

According to the Britannica dictionary the word is
shock for stacking bundles of grain upright. Shock
would be to shell something. We stacked bundles
of grain upright so they could dry out for later threshing.

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Prairie Daydreamer: Gene Amdahl *

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The summer Gene Amdahl graduated from high school he spent mostly in the fields, shocking grain or pitching hay. He found the work mind-numbing, and to keep mentally active he began reflecting on a newspaper picture he had seen of a new Sikorsky helicopter. It had not only a large, central rotor blade that lifted the craft but also a much smaller one on its tail. This made Gene curious. He soon figured out that the smaller blade must be there to prevent the thrust of the large one from making the craft spin--by exerting its own thrust in the opposite direction. He had read in the family's *Book of Knowledge* about internal combustion engines and automobile differentials, and he began putting some ideas together. In his mind he began designing his own helicopter. It would get its lift equally from two twelve-foot rotor blades--one on each end of the craft--that would turn in opposite directions and be coordinated by a differential. If the two rotors turned with an equal thrust, his helicopter would stay on a steady course, but it could be steered left or right by slowing down the front or the back rotor with a light brake applied to its shaft. 5-AP

However long and hard Gene's physical labors, he would work all day in his mind, putting together all the pieces. He would visualize the angle of attack of the blades, their drag, and their lift--and estimate the combined effect on the helicopter's direction and stability.

The boy didn't feel he could share his ideas with his friends from school, but toward the end of the summer his uncle, Lawrence Johnson, was helping to pitch ^{grain bundles} hay onto a ^{hay rack} wagon to take to the threshing machine. This was someone in whom Gene sometimes confided, so he told him of the helicopter "just because I was so caught up in it." Johnson "couldn't really follow what I was saying," but Gene soon learned that his uncle had told

* This article is based partly on the author's extensive review of the published literature, some archival material, and a series of interviews with Gene Amdahl. Even a glance at the footnotes or references, however, would suggest a special debt to the approximately one thousand pages of transcripts of interviews that Linda Runyan conducted during 1991 and 1992 with Amdahl, his relatives, and his friends from his early years. The article owes much to the depth of those interviews, the insights of both the subjects and the interviewer, and the generosity of Linda Runyan and Gene Amdahl in making them available. It has also benefited greatly from the meaty interview that Arthur Norberg conducted in 1986.

others and "had been quite excited about the fact that I was thinking about those things." This news "made me feel good," he recalled.

There weren't tools or materials on the farm that would let Gene build a true model. Instead--with the help of his younger brother, Lowell--he made a crude mock-up of two blades coordinated by a differential. For gears they fashioned wooden cones without teeth but with rubber strips from an old inner tube to create friction. "Considering the tools we had," Lowell reflected later, "it was a fairly remarkable gear." * (Amdahl interviews, 1991, 1996 and 1997; Gene Amdahl, interviews with Linda Runyan, October 12, 1991, and March 21, 1992; Lowell Amdahl, interviews with Linda Runyan, September 17 and October 12, 1991; *Current Biography*, 1940, p. 734)

* Gene never pursued his idea further, but five years later a tandem twin-rotor helicopter was developed for the United States Navy, and larger versions--most notably the *Chinook*--were used as troop transports during the Vietnam War. (Gabelhouse, 1967, pp. 67-70, 87-9, 98-100, 156)

Family background

Gene Amdahl's grandparents were all immigrant farmers--three from Norway, one from Sweden--who settled in the Dakota territory in the 1860s and 70s, about the time it was opened for homesteading. The Norwegians all derived from small farms along a coastline severely divided by finger-like fjords and ice-topped hills, creating isolated communities so small that high degrees of specialization were impossible. Farmers developed skills at carpentry and fishing, all of which required "quite a lot of individual initiative as well as individual responsibility," Gene's oldest brother reflected later. Long winters and short summers put a premium on planning to manage the ever-present risks, and "being pessimistic and ever-alert for problems was part of their character." (Alton Amdahl, interviews with Linda Runyan, July 30, 1991, and March 13, 1992)

As families grew and farms had to be increasingly subdivided, the appeal of the rich, plentiful farmlands of the American West lured hundreds of thousands of Scandinavians to emigrate. At first life was even harsher on the desolate plains of Iowa, Minnesota and the Dakotas, but the new Americans persisted in the stubborn hope that courage, hard work, honesty

and frugality would eventually bring prosperity. Gene Amdahl knew all his grandparents and recalled them as hardy and heroic pioneers--and as "very upright citizens." Many people, he observed, "just couldn't take the amount of hardship that was required." (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Amdahl interview, 1996)

Gene's most remarkable grandparent was his mother's mother, Bertha Larson Brendsel. Born of peasant stock near Trondheim, as a young girl she spent summers tending cattle in the mountains, where her grandmother taught her to read the Norwegian Bible. As she began a lifetime of eager reading, she learned about the American experience in democracy and soon revered Thomas Jefferson as her hero. Her family migrated to America toward the end of the Civil War, when she was nine. They first settled in northeast Iowa and then traveled by covered wagon to the territory that was to become South Dakota. Bertha mastered the English of the McGuffey Readers so quickly and so well that she was the first person in her area to go to college, because, Gene reflected, her family "put a great deal of value on education." Before she was 16 she studied to be a teacher at St. Olaf's normal school in Minnesota, then began teaching in accentless English in the one-room schools back in South Dakota. (Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Amdahl interview, 1996.)

At age 20 Bertha married a somewhat older man, Anders Brendsel, who had also been born near Trondheim but had migrated to the United States as a young adult. He came from a cultured and politically-prominent Norwegian family and became a polished, sensitive man who played the organ and sang beautifully all his life. He had worked for a few years as a lumberjack to save enough money to homestead in Brookings County, South Dakota, but he "wasn't really a farmer at heart," Gene's sister concluded. After their marriage Bertha learned that he lacked such basic knowledge as how to spread manure on the fields. They supported their large family on a series of small farms in the southeast corner of the state--but only with great struggle. (Lars Brendsel, interview with Linda Runyan, October 9, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991; Evelyn Amdahl Olson, interview with Linda Runyan, August 31, 1992)

The most heroic story passed down in the Brendsel family involves Bertha. She was home with the children on a day when she spotted an approaching prairie fire--and quickly hitched up a team of horses and plowed up a strip of ground that the fire couldn't cross. But she was noted more for the

strength of her will and her intellect. One grandson remembered her as "a highly intelligent woman" who "worked hard all her life". Gene was impressed at the range of her intellectual interests and her ability to remember and to "catalogue" what she had read. "Her depth of understanding was just phenomenal," and "she struck a very responsive chord in me." She also had a sense of humor, and even in old age she would be remembered as "very witty" and "very, very perky." * (Evelyn Amdahl Olson, interview with Linda Runyan, August 31, 1992; Lars Brendsel, interview with Linda Runyan, October 9, 1991; Gene Amdahl, interviews with Linda Runyan, November 30, 1991, and February 15-26, 1992; Marian Amdahl, interview with Linda Runyan, February 20, 1992)

* Another of Bertha's grandchildren, Leland Brendsel, became the longtime head of the Federal Home Loan Mortgage Corporation, better known as "Freddie Mac". (Carnevale, 1988, p. 31)

Mother—Ingeborg Brendsel

Bertha Brendsel passed on her love of learning to all her children. Gene's mother Ingeborg, or "Inga," and her six sisters all went on to normal colleges and taught school, and one of the three brothers also attended college. Bertha also passed on her strong religious faith, which was to be a central part of Inga's whole life. Bertha's Norwegian reserve was such, however, that her daughter never really sensed that she was loved. (Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interview with Linda Runyan, November 30, 1991)

In her musical family Inga learned to carry a tune at the age of two. She later showed a combination of determination and mechanical skills. As a girl she had a pedestal that she considered too tall, but her father said that it couldn't be cut down accurately enough, so she fetched a saw from the tool shed and cut all four legs to the proper length. (Lars Brendsel, interview with Linda Runyan, October 9, 1991)

Inga attended teacher's college and taught for several years in one-room schoolhouses--so skillfully that student teachers were brought in to observe her at work. One of her pupils later remarked, "I don't think there was a better teacher anywhere," calling her "kind in every way and ready to help" but also a strict disciplinarian. "We didn't fool around with her." During this period she also showed a more adventuresome spirit than most young women of the age by taking a vacation with a sister in faraway California. It was considered "somewhat daring," her oldest son remarked.

Her final teaching job was near Flandreau--a predominantly Norwegian community that had begun as a French trading post--where she met the man she would marry, Anton Amdahl. (Amdahl interview, 1996; Wilbur Johnson, interview with Linda Runyan, October 10, 1991; Gene Amdahl, interview with Linda Runyan, November 30, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991)

Grandfather--Ole Amdahl

Anton's father, Ole, was remembered as the most heroic pioneer in his generation of Amdahls. Born on the shore of Stavanger Fjord on the southwest coast of Norway, he had crossed over to Quebec with his family at the age of two. There his father took ill and later died, but his mother and her sons pushed on to Lanesboro, in the southeast corner of Minnesota, where she remarried and settled on a farm. At the end of his teenage years Ole walked more than 200 miles across the state to South Dakota, through prairie grass so high he often couldn't see above it. He took odd jobs along the way to earn his keep, but he had so little money that he couldn't even afford a postage stamp to tell his mother that he was safe. After a few weeks he stopped in Sioux Falls, where he worked for several years. He married Sophia Erickson--who as a young woman had migrated with her family from Vermland in Sweden, about a hundred miles due east of Oslo--and finally saved enough money to claim a homestead in 1884. Their first house was little more than a shack, but their first two sons were born there--Oscar the next year and Anton, who would become Gene's father, the year after. (Amdahl interview, 1996; Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992)

The winter of 1886-87 was exceptionally severe. Many Dakota ranchers like young Theodore Roosevelt lost most of their herds, starved and frozen in "the Great Die-Up". Farmers like the Amdahls faced snow accumulations so deep that neither horses nor trains could get through, and their nearest source of food was Sioux Falls, some 30 miles away. In desperation Ole got up early one morning, put on homemade snowshoes, and ran the distance. Then, carrying a sack of sugar and a sack of flour, he ran all the way back and arrived before the next morning. (Ward, 1996, pp. 368-370; Morris, 1979, pp. 370-3; Amdahl interview, 1996; Gene Amdahl, interview with Linda Runyan, June 22, 1992)

Ole established a reputation as "a very honorable person," Gene's sister

recalled. Through hard work and thrift the family gradually expanded another homestead to 760 acres near Flandreau. Ole inherited another 80 acres from his mother, so that he and Sophia--by the time of their retirement to a house in Flandreau--could pass on a farm of 120 acres to each of their seven children. (Evelyn Amdahl Olson, interviews with Linda Runyan, July 30, 1991, and August 31, 1992; Gene Amdahl, interviews with Linda Runyan, February 15-26 and June 22, 1992)

Father--Anton Amdahl

Survival required that young Anton help on the farm from the start of plowing in March until the last corn was picked in January. This allowed so little time for schooling each year that he ended up with the equivalent of only a third grade education. "I wanted to go to school," he once lamented, "but they wouldn't let me." He "felt that he had missed out on a lot," Gene recalled, and "he felt that made him inferior." (Amdahl interview, 1996; Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interview with Linda Runyan, November 30, 1991)

As a young man Anton traveled to Montana to consider homesteading there. In the end he satisfied his adventuresome spirit by staying on the family farm only until he had a chance to enter the exciting new automobile business with a younger brother, Cornelius. They opened a REO dealership in Trent but later shifted to selling Fords. The brothers would replenish their inventory by taking the train to Detroit, then each driving back a new car, traveling north through Canada to avoid the major rivers that as yet offered few automotive bridges. (Amdahl interview, 1996)

While still selling cars in Trent, Anton began courting Inga Brendsel. Tall, muscular, with a handsome face and blonde, wavy hair, he would always be ← coming to call in a new car from the agency. He greatly admired the social graces of the Brendsels, who could talk well and even sing well. The couple were married in 1917, when he was 30 and she 28.

That year the United States entered World War I the Amdahls went back to the farm so that Anton could avoid being drafted. Anton was not "a ← pacifist in the strictest sense," his youngest son explained later, but he "especially abhorred trench warfare." The Amdahls had a child during each of the next three years--first Alton, then Evelyn and Orin. After the war Anton sold his livestock, opened a second dealership with Cornelius in Flandreau, and bought a house there near that of his retired parents.

(Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interviews with Linda Runyan, February 15-26, and June 22, 1992; Alton Amdahl, interviews with Linda Runyan, July 30, 1991, and March 13, 1992; Amdahl interview, 1996; Lowell Amdahl, interview with Linda Runyan, March 13, 1992)

Business was booming. During the war and its immediate aftermath Europe depended heavily on American foodstuffs. Farmers buoyed by higher grain prices happily borrowed to buy their first cars, and the Amdahl brothers happily accommodated them by cosigning their bank loans. Anton made enough money to buy some of his father's farmland. Then the postwar recession hit. Farm prices collapsed, loans were defaulted, the banks went after the cosigners, and the brothers lost their business. Anton had acquired some assets he could sell, but before long he had to declare bankruptcy. Over the years he gradually paid off a staggering total of a quarter million dollars in obligations. (Amdahl interview, 1996)

It was into this bleak economic environment that Gene Myron Amdahl was born in the house in Flandreau (population 1,929) in 1922, with a midwife in attendance. A year and a half later Anton reluctantly returned to farming, first renting land from a family friend for a short time, then renting from his father a plot 11 miles from Flandreau, which he would later inherit. (Amdahl interview, 1996; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992)

Amdahl farm

In South Dakota, Inga's brother would comment later, "The winters are too long and the summers are too short," and grasshoppers were always a menace. Though farm life would be hard and uncertain for many years, the Amdahls would respond in part by gradually diversifying their production. They were located just inside the corn belt, and they grew that crop both for fodder and for sale. But their small grains included oats, barley, flax and some rye, and crops were periodically rotated with alfalfa to restore nitrogen to the soil and to feed animals. There was enough grazing land to raise about 50 head of beef cattle, for which Anton eventually had to build a silo. As the duststorms and Depression of the 1930s cut their income, the family started raising more animals--a hundred pigs, several hundred sheep, a few hundred hens to lay eggs, and two thousand chickens to be sold for meat. A handful of cows provided enough milk for the family to

drink, with cream to be sold to the local creamery. The Amdahls made their own bread and initially their own soap and candles, and they butchered their own beef and pork, drying part of the meat for the winter. They ordinarily had one hired man in the summer, especially when the children were too young to help in the fields, and in the fall all of the neighbors would join together to harvest the crops and thresh the grain. (Lars Brendsel, interview with Linda Runyan, October 9, 1991; Amdahl interviews, 1991 and 1996.)

The Amdahls lived in a white wooden frame house, with round wooden columns around the porch. Like so many farmhouses of the period it had a telephone but no electricity or indoor plumbing until the time Gene was in high school--just "four bedrooms and a path," he joked later. The living room was heated with a cast-iron stove, banked with hard coal, while stoves in the dining room and kitchen were fueled mostly with corn cobs, sometimes with wood. Water was drawn from wells--hand-pumped from a shallow one or drawn from a deeper one powered by a tall windmill--and could be heated in a reservoir in the kitchen stove. (Amdahl interviews, 1991 and 1996; Evelyn Amdahl Olson, interview with Linda Runyan, September 31, 1992; Amdahl, 1986; Caddes, p. 62; Gene Amdahl, interviews with Linda Runyan, February 15-26 and March 28, 1992.)

The parents

Anton was a tall, muscular man with erect posture, fair skin, and a full head of wavy blonde hair. His oldest son felt that "he never really recovered" from losing so much money and being forced into the "boring" life of a farmer--and that this explained how "quiet and self-effacing" he became. Indeed, the next generation of Amdahls would recall him as a gentle, soft-spoken man who shunned controversy and "didn't push himself on others." He was "reflective," always thinking before he spoke, but "if he was convinced of something he was never afraid to speak his mind." Anton continued his own family's strong work ethic, and his labors were both steady and dependable. Almost all his efforts were put into the farm, but he was perceived in the community as both wise and fair and was sometimes asked to mediate disputes within other families. (Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991; Arlene Amdahl Zeigler, interview with Linda Runyan, October 10, 1991; Oliver Amdahl, interview with Linda Runyan, October 10, 1991; Gene Amdahl, interview with Linda Runyan, November 30, 1991; Amdahl interview, 1996; Marion Amdahl, A-SP

interview with Linda Runyan, July 23, 1991)

Inga was a foot shorter than her husband, with dark brown hair and lively brown eyes. She had, her daughter thought, an "aristocratic look," and she was meticulous about her appearance, though she gradually lost her slender figure in the course of bearing children. Her feminine appearance disguised a prodigious physical strength. Once, Gene recalled, the large cast-iron stove caught fire, and she single-handedly dragged it out of the house, but "it took four men to carry it back in." (Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interview with Linda Runyan, November 30, 1991)

She was also a person of strong mind and strong will--"very brilliant" and "very determined," Gene recalled. She "recognized the importance of duty and behavior on the fabric of the community," Gene thought, and in turn she "was viewed as the pillar of the community." She was more outgoing than her husband and "a very good conversationalist," while still maintaining some emotional reserve. She sometimes had a twinkle in her eye and showed a sense of humor in her choice of reading and her enjoyment of puns--but was also a serious person who seldom laughed with gusto. (Amdahl interview, 1996; Gene Amdahl, interview with Linda Runyan, November 30, 1991; Marion Amdahl, interviews with Linda Runyan, July 23, 1991; February 15-16, 1992; and February 20, 1992) ← SP

Inga suffered from a shaky hand--a "benign tremor" that she inherited from her mother and passed on to several of her children, including Gene. Still, she enjoyed doing detailed handwork--painting, sewing, embroidering, and making decorations for the Christmas tree. She demonstrated her resourcefulness by cutting the children's hair as well as a professional barber and by making them clothes better than those sold in stores. She brought her talents as a teacher to the church's Sunday School, but she also did some of the hardest farm work, like shocking grain in the fields. (Amdahl interviews, 1996 and 1997; Gene Amdahl, interviews with Linda Runyan, November 30, 1991; February 15-26, 1992; and October 12, 1991)

Throughout their married lives Anton and Inga had great mutual respect, but they were not playful together, and they did not display their love for each other in hugging and kissing. Her conversational sparkle never seemed to extend to her husband, but they shared the same goals--to see

their children educated and ready to live according to Christian principles.

They showed a Norwegian stoicism and a constant sense of duty that repressed many feelings. If they were pleased at something, they would show it only in a muted way, Gene recalled, but they tried not to show disappointment in tough times. "They had so many adversities that they could not afford to show any feelings of defeat" The children were allowed to express sadness or disappointment, but not anger. "You couldn't confront," and "you were not to hurt their feelings."

When the parents argued, sometimes bitterly, it was typically over her desire to spend more to improve their living conditions or to provide for their children's education. With her own greater education she could "overpower him verbally," Gene reported, and "knew what strings to pull to obtain the superior position." Then Anton would become frustrated and angry, and he sometimes ended up spending more than he thought they could afford, so that both parents ended up having to work extra hard to make ends meet. (Lowell Amdahl, interview with Linda Runyan, September 17, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991; Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interviews with Linda Runyan, November 30, 1991, and October 12, 1991)

The five children

Alton, as the first born child, was often expected to look after the younger ones, a role he came to resent. But for many years he was his mother's ideal of a serious student. He acquired a lifelong addiction to reading, often doing it oblivious to the world around him, and he skipped a grade in elementary school. When he won the Moody County 8th grade spelling contest, his determined mother coached him for months with word lists for the forthcoming state contest, in which he also came in first. Yet inside Alton had no "clear picture of how I was going to live up to the expectations" his parents seemed to have. "I felt that I was being stamped into a mold, and I didn't like the mold." As a young boy Gene admired his older brother--"the most brilliant one in the family"--but the four-year age difference limited their interaction. (Alton Amdahl, interview with Linda Runyan, July 30, 1991; Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interview with Linda Runyan, November 30, 1991)

Evelyn, on the other hand, had a happy childhood. She paired off naturally with her mother in a family of boys, and she readily accepted Inga's religious teachings and her love of learning--as well as the demanding role of farm daughter. (Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991)

The middle child, Orin, had the most winning personality and was a favorite within the family and outside. He was handsome and muscular, skilled as a writer and an athlete. He had his mother's sense of humor and musical bent and his father's love of farming. In grade school he played the ^{trumpet} ~~cornet~~, and in high school he sang in the operettas. Gene's wife Marion reflected later that Orin was "everything that a parent would want in a child that Gene wasn't". Evelyn considered Orin thoughtful and sensitive, but Gene deeply resented his older brother. First there was jealousy: "Everybody admired his talents, and nobody was admiring mine." But more important, Orin would tease Gene mercilessly--with humor so cutting that its details were one of the few gaps in his later rich memories of childhood. "He'd get my goat," Gene remarked later, but in ways that amused the other family members, while Gene's anger was less "endearing". (Gene Amdahl, interview with Linda Runyan, November 30, 1991; Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991; Marion Amdahl, ^{4-5P} interview with Linda Runyan, July 23, 1991; Gene Amdahl, interview with Linda Runyan, November 30, 1991; Amdahl interviews, 1996 and 1997.)

By contrast, Gene entered the family as a sickly baby. He was unable to digest milk and was not expected to survive until his mother found a brand of condensed milk that he could handle. He was never a strong child, but he had an appealing manner with his full head of blonde hair and a twinkle in his deep blue eyes. A cousin remembered him as "more shy than forward," with "a good disposition and nice personality." Gene developed a harsher view, recalling himself as "awkward and introverted". (Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Lars Brendsel, interview with Linda Runyan, October 9, 1991; Amdahl interview, 1997.)

The last child, Lowell, was born when Gene was three. Gene remembered him as a "cute, cheerful, friendly little guy." The two would share a bedroom and generally pair off together within the family. (Gene Amdahl, February 15-26, 1992)

Early memories and activities

Gene's earliest memory was of a time when he was just two years old. A distant relative from west of the Missouri River put the tot on his lap, described his ranch, and promised him a pony if he would come and visit. The family never made the trip, but it was Gene's first excitement at the idea of distant adventures. His next memory was of age three-and-a-half, when he was playing in the yard of the family farm. His mother had asked him to do a chore that he hadn't done, and she scolded him. It was to be a precursor of many similar encounters during his youth. (Amdahl interview, 1996; Gene Amdahl, interview with Linda Runyan, October 12, 1991)

The farm offered plenty of opportunities for mishaps for an adventuresome lad. Once he was out in the pasture when one of the sheep came so close that he could climb on its back for a ride. The animal soon ran into a fence of barbed wire, which cut deeply into Gene's cheek. Later, when Gene was about three, he was exploring the hayrack in the barn of his uncle, Lars Brendsel. He managed to work most of his body through the floorboards, but his head would not go through. When Uncle Lars rescued him he was hanging by his hands and crying. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Lars Brendsel, interview with Linda Runyan, October 9, 1991)

Gene's early toys were also precursors of later interests. There was a cast-iron tractor half a foot long that may have encouraged his early interest in mechanics. There was also a small golf club that anticipated the primary leisure activity of his later years. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992)

Indoor play included highly-competitive board games, like checkers and Chinese Checkers, in which Gene joined as early as his older siblings would admit him. Alton, especially, "was very good at outsmarting me". Opportunities for outdoor play varied with the seasons. In warmer weather there would be softball games after church, or games with the Amdahl cousins, who generally lived much nearer than the Brendsels. "Bear-Around-the House" was a version of "Hide-and-Seek", and "Ante-I-Over" involved throwing a ball over top of house where the clan was gathered. The full heat of summer would permit swimming, usually in a pond that Anton dug with a large scoop shovel pulled by a team of

horses, but sometimes in the Big Sioux River in Flandreau, and once in *a pool in* Sioux Falls, some 35 miles away. The cousins enjoyed climbing into the hayloft and catching doves to be made into a delicious soup. Gene would sometimes annoy his father by climbing to the top of the farm's 55-foot windmill or by playing on its bottom struts eight feet from the ground--until he fell off the struts and banged his head on the flywheel below.

