new day new computer

World War II was entering its final phase. The U.S. forces had taken their lumps and had rapidly learned to administer a few of their own. The famed B-17 *Flying Fortress* and the somewhat less publicized but equally potent B-24 *Liberator* were the big guns of the Army's pubescent, but growing and

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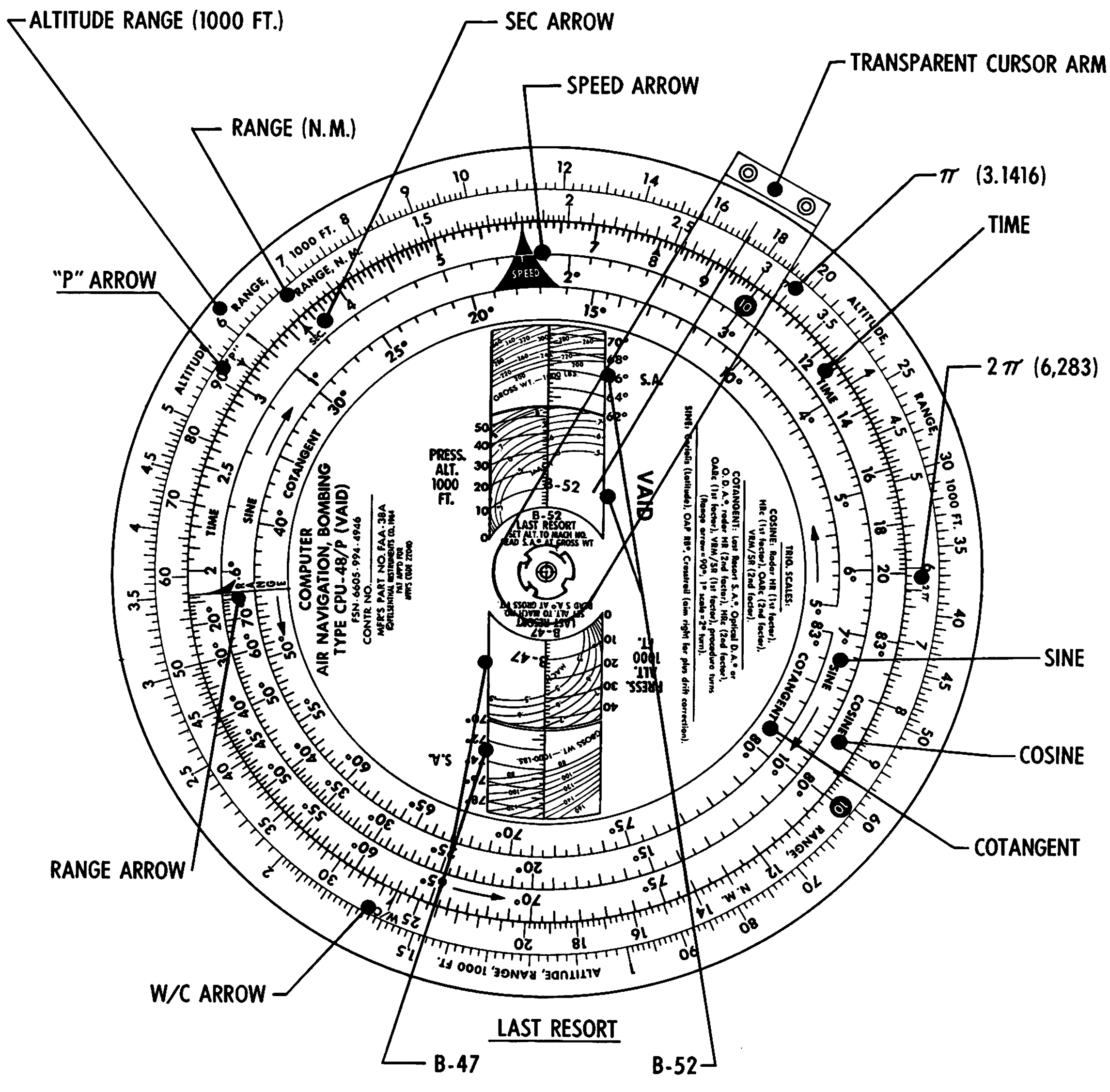

FIGURE 1. CPU-48 P COMPUTER, SLIDE RULE SIDE

maturing, Air Corps. Uncle was flexing his muscles and the end was in sight!

