RETIRED MEN'S ASSOCIATION

Cigar Box Bulletin

VOLUME 23 ISSUE 6

JUNE 2019

To the Moon and Back with Apollo

Don Eyles

Space Tech Author and Key Apollo Player

Reporter: Rich Phillips

Near the 50th anniversary of the first lunar landing (July 20, 1969), Don Eyles, who had programmed the landing algorithms in Apollo's Lunar Module, spoke at the June RMA meeting. He was introduced by RMA's own Norm Sears, also a Draper Lab (originally called the MIT Instrumentation Lab) retiree. Norm was the head of the Apollo Guidance, Navigation and Control Division. As well as being co-workers, Norm and Don were tennis partners along with two other Lab Apollo luminaries - Dick Battin and Hal Laning (more about them later).

In his introduction, Norm reviewed the development of inertial navigation and guidance which led to Draper getting the first NASA contract for the Apollo mission. During WWII, the Navy needed to protect its ships from aircraft attacks, but it was very difficult to hit a moving plane from a moving ship tossing in the ocean. The solution offered by Draper was the Mark 14 gunsight, which was gyro-stabilized and computed the appropriate angle lead to apply to the pointing direction. The lead depended on the angular rate as measured by these gyros and an estimate of range supplied by the operator via a dial on the side of the gunsight. It yielded a vast improvement in anti-aircraft accuracy - from two ships lost and two enemy torpedo bombers downed to no ships lost and 26 to 32 planes downed. After the war, the Lab continued to work with the Navy on ballistic missile and submarine inertial navigation and guidance.

Another ground-breaking feat was the accu-

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INSIDE THIS ISSUE:

June Meeting Minutes

Ship's Bell Rang at 10:00 AM

Reporter:

Chris Hammer called the meeting to order.

Chris led members in the Pledge of Allegiance followed by the singing of the Star Spangled Banner.

New Members:

Nick Veeder announced that there were no new members today.

Visitors:

Don Jorgen - from Denmark, and a guest of **Nick Veeder**

Eugene Radnor - retired, and a guest of **Ken Taylor**

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UPCOMING MEETINGS

No July Meeting

Thursday, August 8

Friday, September 13

Speaker — Continued

rate east-to-west-coast flight of the SPIRE system (inertial navigation and guidance) in 1953. After a nearly 13-hour and 2200-mile flight, the navigation error was only 9 miles. The flight had taken Doc Draper (head of the above Instrumentation Lab) to a Univ. of Cal. conference on inertial guidance at which several speakers "proved" that inertial systems could not navigate over long distances. Finally, Doc Draper stood up and said "We have just done that".

So, the technical stage was set. But additional impetus for U.S. involvement in space was provided by the 1957 orbiting satellite, Sputnik. Then, in April of 1961, the manned orbital flight of Yuri Gagarin added to the pressure for the U.S. to do something. A month later, May 1961, President Kennedy proposed that the U.S. land men on the moon (and return them to the earth) within the decade.

Don started work at the Lab in 1966, just after graduating from Boston University. He chose to work in the programming arena and was assigned to the landing algorithms. This choice and assignment led to his close interaction with a number of the astronauts and with Lunar Module simulators at the Lab, at the Manned Spacecraft Center in Houston and at Cape Canaveral. The astronauts were most heavily and intimately involved with the computer and the spacecraft in the real time / real life landing phase of the mission.

Two of Don's tennis partners, Dick Battin and Hal Lanning, were Lab resident geniuses. Battin's area of expertise was orbital mechanics, extending the work of Johannes Kepler and Johann Lambert to the "practical" task of sending spacecraft to the Moon and planets. Lanning devised the priority-driven operating system for the Apollo / Lunar Guidance Computer, the AGC / LGC. In this operating system, all the various tasks which had to be running simultaneously in real time were assigned priority levels. The highest priority jobs would run first in every 2 sec. computer cycle. Lowest priority jobs might not get run every cycle. Another feature of the computer was its ability, in the case of an interruption, to restart and continue where it had left off. Of course, this required storing data from intermediate steps in the computations, but it proved critical on the first Moon landing when the rendezvous radar (mistakenly turned on) flooded the computer with useless data. The overloaded computer raised the alarm and restarted.

