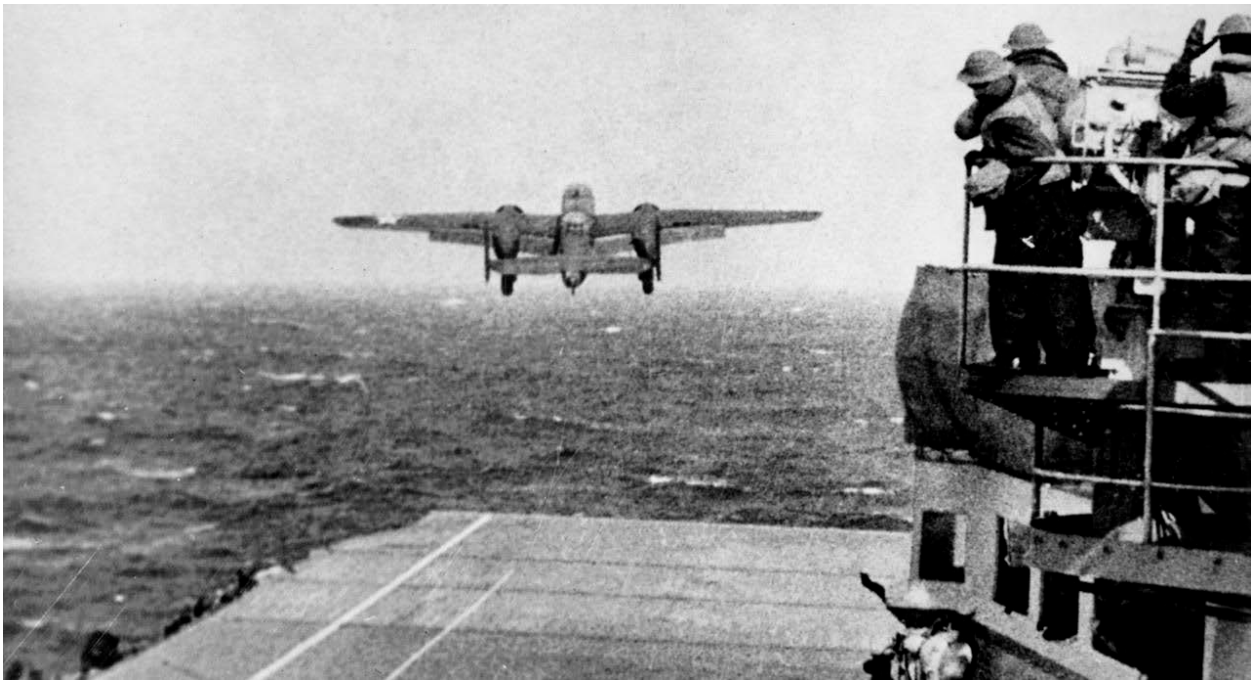


Education is the Wellspring of Innovation

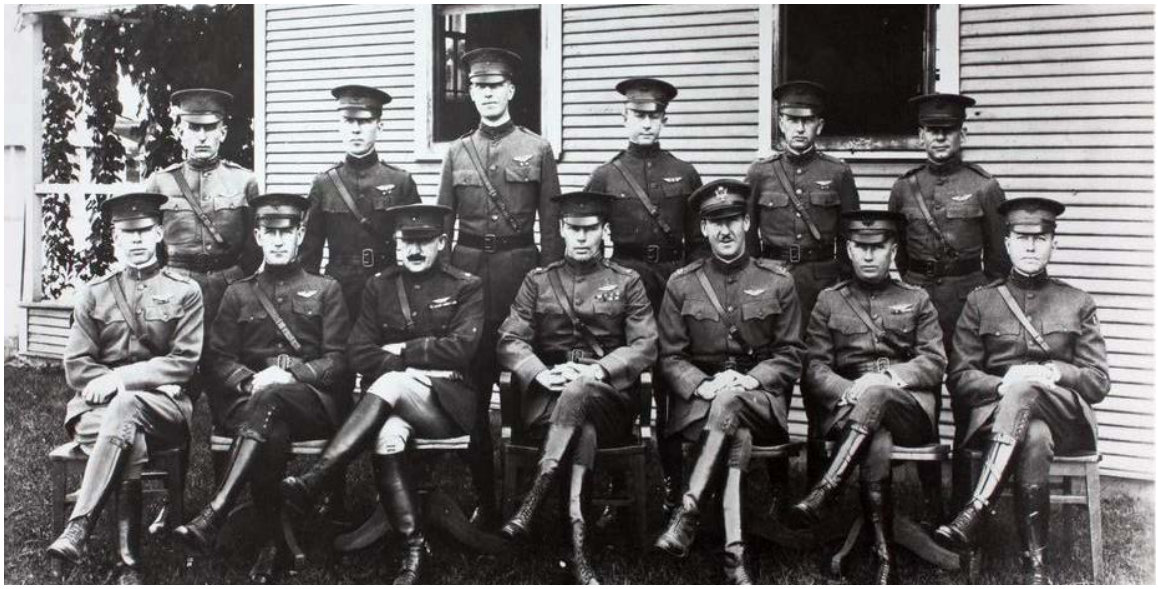
The launch of Lt Col James H Doolittle's B-25 on 18 Apr 1942 from the deck of the USS Hornet was the denouement of a series of complex engineering challenges. The daring and innovative operational concept of launching sixteen, highly modified Army Air Force B-25s from the deck of the Navy's newly commissioned aircraft carrier was conceived, designed, tested, and executed in less than four months, an operational timeline that is inconceivable today.