Inside the crude but often ingeniously designed Quonset hut bars scattered from Algiers to Assam to Attu, fuzzy-cheeked green-shirted navigators exchanged short snorters and tall tales with recently-weaned pilots in pink pants and under-aged bombardiers in brown shoes. It was pretty much of a toss-up which was more colorful—the stories or the uniforms! The Inspector General was a virtually unknown—and certainly unfeared—quantity, and the atmosphere was generally quite carefree. Death—though an omnipresent specter—was usually treated lightly and brushed away as something that could only happen to somebody else. Most of the time, the conversation over the warm beers centered around those time-honored and divergent (yet somehow related) topics—girls and combat. The dearth of one was more than compensated for by a surplus of the other, and an understandable amount of youthful exuberance and overstatement was normally interjected into both subjects.

Visual bombing was still king of aerial warfare, with the famed Norden bombsight (never surpassed for sheer accuracy on its own terms)

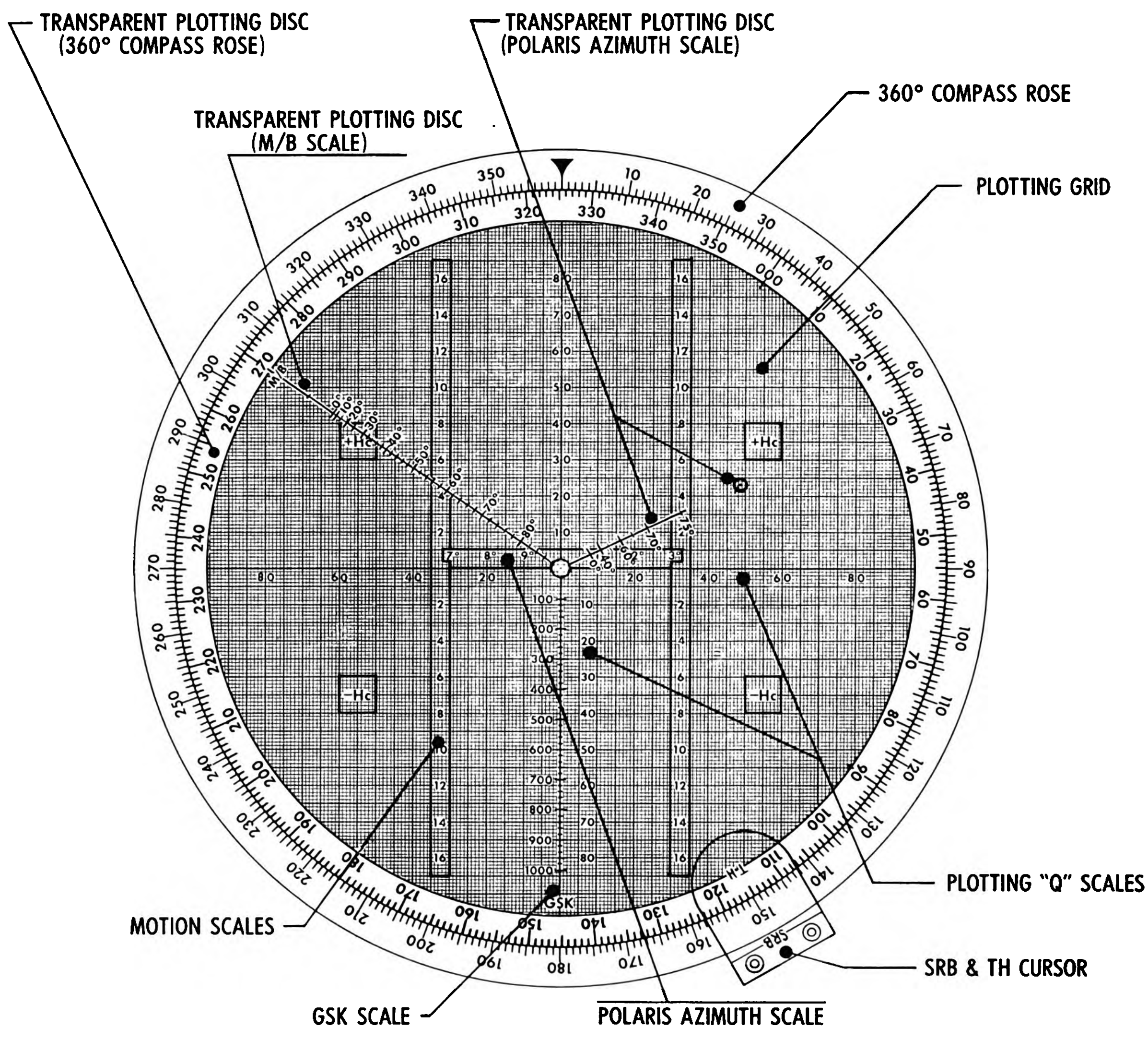

FIGURE 2. CPU-48/P COMPUTER, PLOTTING (GRID) SIDE

holding court as crown prince. Lurking in the outer fringes, however, a mysterious and as yet vaguely-known interloper—Radar—was just beginning to demand his rightful share of recognition. His constant companion and primary carrier, the B-29 *Superfortress,* was impatiently awaiting her debut and would soon become the acknowledged queen of the Pacific skies.

War is no time for pomp and ceremony. Radar was needed; Radar was put to work—just like that. So swift was the development of this new and wondrous all-weather sighting equipment that operator techniques, so often taken for granted nowadays, failed initially to keep pace. Precision bombing was an absolute must in those pre-nuclear days, but how to achieve this when the target couldn't be visually observed was indeed a problem. As is happily still the case with even our most advanced bombing and navigation equipment, some of the better solutions were derived by the users themselves.

Shortly after the arrival of the 20th Bomb Group at Saipan in 1944, its B-29 radar bombardiers recognized an urgent requirement for a simple aid to assist them in their mathematical calculations of the proper slant angles for radar bombing. Every outfit has its thinker, and the 20th didn't stand short in this area. Second Lieutenant George Woodrow hit upon the circular slide rule solution as being the most practical and foolproof of several methods with which he had toyed.

The exigencies of a shooting war created a favorable atmosphere for the rapid transformation of thought into reality. The value of Lieutenant Woodrow's idea was recognized by his superiors, who immediately ordered the young officer returned stateside, along with his built-by-hand computer model.