In winter there was often enough snow to build forts at school or at home. Christmas initiated a rotating set of gatherings within the Amdahl family, in which Gene was one of 21 grandchildren. Winter also provided opportunities to visit neighbors in a horse-drawn sleigh, with heated bricks and horsehair blankets to ward off temperatures that often reached 20 degrees below zero. But the fun of childhood also brought its own tragedies. For several years Gene had his own dog, Ponto, but it was suspected of killing sheep, and at age 11 Gene had to agree to its being shot. (Amdahl interview, 1997; Gene Amdahl, interviews with Linda Runyan, February 15-26, 1992, and March 21, 1992; Alton Amdahl, interview with Linda Runyan, July 30, 1991; Oliver Amdahl, interview with Linda Runyan, October 10, 1991; Evelyn Amdahl Olson, interview with Linda Runyan, August 31, 1992)

Religion

Gene's parents were strong Lutherans who insisted that their children be faithful in attending church and adhering to its moral and ethical tenets. The preaching at the Bethania Lutheran Church, three-and-a-half miles from the house, was strict. Alton would recall it as "very much like the Puritans," Gene as "mostly about hellfire". As a teenager Alton taught Sunday school and served as president of the young people's Luther League, but he rebelled internally against the religiosity with which he was raised. Inga, however, was well-versed in Lutheran theology and would brook no debate. She wasn't fundamentalist in the sense of objecting to anyone learning, Gene recounted, "but she didn't want you to believe something else." Gene attended church faithfully and mastered his Sunday School lessons--"My mother insisted that we learn it"--but within himself he also "emotionally rebelled" against the fire-and-brimstone approach. He would later come, however, to appreciate that his parents' religion enabled them "to have faith when there was very little that you could have faith in." (Amdahl interview, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interview with Linda

Runyan, November 30, 1991, and February 15-26, 1992)

Discipline and values

Gene recalled his mother as "very forceful"--at least within the family, while his sister remembered "a good, quiet disciplinarian and teacher." She was "very insistent on us being morally upright," Gene said. She had "a little trouble letting you know how much she loved you--but the way she took care of you, you knew she did." If he misbehaved he was punished by strong words but only a couple of times by spanking. His parents "did spare the rod," he joked, "but they were careful not to spoil the child". They stressed his need to "accept responsibility" and to do "the right thing," to be "an honest, upright citizen," both productive for society" and respected within the community. (Amdahl interview, 1996; Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interview with Linda Runyan, March 21, 1992)

Anton served as disciplinarian only on one issue--"We weren't allowed to fight with each other"--which was not Gene's weakness. Once when Alton was in college and Orin in high school, the two fought in the corn crib, and Anton separated them by lifting them both up by the shirtcollars and shaking them. It was "an almost impossible feat," Gene marveled, "because together they weighed at least 300 pounds." (Amdahl interview, 1996; Gene Amdahl, interview with Linda Runyan, November 30, 1991)

Lessons in honesty were conveyed heavily by example. Both parents were "totally upstanding," Gene recalled. The children took pride in their father's valiant efforts to pay off his debts--and in the fact that in later emergencies he was later able to obtain loans from friends without documents or collateral. Another example came when Gene was in high school. A man from Trent came to buy some prairie grass for his riding horses. After they had agreed on a price and Anton had loaded up the man's trailer, the man then insisted on paying a lower price for the load. Anton felt deep rage but expressed it by accepting the lower price and then ordering the man to never come back again. "He didn't want to deal with people whom he couldn't take at face value." He trusted his children to take any money they really needed from his pants pockets and later, when away at college, to write checks on his bank account.* (Amdahl interviews, 1991 and 1996; Gene Amdahl, interviews with Linda Runyan, March 21, 1992, and November 30, 1991)

* Gene would recall with pride that he once tried to pay by check at a store in Flandreau, but the owner first asked who his father was. He gave Anton's name, and the owner replied, "He's the honest Amdahl. You can cash your check." (Amdahl interview, 1996)

A stress on frugality was inherent in life on the farm. Anton was always "trying to make ends meet," Gene reflected, and--between his debt burden and his expenses--he often seemed "stretched to the limit". The children grew up with "a sense of scarcity and a sense of necessity to husband the things that you had." The Amdahls set aside extra money for only two things--farm improvements and education. "We never bought anything that was very frivolous. Everything was bought with a purpose, except for maybe a gift that you got at Christmas time or at birthdays," which would often be something that Inga had made herself. When appropriate, the parents invoked old adages, like "Waste not, want not," "A penny saved is a penny earned," and "a stitch in time saves nine". Franklin's *Poor Richard's Almanack* "probably supplied about half of all of them," Gene estimated.

Frugality did not preclude charity, even beyond the limits of the Lutheran Church. Anton Amdahl was very impressed by the work Father Flanagan was doing with inner-city youth at his Boys' Town and sometimes made donations. (Gene Amdahl, interviews with Linda Runyan, November 30, 1991, and March 21, 1992; Amdahl interview, 1996)

Another value in the Amdahl household--shared by children and grandchildren of immigrants across America--was assimilation. Grandmother Brendsel was its most powerful advocate, having seen the United States as her land of opportunity and resolved that her family would become Americans, not Norwegians. There were some carryovers, of course. Anton retained enough of a Norwegian accent to reverse his "J"s and "Y"s, and Inga sometimes prepared Norwegian dishes like *lefse*, a thin potato pancake, and *lutefisk*, dried cod in white sauce. Table expressions included responding to thanks with "*Ingen tingen taka fur*"--literally, "nothing to thank for." Twice Gene went with his family to large Trondheim Day picnics in nearby Baltic. But, Alton recalled, when the older generation talked Norwegian, "the younger people didn't understand it or were embarrassed by it". Grandmother Brendsel's philosophy prevailed--"that the way to become a good American was to get away from the old ways." (Alton Amdahl, interview with Linda Runyan, July 30, 1991; Lowell Amdahl, interview with Linda Runyan, March 13, 1992; Gene Amdahl, interviews with Linda Runyan, March 21, 1992, and February

15-26, 1992)

Grade school

Gene's mother had already taught him the alphabet and how to read a number of words by the time he entered grade school, and he was proud to be old enough to attend. Blinsmon No. 9 was a one-room country schoolhouse with blackboards on three of the four walls. The only heat came through a single grate in the floor from a furnace in the basement. When Gene first entered, the school had nearly 30 pupils, but as he progressed through its eight grades enrollment dwindled to as few as 15. The lone teacher would work with each class in turn, while the other pupils did their homework or reading assignments but could listen in on the lesson being taught. "It worked remarkably well," he concluded later. The pupils were well-grounded in the basics, and arithmetic extended into square roots and elementary algebra. There was an unusual emphasis on current events. Pupils were required to bring in newspaper clippings on world affairs, and they were well aware of the war clouds growing in Asia and Europe, starting with the Japanese occupation of Manchuria and the rise of Hitler. Consistent with the Midwestern isolationism of the period, the children were taught some suspicion of American policy toward Japan--"we didn't have a totally clean slate" on the origins of the war, he reflected later. (Amdahl interview, 1991; Amdahl, 1986; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Gene Amdahl, interview with Linda Runyan, October 12, 1991)

Looking back, Amdahl felt that "a good teacher makes an enormous difference." His first teacher was an attractive married woman who was "very good" and on whom he developed a crush. "I felt that she was interested in my performance, and I learned a lot," but she stayed only a year.

Then the school was taken over by Wilbur Johnson, a neighbor who had been a pupil of Gene's mother and who lived on his parents' farm a mile away from the Amdahls. Over the next five years he became a major shaper of the boy's outlook. He was "a guy who understood lots of things and was willing to talk at my level," and Gene was especially impressed by his "general enthusiasm for things" and sense of fair play. That sense came to the fore one noon hour during the Great Depression, when Gene joined several boys in teasing another whose father had been forced onto a New Deal public works job. Johnson caught them. "The first thing he told

me was that he was a fortunate person, and I was fortunate, and I shouldn't do that sort of thing." Then he made ^{Gene} ~~the boy~~ stay after school for two weeks, cleaning blackboards and erasers. It made "an enormous impression," and "I never, never, did that again."

Gene took to waiting after school for his teacher so they could walk the two miles home together. The boy would "ask questions all the time," Johnson recalled, especially about wildlife. Gene marveled at his teacher's skill with a .22 target pistol--"Most people had more trouble hitting a gopher with a rifle than he did with a target pistol"--and enjoyed it when he was allowed to try the gun himself. One day Johnson dazzled him when he aimed at a nail on a fence post 20 feet away and hit it directly on the head. (Amdahl interviews, 1991 and 1996; Amdahl, 1986; Wilbur Johnson, interview with Linda Runyan, October 10, 1991; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992)

Gene also admired Johnson's abilities in other areas, including music. He was a good violinist and encouraged all his pupils to take up an instrument. First he organized a rhythm band, then an orchestra, and produced "the most marvelous school musicals," with each of the pupils taking a part. Gene tried first the violin, where his shaky hand was already a problem, and then the flute, but the high tones would give him a nervous tic in his eye. Johnson would recall Gene as a capable player, but the boy quickly concluded that the Brendsel aptitude for music had passed by him.

Beyond the musical events Johnson developed a broad program that "made school interesting"--a newspaper, a school fair with booths where the parents and neighbors would come and test their skills, and plays in which Gene enjoyed acting. He also took to declamation contests, in which each pupil would select and recite a story. Gene would "present them with all the emotive power I could," and in fifth grade he took first place in a Moody County public speaking contest. "You can be an actor even though you're shy," he explained later. "That's because you are not presenting yourself, you're presenting someone else."

Though Gene was unathletic as well as shy, he was still well-liked. He was intelligent, inquisitive, and, Johnson remembered, "quick to catch on to anything mechanical." Mathematics was his best subject, and he sometimes made the honor roll, but he did not apply himself to school as well as his older brothers. (Gene Amdahl, interview with Linda Runyan,

February 15-26, 1992; Amdahl interviews, 1996 and 1991; Wilbur Johnson, interview with Linda Runyan, October 10, 1991)

Value on Education and Reading

Anton Amdahl was proud of his wife's education and felt "disenfranchised" by his own lack of it--a disadvantage he was determined his children would not share. All five grew up with their parents' assumption that they would go to college--and all five did. It was not based on the parent's economic status, but on the value they placed on education. At least once during the dust storm years Anton could only meet the costs of the children's schooling by borrowing money from a friend, whom he repaid in better times.

The schoolteacher in Inga showed visibly in the fact that the family eventually owned hundreds of books--a high number for the Dakota plains. There were also books from the modest school library or the larger public library in Flandreau--and general-interest magazines like the *Saturday Evening Post* and *Colliers*. There was also *Boy's Life*, in which Gene read all the stories each month. Inga was "very dedicated" to getting the children--as well as her husband--to read intensely, and every evening they did. She would gather them all around the big, round dining room table, each reading or doing homework by the light of a gas lantern. "We were always reading," Gene recalled. Anton would typically read the daily Sioux Falls *Argus-Leader* or a farm magazine--though slowly, as he sounded out the words--while she would read a church magazine, the Bible or a classic novel. Sometimes on winter nights she would read books, like *Ben Hur*, aloud to the entire family.

As soon as her first children were old enough to read, Inga had bought a 20-volume set of the children's encyclopedia, *The Book of Knowledge*. As Gene explained, "she wanted to make sure that we had stimulation." The oldest brother, Alton, read every volume from cover to cover. Gene started reading it at age eight, and by the end of grade school he had read about three-fourths of it, including many articles about faraway countries and famous people. He was "fascinated" by the articles on the machinery he knew on the farm--automobiles and tractors--and especially their transmissions and differentials. He would visualize them in motion, and he felt later that reading about them had sparked his first interest in technology.

Toward the end of grade school Gene brought home from the Flandreau library a book on Esperanto, the synthetic language based on European words. Its promise to become a universal language appealed to the boy, who was already dreaming of world travel, and he persuaded Lowell to study it with him. It began a lifelong habit of affectionately calling his brother "*min frato*." (Amdahl interviews, 1991, 1996 and 1997; Gene Amdahl, interview with Linda Runyan, October 12, 1991; Lowell Amdahl, interviews with Linda Runyan, September 17, 1991 and February 15-26, 1992; Amdahl, 1986.)