HAL, the computer language, developed by Draper "graduates" at (the MIT spinoff company) Intermetrics and used for the Space Shuttle, was named for Hal Lanning, who had developed the first compiler in 1952.

NASA wanted to minimize development of new technology, but the AGC/LGC digital computers were an exception. The vehicles had to pass through the Van Allan radiation belt and survive many days in the space radiation environment. That is to say: the memory had to be robust. Don gives Eldon Hall at Draper, the credit for being the major designer of this computer. As well as the time-sharing / priority-driven operating system, it had a digital interface with the crew (the display and keyboard (DSKY)) and the robust "core rope" memory designed to survive radiation.

The "core rope" read-only-memory consisted of very fine wires passing through (or not passing through) ferrite rings. When the computer is "ON" and the ferrite rings are activated, a wire passing through the ring would yield a current; those not passing through the ring would have no current induced in them. Thus, the read-only-memory is truly "hard-wired". Current in those wires passing through the ring signified a "1". Lack of current signified a "0".

Analysts and software engineers also enjoyed the best available computation services at the time. However, it was in the form of "mainframes" which were fed punched cards and produced huge paper listings (e.g. 6 inches thick stacks) of output. Cards were punched on big clunky devices, all located in the keypunch room - a noisy place. Turnaround time varied from around an hour to overnight. Don showed such a listing of AGC contents for Luminary (the lunar lander code) Version 131. The last Apollo flight used Version 210. There was a Software Control Board of people in Houston which had to approve changes. However, a lunar landing in eight and a half years would not have been possible without a rapid response to lessons learned on each mission, to astronaut requests, and from flight to flight mission changes. The responses were successful due to diligence, devotion, and genius at the lowest levels as well as being uninhibited by undue "process".On the back side of the Moon, the lunar orbit insertion burn takes place. (The same side of the moon always faces the earth; the rotation of the Moon and the period of its orbit around the earth are tightly synchronized.) This maneuver is obviously calculated and performed by the onboard LGC since the vehicles are out of contact with ground control. It was a relief to all when the spacecraft came back into view and was able to report success, a nearly circular orbit with apogee and perigee very close the desired value.

After orbiting the Moon, the lunar module and the command and service modules separated and the lunar module made the descent orbit insertion burn. The result was, of course, an

Continued on Page 5

Minutes—Continued

Bob Kagey - former Sudbury resident, and a guest of **Jim Collins**

Paul Murphy introduced the travelers for the month:

Bob Cooke travelled above the Arctic Circle on a ship. Bob also travelled to Alaska on a cruise ship in March of 2019. This was an "Eagle" viewing trip, photographing wildlife. Bob brought along some great photos from both trips. Additionally, Bob travelled to Yosemite National Park in California.

Don Sherman - Took his 3rd River Cruise. It was the entire length of the Rhine River. It started in Basel, Switzerland, and ended in Amsterdam. Of special interest were two bridges on the trip. One was "A Bridge Too Far", about which the movie by that title was made; the tour depicted its importance in WWII. A second was the bridge at Remagen that was also made famous in a movie.

Chris Hammer (and **Paul Murphy**) - did a river cruise from Paris to Normandy. This was close to the 75th anniversary of the invasion on D Day in WWII. It was an emotional visit given the importance of the Normandy invasion.

Chris thanked the following members who helped with the arrangements for the meeting:

Coffee - **Dave Calder**

Donuts from Stop n Shop - **Ted Grenham**

Badges - **Richard G Smith**

Facilities - **Mike Sheff, Jim Latimer, Fred Jungalwala**

Reporting on the Minutes - **Dan Miller**

Reporting on the Speaker - **Rich Phillips**

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Speaker Illustrations

Figure 1 shows the computer and the display and keyboard, and on the right one of the core rope containers pulled out of the back of the computer

