed to compile a nice cross-referencing feature which means that while studying one topical area, the reader is pointed to related stories having possible attraction as well. Particularly, the presentation of technologies used in the early warning radar networks is a benefit to this feature. Another fine idea which enhances the reader's possibilities in "connecting threads," has been to collect a separate chapter for us true hardware people who have fallen in love with various gadgets. In the journal, the story is called *"Widgets and Wonders."* This section describes huge radar installations such as the aurora-research radar having dual 1.5 MW magnetrons for UHF work, "Caterpillar" working at 18 MHz ground wave and naturally, the Millstone radar series with its 84 feet parabolic tracking antennas. Additional devices shown include a millimeter-wave Moon radar, the portable Chipmunk (AN/TPS-23) intended for front-line use, and the experimental bat laboratory which was

used to record and observe the acoustic radar used by these animals (obviously an effort to learn from them). Also, radar components and test instruments developed at Lincoln are illustrated in this chapter. High power transmitter tubes, spectrum analyzers, and impressing delay lines are good examples of the laboratory's activities in those days. Some of the described experiments might well fall into the category of high energy physics, because the editors have chosen still pictures from a movie which illustrated the effects of tens of MWs of RF power. Arcing in waveguides and rotary joints and the melting of plexiglass elements under radiation were once routine phenomena in the laboratory. Antennas and their feed arrangements have been photographed intensively.

Despite the fact that the journal issue is devoted to the past 50 years of activity at Lincoln, amazingly new and recent things appear on its pages. For example, a special chapter on tactical radars for ground surveillance is very up-to-date and discusses topics such as the ultra wide band (UWB) experiments performed in 1994-1995 and includes snapshots of ground penetrating devices, too. Similarly, a chapter about weather radar development has been extended to describe field tests which were performed in 1998. Modern phased array radars such as Cobra Dane and Cobra Judy are also illustrated and their further improvements outlined in the text. So, much of the information is supposed to be valid and could, thus, be very well applied in various tutorial activities. The editors have selected material for the entire journal issue in such a way that the reader is seldom annoyed by stories ending abruptly as "classified" data. This has apparently required particular skill when dealing with the early warning radar system, which still is – despite the end of the Cold War – an active element in the US defense scheme. Similar talents must have been at hand when creating the chapter about cruise missile detection. At least this reviewer was slightly astonished to see and study in detail a multi-color tactical scenario tested by Lincoln in the Pacific Missile Test Range near Hawaii. One of the very rare cases where technical results from the early 1990s remain classified and are, thus, not documented in the journal, are related to Doppler-laser radar imaging of space-borne objects.

Apparently, for historical reasons (although the editors insist the journal issue is *not* an historical document!) a couple of interesting short stories have been inserted. One of them, possibly not very well-known, discusses the early warning radar false alarm that almost initiated the Third World War in the fall of 1960. On 6 September that year, the early warning radar site in Thule, Greenland, observed an imminent missile attack, which fortunately turned out to be our neighbor – the Moon. The great power and aperture of the radar system enabled it to detect this "target," which was, at that time, traveling some 380,000 kilometers away! Another detail of historical interest is shown in a chapter dealing with ballistic missile detection. When the Soviet Union unexpectedly launched the world's first artificial satellite in October 1957, one of Lincoln Laboratory's radar inventions, the Millstone radar, actively detected and tracked that space vehicle. The journal issue includes a photograph of the respective A-scope view of that day. There is also reading for non-radar people. *What about having a look at a high-speed re-entry test range where pellets were once fired at speeds of up to 32,000 feet/s due to a hydrogen tank failure?*

I highly recommend this special journal. It is particularly suitable for those of us already pushed to the system level, where detailed mathematics is no more a daily topic and where learning from others' mistakes (and successes), have become habit. Many of our European readers might find new details related to past radar system design – at least for me this was a real goldmine of radar history. To be honest, there is only one negative observation I can make about the *Lincoln Laboratory's Fifty-Year Review*: the soft cover version of this heavy volume is mechanically too weak to withstand frequent reading. Pages come loose rather fast and then get wrinkled. Perhaps I have to take my copy immediately to the local bookstore and have it converted to hard cover layout.

– Pekka Eskelinen