Chores and Daydreaming

Gene's chores on the farm began when he was only three--first picking eggs, then weeding the garden and bringing water and feed to the chickens and horses. When he first started school he would only observe as his father and older brothers pitched silage down to the cattle, but by the time he was ten he would be joining in such heavy work. He would also plow corn by guiding a single-row cultivator pulled by two horses, and before school he would milk the half-dozen cows. (Amdahl interviews, 1996 and 1997; Lowell Amdahl, interview with Linda Runyan, September 17, 1991)

As early as the age of eight he knew that he did not want to become a farmer. He liked the outdoor life but not the farmer's dependence on the harsh South Dakota weather--and especially not the labor, which he found "far too onerous. It never let up." He continued to be the frailest of the brothers--perhaps because he suffered from tuberculosis, though it was never diagnosed or treated at the time--and hard labor soon tired him out and made his body hurt. He realized he could never be good at farming, because the process utilized his mind so poorly, and the results offered so little "fulfillment" and "emotional reward." (Gene Amdahl, interviews with Linda Runyan, February 15-26, 1992, and October 12, 1991; Amdahl interview, 1997; Amdahl, 1986)

Neither his family's situation nor its ethos allowed him to vent his pain as anger, so his escape was through daydreaming. "Something would strike a chord in my mind and off I'd go," he explained later. He enjoyed hunting and trapping, mostly shooting a rifle at the jack rabbits that plagued the crops and sometimes shooting at--but never hitting--pheasants. In his early grade school years, then, he romanticized the role of hunter. Within a few years--partly inspired by camping stories in *Boy's Life*--he dreamed

of riding a horse into the mountains and living out of doors, shooting game for his livelihood. "I'd be able to see myself off somewhere actually doing it." (Amdahl interview, 1996; Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991; Gene Amdahl, interviews with Linda Runyan, November 30, 1991; February 15-26, 1992; and October 12, 1991)

Sometime he could keep working while he daydreamed, but all too often he shifted his concentration entirely. "I'd get caught up somewhere in the labyrinths of my mind." While it "sort of anesthetized me for the wear and tear of what I was doing," it also slowed his work pace, whether on the farm or at school. The family's reaction was devastating and made him feel isolated and defenseless. Brother Orin would make cutting jibes that would "really tear down my self-esteem" and inhibit, he felt later, his development of social skills. His mother--never the warmest of parents--chided him often and made him feel that her love was conditional on his performance at chores. He felt "second class," especially when his mother tried to motivate him by predicting that he "would never amount to anything". He came to accept the family's perception of him as lazy--and therefore undeserving and unwanted by the parents he revered. "I could see a reason why I wasn't lovable." The whole process "was painful," he recalled. "It really was painful." At the same time his parents kept working to improve his performance, so at least he didn't feel "discarded".

During a series of interviews with Amdahl, journalist Linda Runyan developed the notion--which he accepted--that he had been caught up in a "vicious circle". The painful responses of his family increased his need to escape into his own mind, which brought on more criticism and more guilt--and then only increased his need to escape into an imaginary world without pain. While the ultimate results of the process would prove fruitful, for years Gene would feel guilt over having been "the least productive family member." (Gene Amdahl, interviews with Linda Runyan, October 12, 1991; November 30, 1991; February 15-26; and March 21, 1992)

Mechanical interests

Gradually Gene became less interested in hunting and horses and more absorbed in things mechanical. During his grade school years he had developed mechanical projects of his own. Early on he took apart a broken wind-up alarm clock to see how it worked and then put it back together

again. He experienced "one of those great and glorious moments" when he found that he had been able to do it with fewer parts than the manufacturer. The clock still wasn't working, and he had no tools to fix it, but there was pride in the realization that he had some parts left over. Sometimes he played with tin cans and pretended they were rocket ships. Later he would go to the tool shed to saw and hammer things out of wood or to bend things out of wire. He also made a few rubber-band-powered model airplanes from kits. (Gene Amdahl, interview with Linda Runyan, October 12, 1991; Amdahl interviews, 1991 and 1996)

Gene's father encouraged him to use tools, and when he was about eight he and Orin undertook to build a primitive pushcart. From a broken little red wagon they salvaged the two wheel-and-axle assemblies. They mounted both of these on two-by-four blocks, which they then bolted to the bottom of a wooden platform, allowing the front block to pivot around its center, while the rear one was fixed. They added a vertical board for a backrest and in front a vertical post, to which they attached a steering wheel with a length of rope nailed to its stem and wrapped around it several times. The boys passed the two ends of the rope through holes at the front of the platform and attached them to opposite ends of the front wheel axle block. Depending on which way Gene turned the wheel, then, he could pull at either the right or the left end of the block and make the cart turn as Orin or Alton pushed it along.

Another small adventure began toward the end of grade school. While walking at an uncle's farm he scraped his foot on something in the ground. Curious, he dug up what turned out to be an old rust-encrusted rifle that his uncle was happy to let him keep. He soaked it in kerosene in a chicken-feeder trough, and every day for two weeks he poked a wire down the barrel to clean out a little more of the rust. Finally the barrel was clear and he could operate the trigger and load the gun manually. Triumph came when he was able to use it to shoot a rabbit 20 feet away. "It was just a fun thing to do," he said later, but "to make that rifle functional was a major achievement". Even his older brother Orin, who had a good rifle of his own, was "amazed that I was able to fire it". (Amdahl interviews, 1996 and 1997)

Gene also joined a cousin, ^{near Sioux Falls} ~~in Flandreau~~ in devising a crude substitute for a bow and arrow. For the bow they used a stick attached to a string that was knotted at the far end. For their arrow they shaped a piece of tapered shingle, using the thin end to serve as feathers and carving a point at the

thicker end. They notched it at the balance point of the shaft and placed it on the string resting against the knot. Employing the combined leverage of the arm, the stick and the string, they could fling their arrow a substantial distance--and even hit a large target 200 feet away. Gene found that "very exciting" and made his own when he got back to the farm. (Amdahl interviews, 1996 and 1997; Gene Amdahl, interview with Linda Runyan, October 12, 1991)

Before electricity came to the farm, the technology he saw was largely mechanical. His father and brothers would routinely repair their own horse-drawn plows and other equipment--and even make some of it when money was short. "As long as you had tools that could do it, you did it." One year they read how to make their own paint--a mixture of skim milk, ocher, and Portland cement that turned out to last almost as long as oil-based paint. Their tool shed held an assortment of basic tools for rough carpentry work, and they built their own wagon boxes and hay racks and their own outbuildings--chicken coops, barns, and silos. "We never had anyone else come in and build."

Gene soon learned to use the tools himself, and if something broke, he would be the one to repair it. "You fixed it in a makeshift manner many times, but you understood that the project had to be done. With a little baling wire and string you could do lots of things." He looked back on this side of life as a source of his later independence. "You depended on yourself. There wasn't so much teamwork. You had your job to do, and you did your job, and you relied on yourself." Eventually, "I repaired everything from a sagging roof line on the house to a water tank for cattle." (Amdahl interviews, 1991 and 1996; Amdahl, 1986)

Tractors were also a source of Gene's interest in mechanical devices. The family had a car from the time Gene could remember, but he was about ten before his father bought a Fordson with wide steel wheels. Horse-drawn plows were still used in planting corn, but the tractor could be used for general plowing and for driving the belts on equipment like the corn sheller. Gene watched with interest as his father serviced and repaired it. He was also impressed with the speed with which it could plow--"a marvelous thing to see." He drove the Fordson a bit himself, but he became more familiar with the family's next machine, a more versatile Allis-Chalmers with adjustable wheels, rubber tires and several attachments for raking and dragging--and for cutting and binding grain. Despite his aversion to farm work, Gene "sort of enjoyed the things you

could do with that". For example, "If you jacked up the rear end of the tractor and swapped two wheels, you could have just the right width to plow two rows of corn." (Amdahl interviews, 1996 and 1997; Amdahl, 1986)

Gene's oldest brother, Alton, later reflected on how their father, like his Norwegian ancestors, was forced by the problems of farm life to develop ingenuity and a diversity of skills:

I'm amazed at how many things that our father could do. He could doctor horses, chickens and cows. He assisted in the birth of animals. He could fix a plow and plant corn--that in itself is quite an achievement, to get straight lines all the way across a field. He was a good builder and he was excellent with engines of all kinds. So a farmer thinks in terms of physical problems.

Anton, he felt, "liked doing new things really more than being efficient about the drudgery type of work." (Alton Amdahl, interviews with Linda Runyan, March 13, 1992, and July 30, 1991)

Toward the end of Gene's grade school years his love of building things grew. He eagerly participated whenever his father was constructing something on the farm, like a chicken coop or a hog house, and he, too, was "amazed" at Anton's inventiveness and perseverance. "He would stick to something until it was done, no matter how difficult it was. And he'd do it well," so it would last a long time. Once Anton pondered long on how to build windows for the chicken brooder house that would provide ventilation for the heating stoves without risking direct drafts on the baby chicks. He solved the problem by bending some sheet metal into a V-shape and then covering both ends. He nailed this to the side of the house, with the opening of the V just covering the bottom half of the window. When the window was opened by tilting it inward from the top, the bottom half would swing out and rest against the top side of the the V. Air could then enter indirectly over the top of the window--but the bottom half was completely shielded by the sheet metal.

Anton was "very, very logical" and set a standard for care and precision. When he was laying out a foundation for a chicken coop, he would use a carpenter's square to test the corners, but then he would double check by stretching a string diagonally between both pairs of opposing corners to be sure the distances were identical. He was also imaginative in striving

to keep all the sides of the coop at the same height. No carpenter's level would be long enough for the job--so he made his own by resting an eight-foot chicken feeding trough on opposite sides of the coop and half filling it with water. He would then raise the lower side until the water was at the same level at both ends of the trough. (Amdahl interviews, 1991, 1996 and 1997; Gene Amdahl, interviews with Linda Runyan, November 30, 1991, February 15-26, 1992, and March 17, 1992.)

Interest in inventing

From early in his grade school years Gene read in the *Book of Knowledge* about figures from the world of technology, like Henry Ford and Harvey Firestone. What really "captured my imagination," however, was an article on Thomas Edison--"A Modern Wizard"--describing his work on moving pictures, the phonograph and the electric light. Gene knew that he wanted to become an inventor by the time he was in the fourth grade--"almost from as early as I began to develop an understanding of why things worked the way they did." (Amdahl interview, 1996; Mee and Thompson, 1923, pp. 6349-6351.)

Aviation was an exciting new field, and Gene had two brushes with it. When he was eight the family drove to an airport to watch a barnstorming pilot--and Inga showed her adventuresome spirit by paying to go up with him for a spin, while Gene looked on enviously. Later the family went to the Sioux Falls airport to see a strange new gyroplane. Behind the cabin it had a motorized propeller that pushed the craft forward, and on top it had a larger, passive propeller that then turned in response to the rush of the air and provided extraordinary lift. The interest it sparked would show itself several years later in Gene's design of the double-rotor helicopter.

Radio was another technology that caught his imagination. Even before electrification, the Amdahls owned a battery-operated radio, and Gene would listen to children's programs, mostly from a powerful station in Yankton, about 90 miles away. The programs "made you see things in your imagination," he reflected later, "so it built on what my tendency was anyway." (Amdahl interviews, 1996 and 1997)

Some potential influences did not seem to stir him into new projects. Though Anton must have known a great deal about automobiles from his years at the dealership, he did not teach his son about them, and the boy did not tinker with the mechanical side of the family's car or tractor. He

had a small Brownie camera but was "not really excited about photography" and never developed or printed his own pictures. His parents visited the Chicago World's Fair when he was 11, and they recounted many stories of what had impressed them, but he remembered best a model Greyhound bus that they brought back "to show us what they rode around in." (Amdahl interview, 1996)

Later chores and daydreams

As he grew older Gene increasingly worked alongside his father on the farm. At about age 12, as Gene was constantly bending to help shock oats, his stomach would become so upset that he had to vomit in the fields. Then he noticed that his father had the same problem but never complained about it, so "I understood I was supposed to keep on anyway." It was another lesson in Norwegian stoicism--to persevere even in the face of extreme pain. (Gene Amdahl, interviews with Linda Runyan, October 12, and November 30, 1991)

While shocking grain was pure strain for Gene, the threshing process at least added a social side during his high school years. Anton's older brother, Oscar, owned a threshing machine and would take it around to the farms of his brothers and other neighbors. The farmers would follow along with hired men and kids to pick up the bundles in their hay racks and put them into the threshing machine, so that more than two dozen men and boys might be involved. Gene's cousin Arlene recalled some times of "wonderful togetherness." But Gene remembered more the harsh side, like the time he was shoveling grain with a male cousin. For the first week he could keep up, "but I kept getting tireder and tireder". After ten days of shoveling he had to quit, because he "could hardly stand." (Arlene Amdahl Zeigler, interview with Linda Runyan, October 10, 1991; Gene Amdahl, interviews with Linda Runyan, February 15-26, 1992, and October 12, 1991)

By Gene's last two years in grade school, mechanical devices--especially motors--had replaced hunting adventures at the center of the daydreams by which he mentally escaped from such chores. There were, he estimated later, "hundreds of little things" he actually wanted to build, but the materials and tools were not available, and so "fantasy was the major thing". (Gene Amdahl, interviews with Linda Runyan, October 12, 1991; February 15-26, 1992; and March 21, 1992)

He did not subscribe to either *Popular Mechanics* or *Popular Science*, but sometimes he could save up enough money to buy one or the other when the family went into Flandreau. He would sometimes read of an airplane or other new device--"that gave me something concrete to dream about," he would design improved versions in his head by applying mechanical principles he had learned from *The Book of Knowledge*. While still in grade school he conceived a "rotor motor"--a two-cylinder internal combustion engine with pistons that rotated back and forth at the center of each cylinder. It would act, he felt, like a four-cylinder engine but achieve high compression for so small a volume.

