"From the Slide Rule to the Supercomputer: An Oral History of Aerospace Computing at Langley"

INTRODUCTION

Welcome to the NASA Langley Research Center in Hampton, Virginia, our nation's oldest government-supported aerospace laboratory. My name is James Hansen, and I am the historian in residence here at Langley.

The following program explores the history of aerospace computing at this research center. The program has two parts. The first part, entitled "When Computers Were Humans," addresses the important role that "human computers" played in the research conducted here at Langley before the advent of the modern electronic computer in the late 1940s and 1950s. The second part, entitled "The Electronics Revolution," examines how the modern computer, the machine, has in the past four decades dramatically and forever changed the fields of aircraft design and engineering.

INTRODUCTION TO PART ONE

Computers have been important at Langley for over fifty years. But they have not always been machines. In the early days of aeronautical research, computers referred--not to electronic devices--but to the mathematical technicians, the human beings, who processed the aerodynamic information and supplied researchers with the results.

With me today are three women, each of whom worked as human computers at Langley during World War II.

[Camera will be off me]

To my far right is Vera Huckel. A native of Philadelphia, Vera received a bachelor of science degree in mathematics from the University of Pennsylvania in 1929. After holding various jobs in the 1930s, she came to work at Langley as a computer in June 1939. Here she worked on mathematical and computational problems, and carried on individual analytical research, relating in particular to flutter and gas dynamics. Vera also played a leading role in organizing Langley’s computer techniques. She retired from NASA in 1972.

To Vera's left is Helen H. Willey. Helen received a bachelors degree in mathematics from Randolph Macon College in 1931 and a masters in mathematics from Columbia University in 1938. She began working as a Langley computer on December 5th, 1941, the Friday before the attack at Pearl Harbor. For many
years Helen was the head computer for the researchers working in Langley’s 8-Foot High-Speed Tunnel, an important facility in which some of the world’s first reliable transonic wind tunnel data was gathered. Helen retired from NASA in 1973.

Finally, to Helen’s left is Marie Burcher, a Virginia native who worked as a Langley computer from 1942 to 1949. Like Helen Willey, Marie did computational work that supported wind tunnel research. Unlike Helen and Vera, who stayed at Langley for long careers, Marie exemplifies the hundreds of women who went to work because of World War II and who returned to "domestic engineering" not long after the war’s end.

Questions

1. Let’s begin by having each one of you relate how it was that you came to work at Langley as a computer, beginning with Vera Huckel since she arrived first.

2. Were the qualifications for the computers very rigid? Did the computers have to have a strong background in mathematics?

3. Were the majority of computers college graduates? Did they have to pass a proficiency test on the type of calculating machine they were going to use?

4. Were a number of the computers former school teachers?

5. All of the computers seemed to be female; why was that? Did the men feel that this type of work just came more naturally to women? Were there any male computers? Did some of the computers also have typing and secretarial duties?

6. How were the computers organized? In the beginning weren’t they part of a central pool, like a typing pool?

7. Since the size of the research sections varied greatly, I imagine that the size of the computing group assigned to each section also varied greatly?

8. Helen and Vera, you were both "head computers." What did this designation mean pertaining to your responsibilities and authority?

9. Who selected the head computers? Were the head computers usually better educated than the rest?

10. What were your working conditions? Was everyone in one big room rather than in small offices or workstations?

11. What was the pay? How was it equitable relative to the pay of male employees? Did the Civil Service consider computers to be professional or sub-professional employees?
12. I understand that there was a segregated group of black computers. What kind of work did they do?

13. Vera, you worked as a computer for a research division that did more theoretical work. Describe how your work differed from the work of the computers who processed wind tunnel data.

   o Did your work require a good knowledge of trigonometry and calculus? (What about your work, Helen and Marie?)

   o Vera, you worked for a prominent researcher by the name of Theodore Theodorsen. Tell us something about Theodorsen and your working relationship with him.

   o Describe some of the most interesting projects on which you worked.