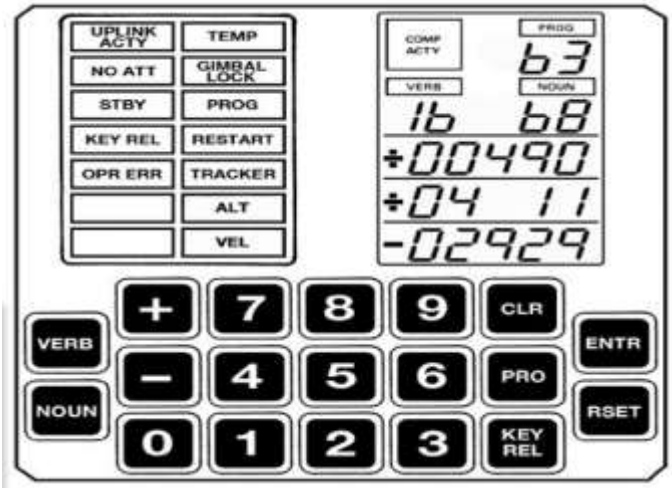


Fig. 2. The display and keyboard was used by the crew to "talk to" the computer

Fig. 3. The Apollo payload: the command module, the service module and the lunar module.

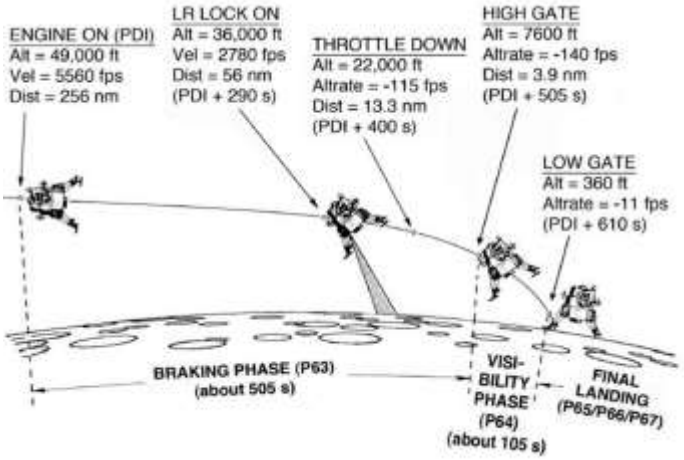


Fig. 6. The lunar landing and associated events.

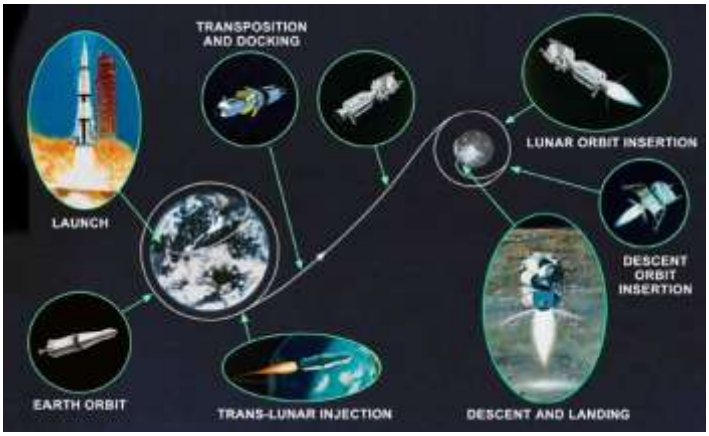


Fig. 4. The outbound trajectory and associated events.

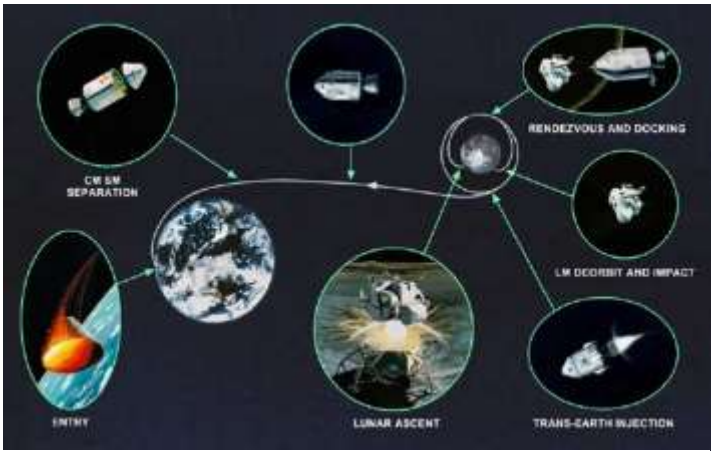


Fig. 5. The earthbound trajectory and associated events.