Gene also daydreamed about a simpler idea, derived from his experience operating the farm's cream separator, a centrifuge that spun milk to divide it into cream and skimmed milk. He imagined using the device for recycling used crankcase oil--after first filtering out the sludge--by separating out the light components, like kerosene, from the heavier ones, like heating fuel. He saw the separator as his own oil refinery--the basis for a business that might earn enough income to get him off the farm--but he never dared to test it for fear the device could never again be used on milk. (Amdahl interview, 1996; Gene Amdahl, interview with Linda Runyan, March 21, 1992)

Once he was preoccupied with such a device while climbing the stairs, and his toe slipped on the next step so badly that he rolled down the staircase. Sometimes he could be seen out in the fields, his work slowed as he gestured with his hands to try to simulate some mechanical motion, to develop a greater inner feel for the operation. Other times, walking to and from school he would wander off the roadbed while visualizing the structure of a device and then mentally monitoring its operation, figuring out practical problems, like how to lubricate it. If he saw weaknesses in the operation he would alter and simplify the design. "I'd keep everything in my mind. Then once in a while, when there was something I had trouble visualizing mentally, I'd try drawing it." His ability to visualize mechanical processes improved with practice. "It was a talent I cultivated, because there a rewarding sort of thing--an emotional reward." (Amdahl interviews, 1991, 1996 and 1997; Gene Amdahl, interviews with Linda Runyan, October 12 and November 30, 1991; Alton Amdahl, interview with Linda Runyan, July 30, 1991)

His daydreams created "a world inside" that he could control, unlike the outside world that seemed to confine him so much. He was very alone in

this world but felt "self-sufficient psychologically" rather than lonely. He also valued his imagined inventions for their own sakes: "The things I would think of there were ever so much more satisfying, fulfilling, and exciting than what I was actually experiencing in the world around me." But he could also dream that one of his inventions would actually work and help him to escape from the life he found so boring and so painful, both physically and emotionally. (Gene Amdahl, interviews with Linda Runyan, March 21, 1992, and February 15-26, 1992; Amdahl interview, 1991)

Brother Alton later recalled listening to Gene's descriptions of his imagined inventions "with some respect, more than the rest of the family." In general, however, Gene remembered that others "didn't think of me as a prodigy so much as a dreamer," with "a negative cast" on the word. But his daydreams got him more and more interested in learning the principles of the physical world. (Alton Amdahl, interview with Linda Runyan, July 30, 1991; Sedgwick, p. 44)

December 1, 1997

Egan High School (1936-8)

Some 400 students from several of the rural districts were enrolled in the newly-consolidated public high school in Egan (population 569). When Gene began attending in the fall of 1936 he would ride the 11 miles in a bus driven back and forth by one of the older students who lived at the far end of the line.

Gene spent a lot of time on subjects that would not be important to him. Courses in agriculture were required, and Gene even joined the Future Farmers of America. He learned such things as how to test for the butterfat content of milk, but he already knew that he didn't want to become a farmer. Some things that would later be important did not stick well. He took algebra but didn't think the teacher was very good and soon forgot much of what he had learned. He did, however, take plane geometry one quarter--and it "grabbed me just like that!" It appealed both to his "pictorial sense" and to his sense of logic. He "just loved proving those theorems" and was something of "a whiz" at them.

His parents expected him to be active musically, but he was the only family member with a "tin ear". He played trombone in the school band, but it was hard for him to see the music--and even if he could, he couldn't read it. He also sang in the chorus and enjoyed it a little more--although his voice was "not so hot," he could do it without having to read music. His favorite school activity was performing in a couple of plays. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Amdahl interview, 1996; Amdahl, 1986)

He recalled himself as "a nerd." He wasn't much of an athlete and was socially "a little awkward." He dated girls, usually in a group setting--at a basketball game or after a play rehearsal--but he felt he was physically unattractive--too short and with ears that stuck out too far. Still, given his lonesome past, he "began to blossom socially" at Egan, and he obtained some satisfaction from being "noticed as a person" and being considered an "insider". In the hopes of gaining greater acceptance he began occasionally smoking cigarettes and drinking whiskey mixed with Coca-Cola--but this convinced his mother that his friends were leading him astray. (Gene Amdahl, interviews with Linda Runyan, February 15-26, 1992, and March 21, 1992; Amdahl interview, 1996)

One influence on his later life came not from school but from nature, in the form of the huge snowstorms of 1937 and 1938. The drifts were so deep that the top of one automobile was buried ^{up} fourteen feet, and the plows eventually couldn't clear the county roads. When a few neighbors combined forces they had to shovel four-and-a-half miles of driveways and roads, and in some places the drifts were so high that Gene couldn't throw the snow over them. He began dreaming of living in a warmer climate, and, when he heard travelers' tell about visiting California, it seemed "like having one foot in heaven." His own travel at the time was largely confined to a trip or two with the Future Farmers of America to northern Minnesota and Wisconsin. He was uninterested in the farming aspects but fascinated by a tour of a factory where milk was being dried and powdered. (Gene Amdahl, interview with Linda Runyan, October 12, 1991; Amdahl interview, 1997.)

Electricity and telephone lines

During Gene's last year in grade school, the New Deal's Rural Electrification Administration brought power to the area, and he had watched with interest as his mother's brother wired up the Amdahl farm. Getting electricity "was wonderful," he recalled, providing better lights and permitting family members to read at places other than the dining room table. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992)

Soon Gene's father began supplementing his depressed farm income with a contract to maintain the local telephone lines--splicing breaks after a sleet storm and alternating the height of the two wires every fourth of a mile to reduce interference from the new power lines. Anton had no prior experience, but "he was very intelligent, and he observed what had to be done." Gene helped by replacing poles that were blown over and by climbing posts to tighten or replace lines broken by sleet storms. It "wasn't a very technically demanding job," but it gave him his first experiences working with electricity. He would sometimes get an abandoned phone to work again. The greatest fun, however, came from using the telephone hand cranks--or the magneto borrowed from the family's defunct Ford Model T truck--to deliver shocks that were memorable but not injurious. (Amdahl interviews, 1991, 1996 and 1997.)

About the time he was starting high school, he saw an ad for crystal radio

sets in *Popular Mechanics* or *Popular Science*. He sent away for a kit and put it together, adding an earphone that his father used to test telephones. He could hear enough static to convince himself that the little set was working, but he was too far from any station to pick up broadcasts, so he decided there wasn't much future in building another. 1996; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992)

Augustana Academy (1938-40)

Gene's mother wanted to be sure he was exposed to good moral influences, so after two years at Egan his parents transferred him to a Lutheran boarding school, Augustana Academy in Canton, some fifty miles south of home. (Amdahl, 1986)

Circles of friendship--like his own at Egan--had already been formed during the first two years at Augustana, and as a transfer student Gene "felt like an outsider". He roomed with an older cousin and one of the cousin's friends, but they treated him as a youngster, not a peer. The other students all seemed more socially polished and more overtly religious--his own belief was real but "all private"--so he didn't try hard to fit in. It was a hard time to have no friends, and the unhappiness and low self-esteem of his earlier years only deepened. Although Augustana was coeducational, he did not continue dating when he went there, because none of the girls especially interested him.

Still conscious of his parents' expectations, he continued to sing in one of the choruses--"but not the good one"--and to play trombone in the band--but "I was lousy at it." He tried out for football but soon found that "I was the one they would practice against," and the only result was some cracked ribs. His easiest social interaction was a mindless game of tossing checkers into a cigar box across the room. But he also enjoyed using his skills at visualizing to help another cousin at the academy with his geometry problems. The first time the cousin asked for assistance, "I ground out the answer for him in short order," and then he would come back whenever he needed help. (Gene Amdahl, interviews with Linda Runyan, February 15-26, 1992, and November 30, 1991; Amdahl interview, 1996)

If his powers of mental visualization were growing, his eyesight was fading, and by his first year at Augustana that he couldn't make out the words on the blackboard even from the front row. He didn't want to wear

glasses, but a teacher convinced him that he should tell his parents. He was diagnosed with both astigmatism and nearsightedness, and by his senior year he was wearing glasses and could read blackboards again. (Amdahl interview, 1996; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992)

Academically, Gene concluded, Augustana had been weaker than the public high school. There were "dedicated teachers and a lot of dedicated students," but "too few teachers with too little experience." One he admired was the woman who taught English and inspired him enough that his eye problems didn't hold him back. Another favorite teacher was Mr. Strand, a strong but fair disciplinarian who taught business math, a course apparently designed for people who were going to run stores. Strand would train the students to listen to a list of three or four-digit numbers and immediately come up with their sum. "He'd teach you some little tricks" that were "very effective" in dealing with numbers." After that training numbers for Gene were no longer "a fearful thing". (Amdahl, 1986; Amdahl interview, 1996)

He also enjoyed a wood shop course. He could easily visualize what he wanted to make, but "I wasn't a great user of those tools," and workmanship was "a little shoddy." His major project was making a "pretty good" archery bow. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992)

When the academy introduced a semester of physics, the teacher "was basically one jump ahead of the course he was teaching." Still, the subject interested Gene, "because I was learning how things worked," and because "I always thought of physics as part of my inventing, how to solve things." He did not remember enough algebra to understand many of the physics formulas, but he could solve the problems, because "I had a feeling for how things went." He could visualize that "energy was proportional to the square of the velocity--that made sense to me." He earned one of the best grades in the class.

During the course he began hearing terms like "sine" and "cosine," and, when he asked about them, the teacher lent him a college-level text on trigonometry. Gene studied it casually and enjoyed the geometrical side enough that he quickly "got a feeling" for it. (Amdahl, 1986; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Amdahl, 1986; Amdahl interviews, 1996 and 1997)

Reading and tinkering

Gene had come to see himself as locked in "a pretty pedestrian world," and one escape was through reading. Just before high school he had begun reading futuristic adventure magazines like *G-8 and His Battle Aces*, but his mother belittled them as "dime novels." At Augustana he turned to the adventure novels of Zane Gray and Jack London--but especially to magazines like *Astounding Science Fiction* and writers like Isaac Asimov and Robert Heinlein. Just as he had first sought escape by imagining himself as a hunter, now he imagined himself as a flyer or even a space traveler. He would later recognize himself in the title character of the James Thurber story and Danny Kaye film, *The Secret Life of Walter Mitty*, a timid man who escapes from a humdrum life with fantasies of derring-do. "I lived ten times as much internally as I lived externally." Science fiction "expanded my imagination," making him interested "in learning about much more than I'd experienced before." After reading only a short while he would often "get caught off in some thinking process," and once he was inspired to do drawings of his own rocket ship. (Gene Amdahl, interviews with Linda Runyan, February 15-26, March 17, and March 21, 1992, and November 30 and October 12, 1991; Amdahl interview, 1996)

A more ambitious project during his Augustana years arose from a sci-fi article written by a physicist. It described a "by-the-bootstraps" lifter--a contraption to convert the direction of momentum. Weights on spokes would be rotated from a hub and would slide out the spokes to increase the momentum--and if the device were turned the forward momentum of an automobile engine could be converted to upward momentum and lift the car off the ground. It was actually a spoof, and Gene knew it, but the writeup was so convincing that he was determined to find out why it wouldn't work. He redesigned the machine to fit the availability of tools and parts and enlisted the help of his oldest brother, Anton, and his younger brother, Lowell. Using only pliers, wrenches and hammers they created a hub with holes in it, inserted four wooden dowels for the spokes, and placed on each spoke a two-pound weight made by winding up lots of their father's telephone wire. Again they made gears out of wood with pieces of an inner tube to provide friction. The model was rough but good enough to help them understand why it would not work. In such ways Gene continued quietly to nurture his inventive side during his Augustana years, but there was nobody at the Academy he thought was

interested in it. (Amdahl interview, 1996; Lowell Amdahl, interview with Linda Runyan, September 17, 1991; Gene Amdahl, interviews with Linda Runyan, October 12, 1991, and February 15-26, 1992)

Despite his unhappiness and the vision problems that had plagued him, Gene graduated in 1940 with a grade record that was above average, but well below his potential. He had excelled only in math and physics, which were weak subjects for the "school sophisticates." His indifferent academic record at the academy fell far short of that achieved by his sister Evelyn at Augustana College in Sioux Falls. That was the subject of another jibe by his brother Orin: "Evelyn graduated *cum laude*, and Gene graduated ^{cum} ~~come~~-lah-de-dah." (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Lowell Amdahl, interview with Linda Runyan, September 17, 1991) ← S.F.