A high-priority project was given to Felsenthal Instruments Company to transpose cardboard into hard copy. With Lieutenant Woodrow's assistance, Felsenthal engineers designed the computer as it has since been used and called it the VAID (V—the old symbol for Radar—plus AID). The grid and compass rose on the rear side were added to provide the radar bombardier with space to graphically illustrate his mathematical calculations and to give him a method of solving target timing winds.

The R-1 VAID computer served its intended purpose well; many a bomb was dropped on Far East targets under adverse sighting conditions but with significant accuracy through the employment of Lieutenant Woodrow's relatively inexpensive device. With the development of the more exotic post-war radar bombing equipments, however, the original purpose of the VAID computer got lost in the shuffle. The slide rule side was used less and less; on the other hand, practical uses for the grid and compass rose —some probably never dreamed of by the designer — were gradually discovered.

The late 1940 and early 1950 advent of the high-speed bomber, with fewer crew members, created the crying need for a simplified celestial navigation method which would enable the navigator to stay ahead of the airplane. The Hydrographic Office fulfilled its part of the bargain by developing and publishing the practical and virtually foolproof H.O. 249 Sight Reduction Tables. Still required, however, was a quick and accurate method of computing the two celestial motions, that of the aircraft relative to the heavenly body being observed (motion of the observer) and of the earth's rotation at the observer's latitude relative to the heavenly body being observed (motion of the body).

Many navigators considered the four-minute motion tables in the H.O. 249 to be relatively awkward and error-prone, and a few of them began to seek something better. Though the claimants are at least several, the name of the *first* navigator to discover the motion calculation potential of the grid and the compass rose side of the R-1 VAID computer may quite possibly never be known. The idea appears to have originated simultaneously at several SAC bases. Certainly *one* of the first was Lt Col (then 1st Lt) Gilbert V. D'Andrea*, who conceived and designed his unique one-minute motion computer while a B-50 crew member at Castle AFB, California, circa 1951. Colonel D'Andrea discarded the R-1 circular slide rule side completely, substituting a 360° sine/cosine scale to permit precise determination of the motion of the body. The grid and compass rose side was used separately to calculate the motion of the observer. The D'Andrea computer was successfully employed for several years by a number of SAC navigators, each of whom constructed his own by hand, utilizing reproduced cardboard "paste-ons" and, of course, a copy of the R-1 VAID computer. At least a dozen or more hand-built copies of the D'Andrea computer are known to still exist and to be in active use. The instrument was extremely accurate, its only apparent drawbacks being the requirement to use both sides of the computer to derive the combined motion solution and its somewhat restricted usability.