Speaker—Continued

orbit designed to "intersect" the lunar surface at the desired landing point. With no atmosphere to slow the vehicle, all its velocity had to be removed by firing the engine, first, against its orbital velocity and, then, vertically to slow its descent.

On the back side of the Moon, the lunar orbit insertion burn takes place. (The same side of the moon always faces the earth; the rotation of the Moon and the period of its orbit around the earth are tightly synchronized.) This maneuver is obviously calculated and performed by the onboard LGC since the vehicles are out of contact with ground control. It was a relief to all when the spacecraft came back into view and was able to report success, a nearly circular orbit with apogee and perigee very close the desired value.

After orbiting the Moon, the lunar module and the command and service modules separated and the lunar module made the descent orbit insertion burn. The result was, of course, an orbit designed to "intersect" the lunar surface at the desired landing point. With no atmosphere to slow the vehicle, all its velocity had to be removed by firing the engine, first, against its orbital velocity and, then, vertically to slow its descent.

Don's major involvement was with the landing phase of the mission, to which we will return shortly. Meanwhile, Fig. 5 shows the trip from the Moon back to earth. The ascent stage blasts off, leaving behind the descent stage which has served as a launch platform. Once at the desired altitude, the lunar module circularizes its orbit behind and below the command / service module and then slowly catches up, makes the rendezvous and docks with the command / service module. The lunar module is then separated and performs a deorbit burn to dispose of itself by crashing on the Moon.

The trans-earth injection burn then breaks the command / service modules out of lunar orbit for their return to the earth. Again, sextant measurements of stars and the earth horizon are made and trajectory corrections are made. These are critical to achieving the right reentry conditions. Too steep a trajectory will cause the vehicle to burn up. Too shallow a trajectory will result in skipping out of the atmosphere and off into space. Finally, the command module separates from its service module and reenters, slows down in the atmosphere, deploys its parachutes and "lands" in the ocean.

Talking about the earlier effort of getting onto the Moon surface, the lunar landing phase refers to the tricky part of the mission after the above-noted descent orbit insertion burn. It takes about 12 minutes from the start of the braking burn to touchdown, depending on how long it takes the crew to find a good landing spot. Fig. 6 shows the lunar module as it progresses through phases of the landing. At "engine on" (powered descent initiation) the crew have their feet forward and are facing down. They thus can see the surface and feel the deceleration in their feet.

At some point, the lander is rotated about the thrust axis by 180 degrees so that the crew is facing up and the landing radar is pointed down. As the LM continues to slow down, it pitches to an ever-increasing "vertical" orientation in such a way as to keep the combined forces of gravity and deceleration along the vertical axis. Given this strategy, the crew was able to forgo seats to save a bit of weight.

The descent engine was throttleable, a most unusual feature. However, it was feared that throttle settings between 60% and 100% would erode the engine nozzle. Thus, the throttle was held at 100% until the guidance-computed level was below 60% (which happened sooner than it would have otherwise). After this point the throttle level was allowed to follow the guidance-computed profile.

As the vehicle pitches more and more toward vertical, the Moon's surface finally becomes visible out the forward-facing windows. A series of programs, P64, P65, P66 and P67, are exercised on the computer during this period. The astronaut can control the descent rate with a contact switch on the console. Each "flick" of the switch changes the rate by one foot per second, rising or falling depending on the direction of the "flick". Note that the function of the translational hand controller (the joystick) is different, depending on the phase of the landing and the program which is running at the time. Early in the landing, it is used to re-designate the landing site. During the final "manual" phase, it is used to direct the thrust and, thus, to fly over the surface.

On the first landing, the pre-chosen site was strewn with large boulders; so, Neil Armstrong had to fly, "helicopter" style, to a more suitable spot. The crew and the ground controllers were both watching the fuel level very carefully. Don pointed out this "manual" flying was all done via astronaut commands to the computer and, then, computer commands to the engines; so, to the pilot with his hands on the controls, it felt like he was flying a helicopter. The astronaut did not have to command either the main engine throttle level, pointing direction, or the commands to all the attitude jets. Programming the algorithms that made this translation, from astronaut input to engine commands, was Don's job - quite a task for a new graduate with no previous aero/astro experience. On the other hand, since no one had experience in this field, it was all new to everyone.

