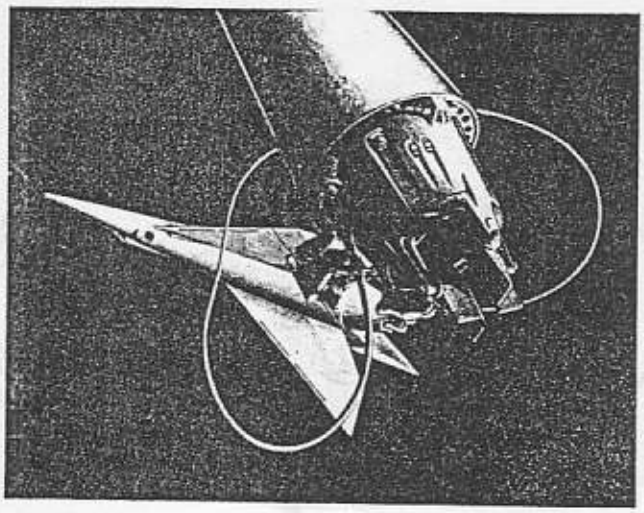
THE GENESIS OF ORBITAL RENDEZVOUS

By. H. E. Ross An Example in the Unfolding of Ideas

The NASA Anthology reviewed on the previous pages once again throws doubt on the origin of Lunar Orbit Rendezvous. Certainly, the idea was already well established in B.I.S. literature of the late 1940's although the technique, as applied in Apollo, has been officially credited to John Houbolt of the Langley Research Center. We asked one of the original B.I.S. advocates to recollect his thoughts of the early Post-War period when individuals and groups within the Society were active in establishing the basic requirements for moonflight. The reader is also referred to a prize essay by Dr. Barton C. Hacker, "The Idea of Rendezvous" (*Technology and Culture*, July 1974) which acknowledges the two B.I.S. papers noted on the adjoining page.



Rendezvous in 1953. A winged shuttle being re-fuelled in Earth-orbit – from a painting by the late R. A. Smith.

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Early Thoughts

Though the idea of rendezvous seems to have been *implicit* in the writings of one or two basic astronautical pioneers, such as Lasswitz and Tsiolkovsky, it was apparently first *explicitly* expressed by the Russian Yuri Vasil'yevich Kondratyuk (1897-1942) in a manuscript published in 1929 but dating back to 1916-17. He proposed detaching a fuel tank in an orbit close about the Moon, and picking it up on the way back to Earth.... My own approach to Revelation (*Orbital Bases, JBIS*, January 1949) arose in the following way:

From the moment of joining the BIS in December 1936 I set about learning all I could concerning astronautics, initially from BIS friends, particularly J. H. Edwards and R. A. Smith, but further from a few contemporary articles and a book or two on the subject. I found, however, that detailed coverage of the subject was far from complete – so I made it my business to fill in the gaps as best I could by my own studies, though I had no formal scientific background and training. Despite this handicap I completed during 1940 the first-ever autonomous spacesuit design. This and other projects were destined to have, Post-War, the great help of R. A. Smith in completing the engineering detail and illustrations. The ensuing publicity was world-wide.

I continued during the War with my self-imposed review of all problems and possibilities associated with astronautics. But I felt deeply (and still regret) the difficulty of finding out what the earlier pioneers had originally considered. In expanding any subject – especially one crossing the boundaries of language – I hold it to be of prime importance to discover and reconsider all that is known, in order to save inventive duplication of ideas, and to give credit where due.