Year on farm

At this stage Gene knew that his parents expected him to have a goal in life--but he didn't have one, except to lead a more interesting, exciting existence than the one he had known. He wished he could be the kind of pious, dutiful person his parents expected--eventually a farmer or a minister--but he knew he could not, and that made him feel less worthy. He was determined to become some kind of a success--part of which meant having enough money to be able to travel widely--and his inventive bent had given him a growing sense of himself as an engineer. He was not especially proud of anything he had done, only of "what I could do in my own mind." That made him feel he had value, but a value that his world did not yet appreciate. (Amdahl interview, 1996; Gene Amdahl, interviews with Linda Runyan, October 12 and November 30, 1991, and March 21, 1992)

By the time Gene graduated from the academy, the family already had several children away at college or private school and couldn't afford another, so he went home and worked on the farm for a year. While his parents had always expected all their children to attend college, when he left the Academy he was not so sure. Full-time work on the farm, however, quickly reminded him how much he didn't want to become a farmer. (Amdahl, 1986)

Designing the double rotor helicopter was the most notable way he took his mind off his chores. It was the most complex invention of his life

before college, but the years of daydreaming had expanded his powers of imagination. "Always the things that I perceived doing in the future." he reflected later, turned out to be "more complicated than anything I had done in the past. I guess it's because you are always taxing yourself by the degree of complexity you can deal with. You can deal with a little more each time you go through." (Gene Amdahl, interview with Linda Runyan, March 21, 1992)

Gene's older brothers as well as his sister had attended Augustana College, but he didn't want a liberal arts education. He felt he had no musical, sports or literary talent to be developed. "I was caught up in technology," despite a lack of actual experience with it, and he wanted to become a mechanical engineer, which meant going to the land-grant college, South Dakota State College of Agricultural and Mechanical Arts. He was reinforced by the decision of his brother Alton, who also wanted to become an engineer, and who left Augustana after two years, because he had already taken all its science and mathematics courses. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Amdahl interview, 1996)

Anton Amdahl was proud of the farm he had built up, and he wanted to be sure that someone would stay on to run it. While he wanted his sons to have an education, "he didn't want us to have an education to learn some other kind of work". (Gene Amdahl, interview with Linda Runyan, November 30, 1991) How he put it to Gene, however, was that "he didn't want me to go to school to learn how to make a living; he wanted me to go to school to learn how to get the most out of life. Even at the time I thought that was remarkable." (Amdahl interview, 1996)

First year of college—Sept, 1941—June, 1942

As enrollment time drew closer, Gene insisted, and his father finally gave up. In the fall of 1941 Gene Amdahl left home for Brookings, where he entered South Dakota State College (now University). His first year's courses did not delve him at all deeply into his chosen field of mechanical engineering, but they helped lay some foundations.

In his first quarter he was required to take remedial algebra, and it brought him up to speed. He took the required drafting class, but his right hand was becoming increasingly shaky and he tended to smudge his work. He also took a course in forging that gave him his first experience in

building things with more sophisticated tools than he had known on the farm. He forged and machined a large jack powerful enough to lift a house. When he took it home his father found it useful in jacking up the big new Allis-Chalmers tractor to rotate its wheels or to adjust their width for different jobs in the fields. Gene also made a meat hook that his father was able to use in butchering cattle. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Amdahl interviews, 1991 and 1996; Amdahl, 1986)

He was somewhat casual about two subjects he took at Brookings, though in both cases his native talent saved him. He had fallen in with some new friends who liked to stay up late drinking beer, and homework was the first casualty. They all had trouble arriving on time for their eight o'clock class in trigonometry, but whenever Gene was there he would volunteer when the teacher asked for someone to present a proof. "I hadn't read anything on it" since the book he had skimmed in high school, "but I just had a feel for it." He would go up to the blackboard and figure out the proof--correctly, as it turned out, every time but one. The teacher "decided it really wasn't terribly important whether I attended the class or not," and she awarded him an A, while his two friends with the same spotty attendance records both flunked the course. (Amdahl interview, 1996; Amdahl, 1986)

He also took most of his chemistry in this lackadaisical period, but whenever the teacher would describe the geometric structures of molecules, Gene would perk up his ears. "I'd question him about what these things were that were mirror images, and things like that, and he was hard put to answer a lot of them. But he appreciated that I was asking those things." Gene's cousin, Arlene Amdahl, was in the same class, and she remembered the teacher telling her, "I'm sure Gene would be a genius if he'd come to class more often." (Amdahl interview, 1996; Arlene Amdahl Zeigler, interview with Linda Runyan, October 10, 1991)

Feeling badly that he "had forced my own way" by attending South Dakota State, Gene honored his father's concern by deliberately picking some non-scientific courses. There was English composition and literature but also ancient history, about which he "got very excited". (Gene Amdahl, interview with Linda Runyan, March 17, 1992) Amdahl, 1986)

Family tragedy struck at Christmastime his freshman year. Gene's older sister Evelyn, who was teaching at the Rosebud Indian reservation,

arranged to ride home in a gasoline truck. On the way the truck tipped over and caught fire, and she was so severely burned that she was not expected to live. After years of convalescence she was able to resume a normal life, and Anton was eventually able to retire the heavy debts he incurred to pay the medical bills, but Gene's anguish at the time was so great that describing the events a half century later could still reduce him to tears. (Amdahl interviews, 1991 and 1996)

That same December the Japanese attacked Pearl Harbor, and the onset of war gave Gene a "sense of romance about being in the military." He tried to enlist--particularly the Navy's Construction Battalion, or "Seabees"--but his draft board rejected him out of concern that there be enough young men left to harvest the crops. Alton was home that summer, so Gene wasn't needed for farm work, and he stayed in Brookings to take classes. He began supporting himself by working as a handyman in a local hospital--cleaning and waxing floors and carrying meals to patients. He received his meals, a small room in the basement where he could live, and \$15 a month--enough to cover most of his other expenses. The work was routine, but he applied himself with diligence and good cheer over the next two years. He continued to try to enlist, feeling like he "stuck out as a slacker" for not participating in the war. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Amdahl, 1986; Amdahl interviews, 1996 and 1997; LaVon Hall, notes on Gene and Marian Amdahl, September, 1991.)

Gene was having trouble getting around town, and his father helped by giving him an old Ford Model A convertible roadster that needed work. Though Gene had not tinkered with cars before, he managed to take apart the motor, replace the bearings, and put it back together again. "It never had anything go wrong that I couldn't fix," he recalled proudly. He also devised a clear plastic flap on the driver's side that he could stick his arm through for making hand signals. He painted the convertible top to make it waterproof and "anything but black," but his choice of tan with orange panels led the car to be dubbed "The Orange Crate". (Amdahl interview, 1996; Amdahl, 1986; Evelyn Amdahl Olson, interview with Linda Runyan, July 30, 1991)

That summer Gene also took his first college course in physics, which continued into the fall and winter quarters. It was taught systematically by Dr. Raymond Reinhart, the head of the two-person department, whose enthusiasm for the subject excited the young man's interest. "All of a

sudden the lights turned on" and he "just fell in love" with the subject. Physics had three appeals to him. First, he was learning something that helped him to "understand the things that I had observed" on the farm--like momentum and energy and acceleration--"and it all made sense." Second, it drew on that talent he had for picturing things in his head. There were "physical things that I could see and that had nice physical relationships that I could visualize" and that "I was very good at." Third, there was the certainty, the ability "to compute what you should expect to happen, and find out that that went very well." It was, he reflected later, "very comforting to know there were laws." (Gene Amdahl, interviews with Linda Runyan, October 12, 1991, and February 15-26, 1992; Amdahl interviews, 1991, 1996 and 1997; Amdahl, 1986)

Above all there was the magic of the field. A later friend, Harold Hall, recalled that "physics was fun for each of us." Its "first magic," he said, was using mathematics to explain the world, like the angle at which a ladder leaning against a wall would begin to slip. "It was magic to think that numbers controlled that." Hearing those sentiments later, Gene remembered that he "very much agreed". (Harold Hall, interview with Linda Runyan, October 12, 1991; Amdahl interview, 1977.)

Over the years Gene had done a great deal of "retreating" from a world that was so painful to him, "where I hadn't yet found myself," and where his only goal was the vague one of being "something different." Now he had a specific goal--"to understand more" about physics. "I could see the door opening. I guess what physics did was give me the tools to expand this world in my mind." From that time on "I was much happier." Gene came through the courses "with flying colors," and Reinhart had begun taking him "under his wing". (Gene Amdahl, interviews with Linda Runyan, October 12, 1991, and March 21, 1992; Amdahl, 1986)

This period also represented a turning point in Gene's attitude toward religion. He had never been comfortable with the "message of hell" preached in his home church, but it was taken over by a younger pastor who offered more a "message of love". This brought him over to a lifetime commitment to the Lutheran church. (Gene Amdahl, interview with Linda Runyan, February 15-26, 1992; Amdahl interview, 1997.)

Advanced Specialized Training Program--Fall,1943-Spring,1944

Gene spent the summer after his sophomore year back home, helping with

the corn plowing and harvesting on his family's farm and one of a neighbor. Back at Brookings in the fall the physics department had agreed to conduct the Advanced Specialized Training Program to provide specialized skills for promising Army recruits. The department added a third professor but still needed someone to teach the laboratory sections. Though Gene had only the introductory physics sequence under his belt, he was hired to do the full-time job when the fall harvest was over.

He divided his students into groups and helped them conduct experiments on subjects like pulleys, inclined planes, and static electricity--and he apparently acted with some authority. During an experiment on the heat of vaporization of water one group's numbers were way off. He got them to repeat all their steps faster, so that less heat was lost in the intervals, and "they were very impressed with the fact that it came out very close to the actual number". (Amdahl interview, 1996; Amdahl, 1986)

Another young man on the program staff was completing a master's degree at the University of Minnesota, and he was still doing assignments by mail on the principles of vacuum tubes. Gene had never studied them, so he asked to borrow the textbook. Then both of them began tackling the assigned problems. Gene was pleased that, while each of them could do some problems the other couldn't, overall "I was able to solve them as well as he could." (Amdahl interviews, 1991 and 1996; Amdahl, 1986)

Navy--Eddy course--1944-1946

In the spring of 1944 he again returned home to help with the planting, and it was there that he received word that he had been accepted into the Navy. For boot camp he was assigned to the Great Lakes Naval Training Center, just north of Chicago. The Navy had recently created its Eddy program--designed by Captain William Eddy, who had worked in Philo Farnsworth's pioneering television laboratory a few years earlier--to train electronics technicians. Gene heard about the program and was anxious to learn electronics, so he quickly took the entrance test and passed it. He went first to a local junior college for a month of basic math and slide rule techniques, then to downtown Chicago for three months of study of radio and electronics in part of an office building owned by the theatrical company, Balaban and Katz. On the floor below the company was experimenting with the new medium of television, and the Navy trainees had several interesting opportunities to watch.