Reporter's note: Don's talk is covered in his most excellent book, *Sunburst and Luminary / An Apollo Memoir,* Don Eyles, 2017, www.fortpointpress.com. As stated by the publisher: it was written solely by "Eyles himself, in his own distinctive, often irreverent voice" and in fascinating detail.

During Apollo 14 the landing abort button was sending random signals which if they had occurred during descent would have aborted the landing. Don developed a 61 keystroke way to bypass monitoring the abort button by making the computer think an abort was already in progress. For this mission rescue Don became "famous", talking to all the Boston newspapers, UPL, AP, and CBS news and a front page article in New York Times .

Minutes—Continued

Bulletin - **Bob Diefenbacher, Koby Kobayashi, Stan Wulf**

Sound Equipment - **Ron Riggert**
Microphone - **Paul Sturgis**

Slide Show - **Don Sherman**

Website - **Ken Mattes, John McKinney, Bill Thompson, Bob Diefenbacher, Al Persson, Richard B Smith**

Photographer - **Art Phipps**

Announcements:

Chris reminded us that there will be **NO Meeting in July.** Next meeting is Thursday August 8. Sept. 13 resumes our normal Friday meeting day.

It was announced that former member has passed on. **Bill Murphy** died at age 94. He was a retired Naval Officer. Also member Bill Metz died at 80 years old.

Bob Malnati reminded us about the Annual Dinner Dance. It will be held on Wed. Oct 16 at the Marlborough Country Club. We will have an expanded menu, bar, music by **Ken** and **Bill**, dancing and a few surprises! Sign up and pay! We have room for 100 people and hope to sell out.

Al Persson is the coordinator for the RMA discussion group. They will meet on 6/19 at Conrad's restaurant. The topic will be Foreign Interference in American elections. All are invited.

PawSox vs Buffalo Bisons - Doc Harrell reminded us of our final game for the PawSox in Pawtucket. They are moving to Worcester. The game will be on Friday July 12th. The cost for the game and bus transportation is $45.00 per person. Other details are elsewhere in the *Bulletin*.

Gerry Brody reported on 15 birthdays in June. The oldest is **Arnold Barnes** at 89 years**.**

Jim Latimer reported on 25 wedding anniversaries in June. The longest married couple is Lee and Art Phipps at 66 years.

Members Health - Joe Bausch informed us that Loretta Thomas (wife of **Ed Thomas**) passed away and a memorial service will be held on July 27. They had been married for 68 years.
Frank Lyons is currently residing at Bridges memory care in Sudbury. Frank is in good physical shape but has some issues with poor memory and confusion. He is not diagnosed as having Alzheimers.

Harold Wilkinson shared several funny stories. He noted that June is sometimes a month of confusing happenings. He also reminded us of some words and phrases that have fallen out of use: Jalopy, Hunky Dory, In like Flynn, Monkeys Uncle and Knee high to a Grasshopper!
Some signs seen around town: Free puppies - 1/2 cocker spaniel and 1/2 sneaky neighbor's dog. Headlines seen in the paper: *Man kills self before killing wife and daughter*. And - *Panda mating fails - Vet takes over*.

Bill Ladoulis played two wistful Gershwin songs for us: *Summer Time* and *Someone to Watch Over Me*.

Bob Malnati announced the ROMEO lunch to be at Fugakyu Cafe on Boston Post Road in Sudbury.

Today's speaker - **Don Eyles -** was introduced by **Norm Sears**.

Note that there will be NO RMA meeting in July 2019
due to a church camp using all the facilities at that time.