Jimmy Doolittle had selected the B-25 as the platform for the surprise raid as the best choice of four medium bombers then in the Army's inventory (the Douglas B-18 and B-23, the North American B-25, and the Martin B-26--none of which had seen combat at the time). Unfortunately, the B-25's range of 1300 nm was only slightly better than half of the 2400 nm that was required for a mission against the Japanese mainland. The requirement for increased range and a specific payload necessitated a series of engineering modifications to the B-25 including:

- design and installation of collapsible, auxiliary fuel tanks (nearly doubling fuel capacity)
- removal of lower gun turrets to reduce weight
- installation of mock guns in tail along with special cameras to record the bombing effects
- modification of bomb racks and design of a new incendiary bomb
- design, test, and installation of a custom-engineered, low-level Mark Twain sight (replacing the Norden bombsight)
- new propellers and adjustment and fine tuning of the carburetors for maximum range
- an increase in max takeoff weight of 10% over design gross weight
- development and flight test of short-field takeoff techniques close to stall speed

All of these were successfully accomplished in a mere three months following Pearl Harbor. The ultimate success of Doolittle's team in designing, testing, and producing the innovative modifications was the dividend of an investment in engineering education that was then two

decades old. The humiliating realization during WW I that the United States had lost its technological lead in aviation spurred the Army in 1919 to establish the Air School of Application at McCook Field in Dayton, OH, because "the progress of military aviation was dependent on highly educated officers capable of leading the new world of aviation to its full potential." Renamed the ***Air Service Engineering School*** the following year, it graduated its first class of nine Army officers in 1920. Lt Doolittle, Air Service Engineering School Class of 1923, would join the ranks of McCook Field's growing cadre of engineers and test pilots responsible for the rapid innovations and technological advances in the decade that followed: the freefall parachute, variable-pitch propellers, the turbocharger, landing lights, radio navigation, guided missiles, and blind-flying instruments including the gyroscopic compass, artificial horizon, and precision altimeter. The innovations and rapid technological progress of these aviation pioneers are a testament to the efficacy of providing students with a foundational understanding of scientific principles and practical methods for solving complex, engineering challenges.



Air Service Engineering School Class of 1923 (Lt James H Doolittle stands far right, 2nd row)

A century later, the 2018 National Defense Strategy highlights an increasingly complex security environment defined by rapid technological change. It calls on the Department of Defense to organize for innovation with a focus on prototyping and experimentation. In essence, the 2018 NDS is calling for 21st century Doolittles to solve significant engineering challenges. The NDS demands that we ***evolve innovative operational concepts*** in the same spirit that Doolittle's team engineered a solution to doubling the range of a land-based bomber alongside techniques for operating it from the deck of an aircraft carrier.

The success of the Doolittle Raid was a return on investment in engineering education that started with the Air Service Engineering School and extended to other institutions. The complex challenges we face today are primarily engineering challenges. To realize the ambitions of the 2018 NDS and solve the challenges obscuring the path of innovation, we best remember the sources of our prior success. Education--and engineering education in particular--was and remains the wellspring of innovation. One of today's students is tomorrow's Doolittle. We must train her well!