Another celestial computer made its appearance in the Davis-Monthan/March AFB areas at about the same time as the D'Andrea version. This was a six-minute computer, conceived by Colonel (then Captain) Patrick E. Montoya. When you think about it, a six-minute base

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is handy in several ways, and the Montoya computer attracted its share of loyal proponents. As with the D'Andrea computer, the two celestial motions were segregated, requiring individual treatment prior to being combined algebraically.

In late 1952, the author was exposed to a concept already being put to good use by several navigators in the 305th and 306th Bomb Wings at MacDill AFB, Florida. This method went a step beyond the previously discussed solutions in that both motions (four-minute time base) could be determined using only the grid and compass rose side of the R-1 VAID. This approach had the obvious advantage of increased speed and reliability without compromising the usability of the slide rule side. During the following two years, the writer cultivated the germ of the MacDill idea until it gradually took shape as a practical one-minute integrated celestial motion computer, which required superimposing a "paste-on" paper grid over the existing grid of the R-1 VAID. By 1955, various additional features were added, including a Polaris "Q" and azimuth scale and a second compass rose (to permit rapid and accurate solving for periscopic sextant relative bearing/true heading, which technique negates the requirement for setting the azimuth dial for each observation). The appearance of this model, labeled "KOMPUR" was, in essence, identical to the grid and compass rose side of the new CPU-48/P VAID computer, to be described subsequently. Hand-constructed models of the KOMPUR were used with highly successful results in the 1955 and 1956 SAC Bombing and Navigation Competitions, in which the Castle crews flew off with most of the navigation honors.

For years, navigators have fussed and argued among themselves as to which time base is the most desirable for the motion solution, i.e., six, four, two, or one minute. This difference of opinion has proved, through the years, to be a definite barrier to the development of a universally acceptable motion computer. Although one minute now seems to satisfy nearly everyone as the obvious answer, it was not always so.

In 1956, the Air Force placed a development project to evolve a four-minute celestial motion computer. When copies of these instruments were distributed for evaluation, Major Frank Barber, a B-47 navigator at Lockbourne AFB, Ohio, visited the Felsenthal Company at Chicago with the request that the experimental computer be revised to provide a three-minute solution to match the observation time cycle then advocated by SAC. The resulting device is the motion computer currently illustrated in AFM 51-40, Volume II, under the title of "B-II Celestial Computer." AFM 51-40 states "The B-II is a VAID computer which has been modified with a special kit." While the Barber computer had considerable merit, it failed to gain solid acceptance by the Strategic Air Command, which was beginning to discover the numerous advantages of the flexible one-minute solution (which, for one thing, is consonant with *any* shooting schedule).

In the late 50's, diversification of SAC B-47 and B-52 tactics created a fresh demand for simplified ballistics and emergency bombing solutions. The bomb *would* be delivered on target, regardless of defenses or status of the installed bombing gear. New names—"Long Look," "Short Look," "Large Charge," "Side Step," "Lay Down," and "Last Resort"—crept into the SAC bombing vocabulary. Practical low-altitude radar navigation techniques were developed, largely through the pioneering efforts of Lt Col George M. Sutherland*, one of the first navigators assigned to the since-rescinded B-47 LABS program. A speedy and reliable graphic solution was devised by the Tactics Branch (DOPLT) at SAC Headquarters for synchronous ballistics and for emergency bombing data; however, something even faster and more accurate was desired for emergency bombing, and an urgent requirement for a practical hand-held computing device became apparent within the command. The author thereupon decided to take another look at the possibilities inherent within the basic design of the R-1 VAID slide rule side.

It was found that most fixed angle type bombing solutions, both visual and radar, could be accomplished by augmenting the existing scales, via the paste-on method, to render them consistent with the demands of modern-day speed, altitude, and equipment conditions. These modifications were subsequently described in SAC Manual 55-10, Combat Bombing and Navigation Tactical Procedures.

In 1962, the Felsenthal Instruments Company was requested to help produce an experimental model of a VAID computer which we hoped would be an improvement more sensitive to modern jet age high/low altitude tactical requirements. (As is normal in such equipment development projects, the military half of the design team has voluntarily foregone all possibility of personal profit.)