14. Helen and Marie, you both worked for wind tunnel sections. Explain what you did exactly, and how you did it. Give us a short course on how wind tunnel data was recorded and processed in the 1940s. What instruments were involved (manometers, oscillographs, strain-gauge balances, etc.)?

   o What equipment did you use in your work (slide rule, calculating machines, planimeters, etc.)?

   o Helen, I’ve heard you referred to as a "Friden gal," meaning that you used a Friden desk calculator as opposed to a Monroe or Marchant machine. Explain how these old calculators worked. What could they do; what couldn’t they do.

   o How did these machines multiply and divide? What did it mean to "multiply by ear?"

15. Were the computers allowed to select their own type of calculator? Did each computer have her own calculator or were the machines shared?

16. I assume that some of your work involved film records from oscillographs and the like. What exactly did you have to do with the film records? Did you ever have to do any drafting?

17. How tedious was computing work? Was it more tiring mentally than physically?

18. When a computer completed an assignment, how was her work presented to the researcher? Was it always explained face-to-face? What happened if the researchers questioned your results?

19. Did the researchers make the computers feel that they were an important part of the team, by freeing them from tedious and time-consuming calculations? Or, did they treat you as less important support personnel who only performed routine work?
20. Didn’t a lot of computers date and marry men who worked with them at Langley? Were married couples allowed to work in the same division?

21. After one became a computer, one could aspire to becoming a head computer, I suppose. But was there anywhere to go after that? Was computing work considered pretty much of a career in itself, or was it also a springboard to other careers?

22. When did the electronic computers arrive at Langley, and how did they change your work as a computer? Did they make the employment of a lot of human computers unnecessary? What could the machines do that you couldn’t?

23. How interested were the human computers in the new computing machines? Did you play a significant role in the selection of the machines to be used, or was this decision left to your supervisors, who were men?

24. So, was the demise of the human computers something that happened very slowly over many years, or did it happen rapidly?

25. Looking back on your careers, do you feel that you performed a vital role in Langley’s research, or do you consider your work routine and supportive. Has history paid enough attention to your contributions.

CONCLUSION OF MORNING INTERVIEW

Thanks to all three of you, Vera Huckel, Helen Willey, and Marie Burcher for sharing your memories about the days "When Computers Were Humans." In part two of this program, "From the Slide Rule to the Supercomputer," we will explore the impact of the "Electronics Revolution" on aerospace computing at Langley.

INTRODUCTION TO PART TWO

Welcome back to NASA Langley Research Center. In part one of this program, "From the Slide Rule to the Supercomputer," I talked with three women who worked at Langley as human computers during World War II. In this, the second part of the program, I will talk with two men who know quite a bit about the impact of the "Electronics Revolution" on Langley’s aerospace research.

My guests are Paul F. Fuhrmeister and Laurence K. Loftin, Jr.

Paul Fuhrmeister came to work at Langley in 1944, after receiving a bachelors degree in electrical engineering from Iowa State University. He spent the next several years in Langley’s Instrument Research Division where he pioneered the development and application of radar tracking units that were vital to the high-speed research being conducted by the National Advisory Committee for Aeronautics, NASA’s predecessor, at its flight test
range at Wallops Island, Virginia. As a member of Langley’s Instrument Research Division (or IRD), Paul became intimately involved in the introduction and use of automatic film readers, new electromechanical calculators, and eventually of electronic computers. In 1961, after spending a year with IBM, Paul returned to Langley as chief of a new Analysis and Computation Division (or ACD). He stayed in this post until his retirement from NASA in 1973.

My other guest, Larry Loftin, brings a special insight into the history of aerospace computing at Langley, because as a research engineer and research manager, he was a frequent user of the computing technology. A native of Lynchburg, Virginia, Larry graduated with a B.S. in mechanical engineering from the University of Virginia in 1943. He joined the Langley staff in 1944, where he specialized in research having to do with aerodynamics and aeroelasticity. In 1961 Larry was named Langley’s Assistant Director with responsibility for all aeronautical research; and in 1970 he was named Langley’s Director for Aeronautics. He retired from NASA in 1973. Larry is now actively engaged in writing books relevant to the history of aeronautical engineering, including his recent, well-received book, Quest for Performance: The Evolution of Modern Aircraft, which was published by NASA in 1985.