He was then sent for seven more months of training at Treasure Island in San Francisco Bay. He mastered radio transmitters and receivers as well as radar, and he qualified as an Electronics Technician's Mate. He thrived on the high-quality course on electronics theory, but with his shaky hand he was not as good at the practical side, like doing "nice, neat soldering jobs." (Amdahl interviews, 1991, 1996 and 1997)

Gene's years in the Navy were a time of further family tragedy. In 1944 his 23-year-old cousin Allayne was killed while riding in car that was hit by a train. Gene was deeply moved and spoke at a meeting of a church youth group in her memory. His sister felt that the accident generated "a kind of spiritual awakening" among the young people. The next year, just two weeks before the end of the war in Europe, word came that his older brother Orin had been killed by a sniper in a church tower while commanding an armored car moving into Germany. Gene was at Treasure Island at the time but received permission to join the family for the memorial service. Orin had been more tormentor than mentor, but Gene shared in the family's grief. (Evelyn Amdahl Olson, interview with Linda Runyan, September 1, 1992; Amdahl interview, 1996)

The members of the Eddy program were learning valuable radar technology, and this gave rise to an ugly barracks rumor--that, if any of them were aboard a sinking ship in the Pacific, a bosun's mate was assigned to shoot them to prevent their being interrogated by the Japanese. Gene had brushed it off, but while he was waiting for his travel papers to attend the service for his brother, he became a believer. He glanced at his papers on the desk where they were being processed and read in big red letters a stamped label: "This man must not be captured". (Amdahl interview, 1996; Amdahl, 1986)

In fact, it had already been determined that Gene would not be sent overseas but would next be teaching in the Eddy program, and he was sent back to Chicago to learn teaching skills. He then taught in the program at another junior college in Chicago and later in Gulfport, Mississippi. In the late spring of 1946 he was discharged. (Amdahl interview, 1996)

Gene's two years in the Eddy program had been a second awakening. "I saw all these marvelous things done with oscilloscopes, radar, sonar, and a host of things like that. That really grabbed me," and it shifted him from an aspiring mechanical engineer to a practical electronics engineer. He had learned the intricacies of flip-flops, one-shot multivibrators, and

radio circuits, including the theory of heterodyning, and he could both generate the equation for feedback and solve it. "I'm not sure how many in the class could, but it sure came through nicely to me."

The unhappiness of his teenage years was now behind him. He was finding a niche, he was beginning to mature, and he had learned how "to take responsibility and act on my own." (Amdahl interview, 1996; Amdahl, 1986; Gene Amdahl, interview with Linda Runyan, November 30, 1991)

Back in the spring of 1943, when Gene was home doing farm work, he had begun courting Marian Quissell, a 15-year-old of Swedish and Norwegian heritage from a farm near the Minnesota border. They met at a community dance, and she would remember being attracted by his shy gentleness, the twinkle in his deep blue eyes, and his flair for clothes. She admired his "internal strength of character," his analytical mind, and his willingness to go someplace or do something new. Since new tires were not available during wartime, when those on the "Orange Crate" would no longer hold air he would stuff them with something else--blankets in one case, and oats in another. "He was very, very creative," Marian recalled. "He felt there was always a way to do something." She and Gene became engaged when he went into the service and were married when he returned home two years later. (Marian Amdahl, interview with Linda Runyan, July 17, 1991)

Finishing college at SDSC--1946-48

Gene's plans for the future focused on his two newly-found intellectual passions--his newest one for electronics and his slightly older one for physics. He hoped to enroll at the University of Minnesota, but there were so many returning servicemen that it was admitting only in-state students. He actually rented a cottage on Lake Minnetonka to try to qualify for residency, joining with a college friend in trying to establish a radio repair business. Customers were scarce, however, and he and Marian survived largely on acorn squash from the Quissell farm, and in the end the effort only delayed his return to South Dakota State until the second quarter. Gene was temporarily depressed by his rejection by Minnesota, but the couple realized, Marian recalled, that he was "going nowhere" without a degree and that the GI Bill of Rights was the only way he could afford to get one. (Amdahl, 1986; Marian Amdahl, interviews with Linda Runyan, July 17, 1991, and February 20, 1992; Harold Hall, interview with Linda Runyan, October 12, 1991)

As Gene planned to return to Brookings, he discovered that housing was extremely short, and he responded in a remarkable way. During the fall quarter he spent time on the Quissell farm building--with little more than a saw and hammer--the floors, walls and roof sections of a very small house. With building materials in short supply, he had to be resourceful. He settled for windows designed for a barn and floor timbers cut for shelving--and he built his own doors from lumber covered by hardboard. He then rented space on the property of some tourist cabins and hauled the parts in Marian's family's truck. Her brother, his father, and his younger brother Lowell--who was now also at South Dakota State to study engineering--all helped Gene assemble the house on concrete blocks one weekend in time for the start of the winter quarter. For heat his father contributed the fuel oil stove from the brooder house on the farm--but most of Gene's family, Marian recalled, considered the project "inadvisable and overly ambitious".

At first the little house was barely livable, so that Marian stayed with her parents 30 miles away and Gene visited her on weekends in his 1935 Plymouth. While he went to college during the winter quarter, he added the plasterboard and finished the inside with more help from Lowell. The next winter had one of the longest cold spells on record, with temperatures going down to 40 degrees below zero at night, and the fuel oil would congeal and cease to flow from the tank to the stove. Gene would then have to get out of bed and attempt to blow oil down the tube. One night his mouth froze to the metal, and when he pulled away he tore the skin off a large part of his ^{lips} mouth. But he eventually finished the interior, and, though the floor still sagged under heavy footsteps, Marian was able to join him for the spring quarter. She began working--first in a plant nursery, later as secretary to the dean of women--to supplement their allowance under the GI Bill of \$110 per month plus tuition and books. (Amdahl interview, 1996; Marian Amdahl, interviews with Linda Runyan, July 17, 1991, and February 20, 1992; Amdahl, 1986; Lowell Amdahl, interview with Linda Runyan, March 13, 1992; Harold Hall, interview with Linda Runyan, October 12, 1991)

Gene took many physics courses upon his return but also ones in electrical engineering, advanced chemistry and mathematics. But he had seen more advanced electronics work at Balaban and Katz and in the Navy than was being taught at the college, and he often found that there were subjects he knew better than the professors of electrical engineering.

Gene received recognition among the faculty for an idea that he developed during his Navy years for a "gyroscopic navigator" designed for ~~rocket~~ *planes and* ships. It was a box that used three gyroscopes and electrical sensors to keep track of its exact location--latitude, longitude, and altitude. His professors were sufficiently impressed to suggest that he send the idea to Minneapolis Honeywell. A company engineer wrote back that he was on to something interesting, but that the gyroscopes of the day still wandered too much to make it practicable. * (Amdahl interviews, 1996 and 1997)

* A quarter century later Charles Stark Draper at MIT would develop gyroscopic navigation to the point that it could be used in landing a man on the moon. Gene also devised an "accelerometer"--a gas-filled tube containing a piston and operating as a voltage divider--with rocket navigation in mind.

After Gene's first year back at Brookings, he, Harold Hall and Harold's future wife, LaVon Doner were among eight students initiated into Sigma Pi Sigma, the physics honor society. That summer Gene began teaching a section of the introductory physics course. He was pleased that all of his students passed the standard test for the course, though they earned fewer top grades than those in other sections. "I was concerned that everyone understand what was going on."

That same summer Marian's family paved the area behind one of the barns, and Gene took the opportunity to carve his identity into the wet cement:

Gene Amdahl
Engineer

(LaVon Hall, notes on Gene and Marian Amdahl, September, 1991; Amdahl interview, 1997; Marian Amdahl, interview with Linda Runyan, February 20, 1992)

Back at Brookings Gene enjoyed getting together with some of the other students--including Harold and LaVon--talking about their work in engineering and physics. Marian would remember him as "very excited about it." Harold recalled Gene in those days as "intrinsically kindly" and "slightly introverted, yet extremely gregarious among his friends". He had "an enormous, persistent curiosity about arbitrary things," including the latest ideas in *Astounding Science Fiction*.. The two had a friendly rivalry, but Harold felt Gene was smarter, so "I had to work harder" to

compete with him--"but you couldn't work harder than Gene, so that made it impossible to overtake him." (Marian Amdahl, interview with Linda Runyan, February 20, 1992; Harold Hall, interview with Linda Runyan, October 12, 1991; Amdahl interview, 1997.)

Gene found himself wanted more courses than were being offered. At one point he persuaded the engineering dean, H. M. Crothers, who had an interest in the theory of relativity, to give him a one-on-one tutorial on the subject. "Here," he recalled feeling, "was the chance to get to the real thing." (Amdahl, 1986: Amdahl interview, 1997)

Gene found that he was viewed differently now--"as a person with some kind of rather remarkable potential." Reinhart was foremost in helping him to recognize that potential, and he was devastated at the end of the fall quarter when his professor died suddenly of uremic poisoning while still in his early 40's. (Gene Amdahl, interview with Linda Runyan, March 21, 1992; Marian Amdahl, interview with Linda Runyan, February 20, 1992)

By June of 1948 Gene had acquired 240 hours of credit, while he needed only 180 to graduate. He had close to a straight-A average in his final two years--the "star student" of his class, Hall reported--but his overall average was dragged down by the first two years when he had skipped so many classes. His credits covered so many subjects that he could have qualified instead for degrees in electrical engineering, mathematics, or chemistry. Instead he chose to graduate as a bachelor of science in engineering physics, a designation that combined his two passions. (Amdahl interview, 1996; Amdahl, 1986; Harold Hall, interview with Linda Runyan, October 12, 1991)

Anton and Inga attended Gene's graduation without showing any thrill, Marian recalled, but "parents at that time didn't say much, because they were afraid you'd get a big head." For the past two years, she felt, she had been providing the kind of "nurturing environment" for Gene's talent that had always been lacking in his family. (Marian Amdahl, interview with Linda Runyan, February 20, 1992)

Planning graduate school

The inquisitive nature that had long ago impressed Gene's grade-school teacher was now dominating his plans. The more he learned about the mysteries of the atom, the more the pendulum of his interests swung

away from engineering far over to the side of theoretical physics, and he wanted to go on to graduate school to pursue it. Its importance had been dramatized by the atomic bomb, but Gene was interested in the structure of the atom, not in nuclear weapons. "I was just so consumed with the excitement and curiosity of learning how the world worked"--a desire "to explain things, not just learn them." He admitted to his wife that, judging from the modest incomes of professors of the day, this would probably mean having to live on a very limited income for the rest of their lives--"like deciding to become a monk". But Marian readily agreed to continue working to help support his studies, she recalled, "because he was so brilliant." (Gene Amdahl, interviews with Linda Runyan, February 15-26, 1992, and March 21, 1992; Amdahl, 1986; Amdahl interviews, 1991 and 1997; Marian Amdahl, interview with Linda Runyan, July 17, 1991)

Though his degree was only from South Dakota State, he applied to three of the better graduate schools in the country. He was rejected by both Yale and Princeton but--after a strong recommendation from Dean Crothers--accepted by the University of Wisconsin. It offered him a lucrative assistantship from the Wisconsin Alumni Research Foundation to study particle physics. This recognition helped him, Marian felt, "to begin seeing that he was better than the grades on his academic record would indicate." (Amdahl, 1986; Harold Hall, interview with Linda Runyan, October 12, 1991; Marian Amdahl, interview with Linda Runyan, February 20, 1992; Amdahl interview, 1997)

University of Wisconsin--1948-52

When Gene arrived in Madison in time for the summer term, he felt "a certain romanticism" about quantum mechanics. Decades later he would still recall his first lecture on the subject by Robert Sachs, a leading young nuclear physicist. Sachs "explained to us that theoretical physics was really very much like a religion, in that it really was based on faith--faith that there would ultimately be a simple description of nature". Gene sought out Sachs for his thesis adviser, "because he was the head of theoretical physics, and the professor agreed, because "I could tell he was bright". (Amdahl, 1986; Amdahl interview, 1997; Sachs interview, 1997)

The work at Madison was harder than at Brookings. The pressure was greater, because the new physics students felt that many of them would be weeded out before getting their doctorates, and Gene developed a

nervous tic in one eye. The Halls arrived during Gene's second year, and the two couples sometimes enjoyed movies, bridge or eating out together, and shifting his concentration to humor--especially puns and Norwegian jokes--helped Gene to relax. But when he became "totally consumed" in his studies, Marion found it hard to distract him. "Eventually, I decided it was too much effort to bring him into the real world." ← SP Even during social occasions, LaVon Hall recalled, she might suddenly realize that Gene's mind was pursuing some new mechanical idea. "One time in the course of a conversation, he thought of a way to make instant tea in bags. He was planning how the machine would carry the bags through." (Marian Amdahl, interview with Linda Runyan, February 20, 1992; LaVon Hall, interview with Linda Runyan, October 12, 1991)

Gene was soon earning top grades, but one of his worst moments came during his preliminary oral exams. He had been unnerved by being assigned to report on the field of "strange particles"--so new that there was almost nothing written about it. "It was not a very satisfying talk" to give before his committee, he recalled, "but then they didn't know anything about it either." When one professor asked him to name the inventor of the cyclotron, he clutched. Sachs asked if he could think of any part of the man's name, and Gene blurted out that his middle name was Orlando and he came from South Dakota. His interrogators all laughed, knowing that he was speaking of Ernest Orlando Lawrence, and "after that they were all on my side."