With the assistance of Mr. N. M. Gaudio, Felsenthal's Chief Design Engineer, the Computer, Air Navigation, Bombing, Type CPU-48/P (VAID) came into being. A one-step "Last Resort" (pilot's visual reference) solution was incorporated on the slide rule side. Complete trigonometric scales were added, including functions of sine, cosine,

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and cotangent (from which tangent, secant, and cosecant functions may be derived). The outer scale was extended to give computer coverage from tree-top level to 100,000 feet. Various useful constants were added to permit simplified solutions of Coriolis, crosstrail (for fixed angle bombing), procedure turns, etc. The obsolete "Time in Minutes" scale on the old VAID was deleted; the dead reckoning (time/distance) functions were retained, though considerably streamlined.

The grid and compass rose side was modified almost entirely in accordance with the one-minute KOMPUR celestial motion computer previously described, with only a few minor changes (the main one being the inclusion of a small plastic cursor to facilitate the instantaneous solving of the periscopic sextant relative bearing).

The entire computer was color coded in a manner permitting instant recognition of each of the various scales and functions. Large, clearly-defined numbers were used throughout to provide readability under the poorest of lighting conditions.

Last, but not least, a fairly comprehensive instruction booklet included illustrations of all of the major operational functions of the new VAID, along with a goodly number of practical examples. Booklet and computer were neatly packaged in an attractive blue carrying case.

Now, it might rightfully be asked, what can be done with the CPU-48/P that can't be done with existing hand-held computers? A partial list of the new VAID computer's functions may provide the answer.

As stated in the instruction booklet "The *primary* purpose of the CPU-48/P computer is to provide a rapid, accurate, and reliable means of solving the bombing problem by use of a fixed radar reference when the synchronous radar method cannot be employed because of electronic or mechanical malfunction. Additionally, the computer is designed to provide assistance to planners, navigators, pilots, and other crew members in rapidly and accurately solving all other recognized phases of the alternate (emergency) bombing problem, including release by timing (DR), optical fixed angle, and "Last Resort" (pilot sighting from a fixed reference). Further, it affords a valuable tool in solving the navigation problem, particularly by celestial means. Finally, various trigonometric and geometric formulae required for the solution of certain additional bombing and navigation problems may be readily solved by use of the CPU-48/P computer. These include procedure turns, acceleration adjustments (Coriolis and heading/velocity wander), target timing wind/ground speed, fixed reference bombing by offset sighting, offset component computations for BNS (synchronous) bombing, great circle and Mercator course and distance computations, off-course corrections, etc.

"The grid side of the CPU-48/P is designed to assist in the rapid and accurate computation of celestial motions, either separately or combined, periscopic sextant relative bearing, true heading, corrected celestial azimuth, Polaris 'Q' adjustment/azimuth, and acceleration adjustments. In addition, LOP's may be plotted; fixes resolved into ranges and bearings, or converted directly into geographical coordinates; and latitude/longitude adjustments computed for updating the BNS present position counters."

The CPU-48/P VAID was designed with the user in mind. The author believes that *all* navigators, including those not assigned to bomber aircraft will surely welcome this new computer, if only for its navigation functions.

One final word. We all recognize that the *real* designers of the CPU-48/P VAID computer are those numerous enterprising navigators who experimented so freely through the years with one idea after another, and who so laboriously constructed paper and cardboard models of their pet proposals. Each of you contributed something, the ultimate result being the CPU-48/P VAID. This new VAID is believed by the writer to be a truly worthy follow-on to the old and venerable R-1, which, after twenty years of faithful service, may now claim an honorable and well-deserved retirement.

Editor's Note

An Eagle River, Wisconsin, high school teacher before entering service in December 1941, Colonel Korger has crewed everything from B-18's through B-52's. During World War II he flew in a B-24 of the 98th Bomb Group, based at Benghazi, Libya. Two of his truly memorable missions were the Ploesti low level attack on 1 August 1943 and the unfortunate later flight when his aircraft was shot down. POW camp became a part of the Colonel's background.

Colonel Korger joined SAC in 1948 as a B-29 navigator and progressed to B-50, B-47, and B-52 aircraft. His crew won the SAC crew navigation award in 1953, and his unit won the wing navigation award in 1956. Also in 1956, he was one of the first men to successfully eject from a B-52 (after a midair explosion).

Colonel Korger served at Headquarters SAC as Chief, Tactics Application Section and Deputy Chief, Concepts Branch, and until recently was assigned as Commander, 725th Strategic Missile Squadron. His most recent previous contribution to THE NAVIGATOR was "The B-52 in NAV Competition," Summer 1957 issue, by then-Major Korger, Castle AFB, California.

Welcome back, Colonel Korger!