NGUYEN XUAN VINH – A LIFE IN HYPERSONIC FLIGHT

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WHO IS N.X. VINH?

- Father of “Vinh’s universal entry equations”
- One of the first researchers to formulate a rigorous theoretical approach to the problem of space vehicle dynamics and control in regimes where both orbital and atmospheric dynamics play crucial roles
- Winner of AAS 2006 Dirk Brouwer Award for outstanding lifetime achievement in the field of space flight mechanics and astrodynamics
- Author of influential textbooks including “Hypersonic and Planetary Entry Flight Mechanics”

BIOGRAPHICAL HIGHLIGHTS

- Born 1930 Yen Bay, Vietnam (Nguyen was surname)
- Attended French Air Force Academy, graduated from nearby Aix-Marseille University in Mathematics in 1954, commissioned as an officer
- 1955: Qualified as a multiengine pilot in the French Air Force
- 1958: appointed Commander and first Air Marshal of Air Force of the Republic of Vietnam at age 28
- 1962: sent to study abroad by President Ngo Dinh Diem.. Stayed in the U.S. after Diem's assassination in November, 1963
- 1965: awarded first Ph.D. in aerospace engineering conferred by the University of Colorado
- 1968: joined the University of Michigan as an associate professor of Aerospace Engineering
- 1972: promoted to professor, awarded a national doctorate in Mathematics by University of Paris, France
- 1998: named as Professor Emeritus of Aerospace Engineering upon retirement

BOOKS

- Hypersonic and Planetary Entry Flight Mechanics, by N.X. Vinh, A. Busemann and R.D. Culp, The University of Michigan Press, 1980.
- Optimal Trajectories in Atmospheric Flight, by N.X. Vinh, Elsevier Scientific Publishing Co . Amsterdam, 1981.
- Flight Mechanics of High-Performance Aircraft, by N.X. Vinh, Cambridge University Press, U.K . 1993. Paperback edition in 1995.

VINH'S UNIVERSAL ENTRY EQUATIONS

Using the following dimensionless variable as the independent variable instead of time:

$$s = \int_0^t \left(\frac{V}{r}\right) \cos\gamma \, dt$$

Equations of motion for three-dimensional entry trajectories:

$$\frac{dZ}{ds} = -\overline{\beta r} Z \tan\gamma$$

$$\frac{du}{ds} = -\frac{2Zu\sqrt{\beta r}}{\cos\gamma}\left(1 + \frac{C_L}{C_D}\cos\sigma\tan\gamma + \frac{\sin\gamma}{2Z\sqrt{\beta r}}\right)$$

$$\frac{d\theta}{ds} = \frac{\cos\psi}{\cos\phi}$$

$$\frac{d\phi}{ds} = \sin\psi$$

$$\frac{d\gamma}{ds} = \frac{Z\sqrt{\beta r}}{\cos\gamma}\left[\frac{C_L}{C_D}\cos\sigma - \frac{\cos\gamma}{Z\sqrt{\beta r}}\left(1 - \frac{\cos^2\gamma}{u}\right)\right]$$

$$\frac{d\psi}{ds} = \frac{Z\sqrt{\beta r}}{\cos^2\gamma}\left(\frac{C_L}{C_D}\sin\sigma - \frac{\cos^2\gamma}{Z\sqrt{\beta r}}\cos\psi\tan\phi\right)$$

- *Apply to atmospheric entry with or without lift and bank modulation*
- *Reduce to the equations for Keplerian motion for flight with no atmospheric drag*

OTHER TECHNICAL CONTRIBUTIONS

- More than 100 published research papers
- Among early researchers who investigated control switching in optimal control problems
- Known for clever use of dimensionless variables, extending mathematical solutions to regimes where previous solutions could not apply
- Served as Associate Editor of ACTA Astronautica for 20 years

EDUCATOR AND MENTOR…

- Chaired the doctoral committees for 30 students
- Estimated that over 1,000 aerospace engineers studied under him
- Served as a chair professor of applied mathematics at the National Tsing Hua University in Taiwan (1982)
- Invited to lecture at universities and international conferences around the world including the United States, Canada, Britain, France, Austria, Germany, Italy, the Netherlands, Switzerland, Norway, Sweden, Hungary, Israel, Japan, China, Taiwan and Australia

Former student Prof. James Longuski of Purdue:
"As a doctoral student of Professor Vinh's, I was extremely impressed not only by his brilliant insights but also by his kindness and generosity in sharing his ideas. I owe a great deal of my success to having Professor Vinh as my advisor and I know many of his students who have expressed similar feelings."

LITERARY CONTRIBUTIONS

- Under the pseudonym Toan Phong, wrote a novel *Pilot's Life* in the form of letters written by a pilot to his sweetheart
- *Pilot's Life* became a best seller, and won the Vietnam National Literature Prize in 1961

SELECTED AWARDS

- Honorary Pilot: Republic of China Air Force, 1960; Royal Thai Air Force, 1962
- Third American (after Neil Armstrong and Frank Borman) elected to membership in the prestigious French National Academy of Air and Space, elected 1984
- Elected to membership in the International Academy of Astronautics, 1986
- University of Michigan Teaching Excellence Award, 1984
- University of Michigan Research Excellence Award, 1991
- Mechanics and Control of Flight Award, American Institute of Aeronautics and Astronautics, 1994
- Elected to the French Academy of Aeronautics and Astronautics, 2000
- Dirk Brouwer Award, American Astronautical Society, for outstanding lifetime achievement in the field of space flight mechanics and astrodynamics, 2006
- St. Louis, MO School of Arts offers an annual award named the "Tradition of Nguyen Xuan Vinh" to encourage local students
- Vietnam National Literature Prize in 1961 for his novel *Pilot's Life.*