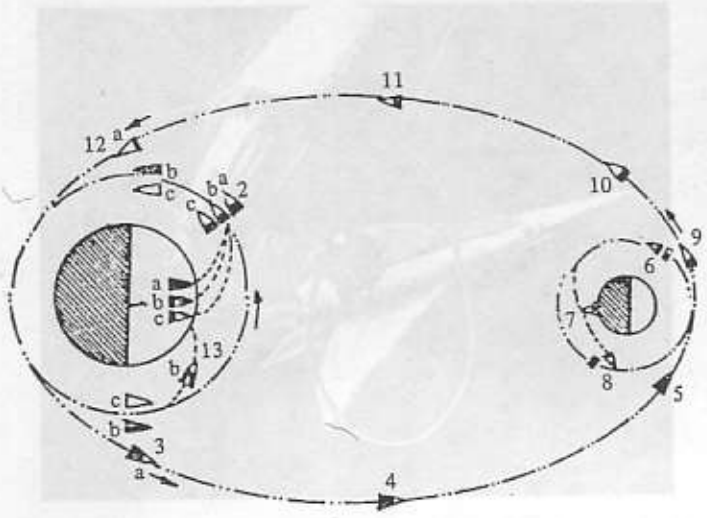
To continue.... I accumulated material for a large book, the illustrations for which were to be done by R. A. Smith. However, this project never materialised. I felt that I really didn't know enough, especially mathematically, and in any case would be in competition with several excellent expositions, including Willy Ley's *Rockets* and later the 1950-51 books of my brilliant friend Arthur C. Clarke. Ley's book contained a wealth of (to me) new information, and valuable historical notes. It was from this book that I became acquainted with the great pioneers, who prior to that time were little more than names to me. The "Step-Principle" was well-known to me prewar. But nowhere, and indeed not until this last year or so, did I come across the name of Kondratyuk. Count Guido von Pirquet's suggestion for "interconnected orbits" came close to the idea of rendezvous, but he was really concerned with space stations as terminals and fuel depots. In my own case, however, I was at the time feeling concern about the high lift-off weight on launch from Earth. This despite the very great reduction that had become at any rate potentially possible by the "cellular" construction of the 1939 1,000-tonne BIS Lunar Spaceship, where the step-principle (staging) was taken to the ultimate. In short, I began to think how it could be made possible to further reduce lift-off weight.

Splitting the Journey

It then occurred to me that the tonnage needed for the journey could be obtained more practically by splitting it between a number of ships, say two or three. This idea was in itself analogous to the problem that worried all the early pioneers – that of the obvious difficulty of providing a motor large enough to handle the discharge of an enormous tonnage of fuel per second at lift-off. This difficulty could of course be solved by using a multiplicity of smaller motors in parallel, as present-day clustering, or exampled in finality with the BIS ship. But even this simple solution seems to have been overlooked generally for quite a time, though Oberth for one, with his spaceship model, had seen the light.

Having got this idea of splitting the launch weight between two or more ships, the next point was obviously that rendezvous of the ships was necessary in order to transfer fuel in (say) "topping-up" a single ship, discarding empty tanks or whole ships in order to reduce the mass to be further accelerated and decelerated during the rest of the voyage.... There was of course to be considered the point that the ships might be launched either simultaneously or sequentially, whichever gave the most accurate rendezvous. And there was the question whether precision rendezvous was possible... I thought it was.

So Rendezvous became an essential part of the method. And obviously the place to rendezvous was in a closed orbit as near as convenient to the Earth, thus using minimum power to the staging point.... Having realized this, it immediately became apparent that much more could be gained in weight minimisation by rendezvous at other points and times in a journey.