Anniversaries in June

Member		Spouse	Anniv.	Yrs.
Howard	Kendall	Ellen	6/8/2014	5
Richard G.	Smith	Yuh-Rong Tsay	6/29/2002	17
Paul	Sturgis	Diane	6/16/1990	29
David	Calder	Danielle	6/12/1987	32
Chris	Hagger	Joan	6/29/1985	34
Thomas	Mead	Elaine	6/23/1979	40
Robert	Lieberman	Lesllie	6/24/1973	46
Terrance	Keeney	Debbie	6/17/1972	47
James	Metcalf	Jill	6/12/1971	48
Nick	Veeder, Jr.	Chay	6/13/1970	49
Seth	Kaplan	Aline	6/21/1969	50
David	Manjarrez	Linda	6/30/1967	52
Richard	Phillips	Joanne	6/18/1967	52
Richard	Testa	Peggy	6/26/1965	54
Paul	Neeson	Carolyn	6/27/1964	55
William	Cooper	Martha	6/22/1963	56
Michael R.	Garfield	M.C.	6/15/1963	56
William	Tafuri	Karen	6/6/1959	60
Robert	McKown	Lois	6/14/1958	61
H. Ronald	Riggert	Karen	6/1/1958	61
Barry	David	Elizabeth	6/23/1957	62
Harold A.	Wilkinson	Alice	6/22/1957	62
Wayne	Clemens	Barbara	6/18/1954	65
John	Whiting	Jill	6/26/1954	65
Arthur	Phipps	Lee	6/3/1953	66

Average Years Married—49

Birthdays in June

Member		Birthday	Age
Jeffery	Levine	06/21/1947	72
William	Beebee	06/13/1942	77
William	Cooper	06/24/1941	78
Frederick	Pryor	06/09/1939	80
Paul	Murphy	06/12/1938	81
Donald	Sherman	06/01/1936	83
George	Ives	06/01/1935	84
Stanley R.	Sakowitz	06/20/1935	84
Harold A.	Wilkinson	06/17/1935	84
John	Beeler	06/22/1934	85
Ed	Najjar	06/21/1934	85
John	Whiting	06/07/1932	87
Richard	Stewart	06/19/1931	88
Arnold	Barnes	06/10/1930	89

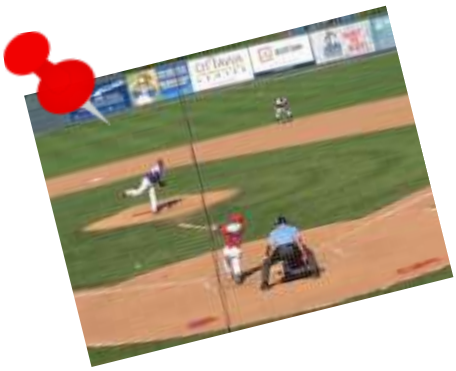
Average Age— 78


2019 ANNUAL DINNER INVITATION
WEDNESDAY, OCTOBER 16, 2019
5:PM COCKTAILS, 6:PM DINNER
MARLBOROUGH COUNTRY CLUB
200 CONCORD RD. MARLBOROUGH MASS.
TICKETS ARE $50 per person, checks to RMA
Mail to RMA Box 261, Wayland MA ,01778
Or, give check to Bob Malnati, Merrill Mack or Larry Vlfquain
Contact Bob at RandRmalnati@gmail.com

RMA Bulletin Board

The PawSox baseball game Friday, July 12. The bus leaves the church at 4:30 pm

This will be the last time RMA members will go to the game in Pawtucket, since the team is moving to Worcester. Contact Chris Hammer chammer6060@gmail.com



Reminder that there will be **No July Meeting** as the church is running a camp that month.

A Members Support Help Line. This is intended to help members or their spouses who are in need of assistance. This could include rides to meetings or helping members in other ways as needed. **Contact Al Persson at 781-235-6910.**

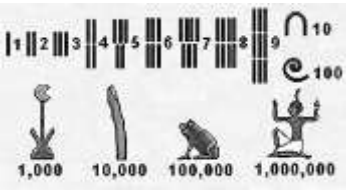
Don't Miss the Annual Dinner

Limited Seating—
Make up a Table if you want,
just email Bob Malnati at RandRMalnati@gmail.com

The RMA Annual Dinner is Wednesday, October 16, 2019 at Marlborough Country Club. Liquid libations at 5:00 pm, followed by a delicious dinner at 6:00 pm. Musical entertainment, dancing, and a good time is promised by chair Bob Malnati

Golfers' Prayer: May my swing be straight and the ball fly far. May my round be blessed with no worse than par. - An Irish Golfers' Prayer

Numbers



The Egyptians used a system of numbers based on ten. It was similar to Roman Numerals that originated much later. In both systems the value of the symbol did not vary based on its position.