Thanks to both of you for coming today.

QUESTIONS

1. Earlier today I talked with three women who worked as human computers at Langley. To begin, I’d like to have both of you comment on the importance of these women in the overall research success of Langley laboratory. Paul, what was the significance of the work done by the human computers?

2. Did you feel that the computers were a vital part of your research team, or did you feel that they played only a supporting role? Did you treat them like you would another engineer, or did you treat them like a secretary?

3. Larry, I see that you have a couple of historical artifacts with you. Show us what you brought and explain their significance.

4. Paul, soon after coming to Langley in 1944, you became involved in getting some of the first transonic data at the NACA’s flight test range at Wallops Island. Tell us a little bit about that experience and explain how it led you into the field of computing technology.

5. Describe in detail what it was that the human computers did with the film records from the rocket-model tests (measured film records with rulers, made plots, got areas with planimeters, etc.).
6. What role did you play in the mechanization of the computational work relating to these film records?

7. How did the new film readers work?

8. In the period 1945 to 1950, Langley began to use some big electromechanical calculators like the IBM Model 602. Explain what these machines did and how they worked.

9. Larry, how aware were you as a researcher and research manager of the new developments in computing technology, such as the arrival of the big electromechanical calculators?

10. Explain how wind tunnel data was recorded and processed. What instruments were involved (manometers, oscillographs, strain-gauge balances, etc.)?

11. Paul, were there particular calculators used specifically for the more theoretical work?

12. Explain the significance of the Aberdeen Proving Grounds in Maryland for the development of computing technology at Langley.

13. When did Langley begin to use its first electronic analogue computers? What were these machines capable of doing that the old electromechanical calculators were not?

14. Explain how these computers were programmed (plug boards).

15. How did the introduction of the analog computers affect or change the status of the human computers?

16. When did Langley begin to use computers for flight simulation studies? How did the early simulators work?

17. Paul, you are credited with killing off the analog computer at Langley. What role did you play in converting Langley of the use of digital computers? Explain the difference between the analog and digital computer? What could the digital do that the analog could not?

18. Larry, how has the computer changed aeronautical engineering and aircraft design. What would have been different about the evolution of modern aircraft if people like yourself had possessed today's computing capabilities 30 or 40 years ago? Would our aircraft be substantially different from what they are today?

19. Paul, when somebody refers to a "supercomputer," like the one that has just been delivered to the NASA Ames Research Center in California, what do they mean? What's exactly is super about it, the number of things it can do in less than a second, or what?
19. Do you think that the computer will someday replace the wind tunnel as the primary ground-based aerospace research facility?

CONCLUSION

From NASA Langley Research Center in Hampton, Virginia, that concludes our program "From the Slide Rule to the Supercomputer." We hope that you have enjoyed our look into the history of aerospace computing over the last half-century here at Langley.
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In part one of this program, "From the Slide Rule to the Supercomputer," I talked with three women who worked at Langley as human computers during and after World War II. In this, the second part of the program, I will talk with two men who related to computing technology in different ways but who experienced firsthand the impact of the "Electronics Revolution" on Langley's aerospace research.

For this program on the "Electronics Revolution"

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Paul Fuhrmeister came to work at Langley in 1944, after receiving a bachelor's degree in electrical engineering from Iowa State University. He spent the next several years in Langley's Instrument Research Division where he pioneered the development and application of radar tracking units that were vital to the high-speed research being conducted by the National Advisory Committee for Aeronautics, NASA's predecessor, at its flight test range at Wallops Island, Virginia. As a member of Langley's Instrument Research Division, Paul became intimately involved in the introduction and use of automatic film readers, new electromechanical calculators, and eventually of electronic computers. In 1961, after spending a year with IBM, Paul returned to Langley as chief of a new Analysis and Computation Division. He stayed in this post until his retirement from NASA in 1973.

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