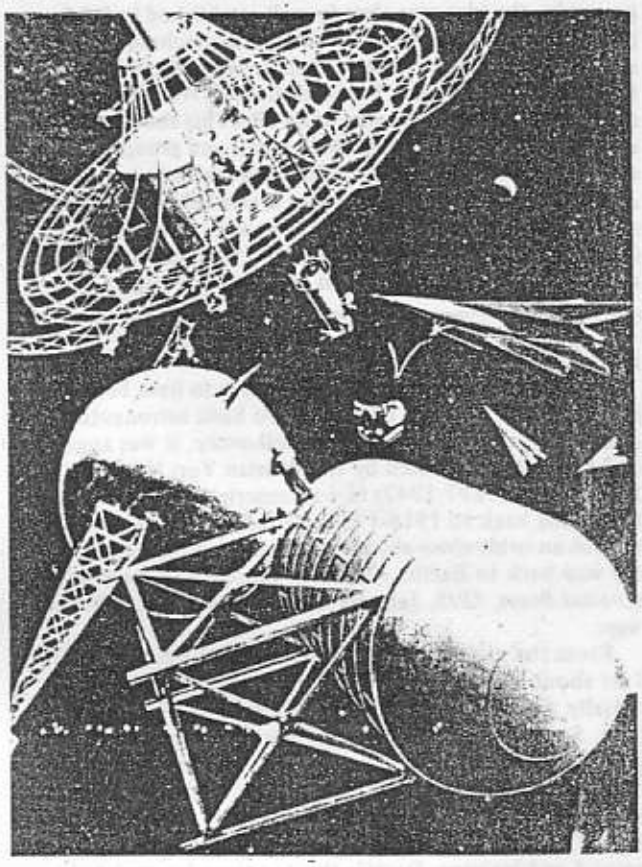


Earth-Moon Round Trip

Three ships using double sub-orbit method

Key:
1. Three ships ascend; 2. Ships in orbit about Earth; 3. "a" and "b" refuel from "c" and transfer crew from "c"; 4. & 5. "a" in transit to Moon; 6. "a" deposits fuel in Lunar sub-orbit in detachable tank; 7. "a" descends to surface; 8. "a" ascends and picks up tanker; 9. commences home flight; 10. & 11. in transit homewards; 12. "a" seeks "b" to transfer crew to "b" for landing; 13. "b" lands.

Lunar rendezvous orbits, from the paper "Orbital Bases", by H. E. Ross, *JBIS* January 1949.



Assembling a space station in Earth-orbit, shuttles in attendance – from an early post-war study by R. A. Smith and H. E. Ross. ("Orbital Bases", *JBIS* January 1949).

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To recapitulate somewhat.... Rendezvous is only the logical ultimate outcome of the step-principle – staging not only the rocket (as shown fully exploited in the BIS spaceship) but also staging the journey itself. Thus, in my specific proposal, there was to be rendezvous staging in orbit about the Earth on the way out *and* back, and also similarly in orbit about the Moon, again on the way out and back.

There was also, though not mentioned in my paper, the possibility of discarding redundant mass on the Moon – as noted by me in my 1939 *JBIS* article about the lunar spaceship. It was also specifically illustrated in a Post-War R. A. Smith drawing of a moon-lander spacecraft. Here there are separate motors for landing on and ascent from the Moon, exactly as in the Apollo missions. It did indeed give me a grim thrill of satisfaction to see the lift-off from the Moon and rendezvous in orbit precisely as I had visualised it.... There was, so far as I could see, only one possible snag in the efficacy of Rendezvous, that too much fuel might be used in the manoeuvres of rendezvous. I did not probe this point mathematically, but it has obviously proved in practice not to be an important factor.

By the way, several of R. A. Smith's pictures show rendezvous – and, mark you, with winged craft, as with the Shuttle. This came about because I said I was sure nobody would for long rest content with arriving back on Earth dangling from a piece of string.

That is all there is to it: the need to minimise lift-off weight was mainly responsible for giving me the idea of *point* rendezvous, wholly devoid of the trappings of a complex terminal in space. In passing, I may remark that in this instance and others it took a great deal of optimism as regards possibilities and rock-steady nerve to make many of the far-out proposals associated with the early days of astronautical thinking. It is rather amazing, however, to find that we were actually very conservative in our proposals, as compared with denouement.

It perhaps only remains to say that I am sure members of the prewar BIS Technical Committee would have been appalled at the prospect of having to launch a 3,000-ton spaceship such as Saturn-Apollo.