They could add and subtract but it is not clear if they added or subtracted as we know it. They also appear to have been able to multiple and divide although the evidence of this is not clear enough for agreement among scholars.

The system of numbers we use today originated in the Arab world. It is also based on a system of ten. This is most likely due to the fact that we have ten fingers. Early, everyday counting was probably done using fingers and only written down when the answer was important. They were like children today who often use their fingers to count.

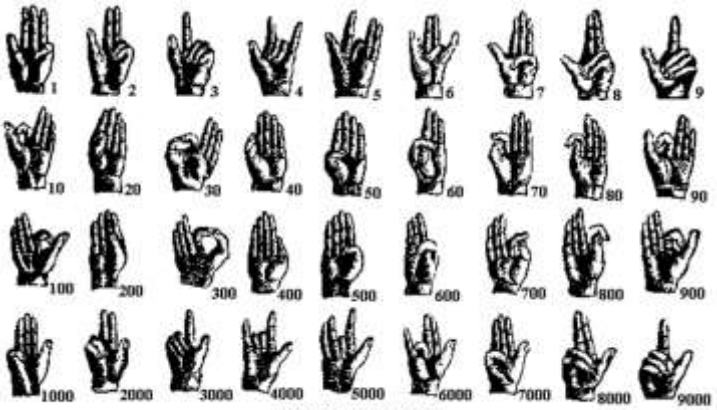
Writing using this system is determined by the number of corners in each symbol. Note that the symbol for one has a small slash mark at the top. Today a one is written in most of Europe with this slash mark. The one is written without the slash mark in England which is the reason we in the United States do not use it.

The zero, having no corners, was added much later. Originally, a space meant zero. However, this proved confusing. The mathematical concept of zero originated with the Greeks.

The Mayans, who lived in Central America, also used the zero and understood the concept. They developed this independently thousands of years ago. Their system used base 20 instead of ten. It is felt that this indicates they used their toes as well as their fingers to count.

In what is now the Middle East, numbers and other symbols were written on soft clay tablets. The tablets were then allowed to dry. It was very difficult to erase or change something once the tablet dried.

They also used 'paper' made from papyrus. These papyrus scrolls were preferred but were very expensive.



FINGER SYMBOLS
(From a manual published in 1520)

Here is an illustration of "finger counting" or finger symbols. Note that this illustration was published in 1520. Both hands are used but only one at a time. Only five fingers are used but the numerical system is based on ten.

To indicate a number, one would put up a hand. If the number was more than ten a second hand was put up. For example, to indicate 11, a person put up ten and then one. As the chart indicates, both one and ten are done using the right hand.

By Al Persson

R.M.A.
Box 261
Wayland, MA 01778

First Class Mail

Next Meeting
Thursday, August 8
Web site RMenA.org
E-mail info@RmenA.org

RMA Meeting: ***Thursday, August 8*** *10:00 am*

How the Beaver Trade Impacted the Exploration of N. America

Jacob Kuykendall

Member of the La Courte Oreilles band of Lake Superior Chippewa Indians

Lasting nearly two centuries and starting before the Pilgrims landed, the quest for the beaver was the engine that drove the exploration of North America. The fur trade spawned the world's largest corporation at the time, the Hudson Bay Company in what is now Canada. It enabled John Jacob Astor, founder of the American Fur Company to become the first American millionaire and the richest person in America.

Jake Kuykendall, now living in Sudbury, MA and a member of the La Courte Oreilles band of Lake Superior Chippewa Indians, has traced his Dutch, French and English ancestors who traveled to the new world in the early 1600's to participate in the fur trade. They learned the Native American languages, established trading posts, served as guides and interpreters, married into the tribes and shirred large multi-cultural families.

Jake spent his growing up years on the LCO Indian reservation in Northern Wisconsin, living on a farm built by his Dutch grandfather in 1900. During this time, his reservation did not have electricity, running water or indoor plumbing. While living on the reservation, many in Jake's extended family still depended on trapping furs as the major source of their income.

Bring a Guest to this Meeting**! Use the "Be My Guest Card"**