Under Sachs Gene began work on his doctoral thesis on a highly abstruse subject--"the contributions to magnetic moments of heavy nuclei due to spin anti-symmetry and velocity-dependent forces." Then things happened that would start the pendulum of his interests swinging back to engineering one last time. (Amdahl interviews, 1991 and 1997; Harold Hall, interview with Linda Runyan, October 12, 1991)

Sachs was interested in a prewar theory of a Japanese theorist, Hideki Yukawa, on the attraction among particles in the nucleus of the atom. He assigned Gene and two other graduate students to see how far that theory could go in explaining the simplest three-bodied nucleus, the atom of tritium, or hydrogen three. For thirty days the three students worked in tandem with an electromechanical desk calculator and a slide rule to hold all the digits of the calculations. In the end they concluded that the theory could not quite describe the tritium nucleus, but it had taken three man-months to get there. "I decided there had to be better ways," he

remarked later, "so I began to invent computers." (Sachs interview, 1997; Newton, 1995, p. 2283; Amdahl interviews, 1991, 1996;)

It was not quite that easy. There were only four large electronic digital computers in the United States at that time, and Gene had no experience at all with any of them. The only real book on the subject he could find was a semi-popular overview called *Giant Brains*.. (Engineering Research Associates, 1950, p. 182; Berkeley, 1949; Amdahl, 1986) So he went to talk with Sachs, who was already beginning to suspect that Gene's powerful imagination might be better suited to practical inventing than to theoretical physics.

As luck would have it, Sachs had had two important experiences that made him sympathetic to this new field. During the war he had worked at the Aberdeen Proving Grounds in Maryland as the chief of the blast section, which gauged the effects of high explosives on their targets. It was Aberdeen that had commissioned and now housed ENIAC, and Sachs--who continued to visit as a consultant--had many friends and associates there who used the machine for their ballistics research. Also, Sachs had read "As We May Think," the 1945 article by Vannevar Bush envisioning a computer-like machine that would provide access to information from libraries across the country. "I was just grabbed by that and felt that he really had everything on his side as far as the future was concerned." Thus Sachs was remarkably open to the future of computers--and to the notion that Gene might have a role in developing them. (Sachs interview, 1997; Bush, 1945)

Sachs knew that the electrical engineering department had a kind of computer--actually, an electronic update of Bush's original analog Differential Analyzer, this one using precision linear amplifiers. * His

* Its output was measured by the amount of electrical charge deposited on a capacitor. Also, the mathematics department had an IBM 602A electromechanical multiplier, but it could do no more than take two numbers that had been punched into a card and then punch out their product. (*Data Management*, 1976, p. 14; Amdahl interview, 1996)

first suggestion was that Gene take a course in using the machine. He did, and soon he began designing a digital version in his head, drawing on little more than his two years of Navy electronics experience and his remarkable powers of visualization. He worked out all the logic--"and I was quite excited about that"--though he did not have a clearly adequate

way to store information. He soon learned, however, that the Northrup aircraft company had recently begun producing a "Magnetic Digital Drum Differential Analyzer", or "MADDIDA," which used paper tape to store numbers. There now no longer seemed to be any point in pursuing his ideas. (Amdahl, 1986; Amdahl interview, 1996; Uttal, 1977, p. 107)

Sachs next arranged for Gene to get a summer job as a programmer at Aberdeen, so he could be exposed to state-of-the-art computer work--not only ENIAC but also EDVAC, its stored-program successor. During the summer of 1950, then, he was able to watch as technicians laboriously programmed ENIAC through plugboards and as engineers struggled to complete EDVAC, with its cumbersome mercury delay lines for memory. "I looked at those and I decided I really didn't like either one," he explained later, so he thought again about designing his own--this time a stored-program digital computer. He saw the instruction manual for the EDVAC but not the circuit diagrams or boards, so he had to rely heavily on his own imagination. By the time he left Aberdeen he had the new computer "almost entirely worked out in my head." (Amdahl interviews, 1996 and 1997; Amdahl, 1986)

In several cases Gene only reinvented wheels that others had already devised. * But even if some of the components were not as new as he had

* For machine memory he knew about revolving magnetic drums, like those developed by Engineering Research Associates of Minneapolis, but he devised "recirculating registers" to read some data off the drum and keep them immediately available--not then knowing that ERA had already developed them under the name of "serial revolvers". The machines at Aberdeen stored numbers with the decimal point in a fixed position on their registers, but Amdahl thought of having a "floating point". Only later did he learn that this had been earlier used on some recent relay calculators. He also devised his own way of doing division, though he learned later that the concept had already been patented by the mathematician John von Neumann.

thought, he had combined them to devise a complete state-of-the-art computer. It would be the first electronic machine to use a "floating point," permitting a limited amount of register space to hold either large integers or long decimal fractions. The machine would also be parallel--executing as many as four instructions concurrently--a process he called "integral synchronization". Thus, the it could become known as WISC--the Wisconsin Integrally Synchronized Computer. (Amdahl, 1986; Amdahl interview, 1996; Data Management, 1976, p. 14)

Designing and Building WISC (September, 1950-June, 1952)

When Gene returned to Madison that fall, he mentioned his ideas to a classmate, who told someone in the electrical engineering department, and soon he was invited to give a talk. It created so much interest that the head of the electrical engineering department, Harold Peterson, decided that the best way to train graduate students in computers would be to have them actually build a machine. He asked Sachs to have Gene drop his physics topic and instead do his dissertation on the design of WISC. Sachs agreed, while remaining the principal advisor, and Gene was hired as a research associate, first to describe and then to build the machine he had conceived. Reflecting later on this last swing of the pendulum, he said that he "was always an inventor". He doubted that he would have become a "very top grade" physicist, because while doing something theoretical he would always become diverted to interesting applications--"these unusual inventive tangents." (Amdahl, 1986; Amdahl interviews, 1991 and 1996)

He was able to find only one more book on computing--a new, comprehensive survey of the state of the art issued by ERA--but after that he was on his own. For the first six months of 1951 he developed his ideas and wrote them up as his dissertation, for which his doctorate was awarded early the next year. It may have been the nation's first doctorate in computer engineering--though it was nominally granted in theoretical physics. (Amdahl, 1986; ERA, 1950; Amdahl interview, 1996; Sachs interview, 1997)

Sachs very courageously lent his name as advisor to the thesis although, as he put it later, "I couldn't read a word of it." Instead, he sent copies to some of his Aberdeen friends. When they judged it valid he "signed off on it," he recalled, "and presumably convinced the thesis committee to sign off, too." Harold Hall looked back with continuing amazement at Sach's boldness--"an extraordinary miracle of foresight and brilliant understanding." Hall also felt he--coming from "a poverty-stricken farm family"--would have lacked the courage to posture himself so precariously between theoretical physics and electrical engineering. But the Amdahl farm was more prosperous, and "if Gene never made a nickel in the world, his father could have somehow found a way to feed him." (Sachs interview, 1997; Harold Hall, interview with Linda Runyan, October 12, 1991)

Gene finished the dissertation by the summer of 1951, and, backed by university funds, began building the machine. He bought war surplus vacuum tubes from a nearby air base. He went to Minneapolis and negotiated with William Norris, then a vice-president of ERA, for a magnetic drum. For input and output devices he used teletypes as well as paper tape. (Amdahl, 1986; Amdahl interview, 1996)

In the end WISC would take four years to build. It would weigh a ton and become, a reporter noted later--a "towering array of tubes, switches and dials"--and be well ahead of any commercial computer of its day. In the back of his mind Gene toyed for a while with the idea of starting his own computer company when WISC was completed. But he did not stay to see it done. During the first year he was building WISC, the International Business Machines company learned of his work, decided it wanted him on its side, and made him a surprisingly large offer. "I managed to retain my calm" and not leap to accept, suggesting that his education had been very expensive and that he and his wife had just had a son, Carlton. IBM then made the offer even larger--half again what his physicist classmates would receive in their first jobs--and he could not refuse. "He got that twinkle in his eye when he told me," Marian recounted. "He knew that IBM was the place for him." He stayed at Wisconsin for half a year more to be sure the WISC project was on its feet, and in June of 1952 he joined IBM. He would be a theoretical physicist no longer. "Gene Amdahl, Engineer" was now in the computer business--and for good. (Sedgwick, p. 44; Amdahl interview, 1996; *Data Management*, 1976, p. 14; Malone, 1985, p. 312; Harold Hall, interview with Linda Runyan, October 12, 1991; Marian Amdahl, interview with Linda Runyan, March 3, 1992; Amdahl, 1986)

November 30, 1997

IBM--First phase (June, 1952-December, 1955)

Amdahl's first assignments were to work on projects too far ahead of their time--simulating the workings of the brain and teaching a computer to recognize the letters of the alphabet. After a year or so he was assigned to a project to improve IBM's original scientific computer, the Defense Calculator or 701, and in November of 1953 he was made chief designer and project engineer. Amdahl's team was soon designing changes great enough to warrant a whole new product, and when the IBM 704 computer was announced the following May it would have twice the speed and would take twice the number of instructions as its predecessor. It would be the first commercial computer to include floating-point numbers and one of IBM's most successful still using vacuum tubes. It would also be the first computer to come with a programming language--FORTRAN, developed for it by a team led by IBM ^{mathematician} engineer John Backus. It would use a cathode-ray tube for machine memory, though these would soon be replaced by the magnetic-core memories that Jay Forrester at MIT had invented for Whirlwind. "Customer acceptance," historians of IBM note, soon "made it a resounding success." (Amdahl, 1986; Slater, 1987, p. 186; Bashe, *et al*, 1986, pp. 179-180; Malone, 1985, p. 312; Amdahl, 1983, p. 213)

Some of Amdahl's co-workers have offered glimpses of his forceful and direct style. One recalled him working on a program that had to be read off a ^{Punch card} magnetic drum, which could only deliver ²⁴ 32 instructions on each of its revolutions, so he wanted to shorten the program to that length. Amdahl kept a symbolic hammer in his desk, "and every day he would say that he had hammered another instruction out of the program." Disturbed that many of the engineers were reluctant to build the hardware for floating point calculations, Backus devised a complicated scheme for adding four of five additional registers to the machine. After he had thoroughly described his idea, Amdahl set him straight: "Backus, you're an absolute idiot; you can build in floating point without adding any registers, and it will cost almost nothing." Amdahl then described how to do it--and it worked. (Johnston, 1983, p. 135; Mapstone and Bernstein, 1980, p. 364)

Amdahl later recalled how he sometimes was listened to by top management when other engineers were not. When one middle level

manager was trying to sell an idea to the head of their division they asked Amdahl to join them and present their story. Amdahl thought their proposal was unrealistic but outlined a more feasible version. They agreed, and, when Amdahl presented his case, the division head agreed immediately. "He told me afterwards that, when he listened to me, he knew he was hearing the truth." That reputation for honesty, he reflected later, "was probably was the best thing going for me." (Amdahl interview, 1996)

Amdahl worked long hours and became "totally absorbed" in work, his wife recalled, and "I knew that he was happy," but this sometimes made him impatient at home. Once she said something to him and got only a growl in response. "Finally he confessed that it was the stress at work." (Marian Amdahl, interview with Linda Runyan, February 15 and 16, 1992)

In the final months of 1955 IBM was actively considering a successor to the 704--a transistorized supercomputer code-named STRETCH. It was intended to stretch the technology and improve performance by two orders of magnitude and become the world's fastest computer. Amdahl was a chief planner of the machine's design and one of two leading contenders for leadership of the project--but at the end of the year he learned he would be denied the position, and he promptly resigned from IBM. He was, he concluded, "no longer going to be in charge of my own project" but instead would be "way down in the innards" of the organization "having essentially very little to say about anything." (Evans, 1986, p. 160; Malone, 1985, p. 313; Pugh, 1984, p. 162-5; Bashe, *et al*, 1986, p. 431; Slater, 1987, p. 186; Amdahl interview, 1996)

California interlude (1956-1960)

During a trip to California for IBM Amdahl had visited his older brother, Alton, who had come to the Los Angeles area during the war to work at drafting machine designs for Lockheed. During a drive around Gene decided that "it was just sparkingly beautiful". He became determined to return whenever he left IBM, and now he went to work in Los Angeles for Ramo-Wooldridge, a spinoff of Hughes Aircraft and a predecessor to TRW, where his younger brother Lowell was already working on logic design for an airborne computer. Amdahl was put in charge of writing proposals for new computers--but whenever the company obtained a contract for one, the design was assigned to an established project group. "So I wasn't getting involved in executing any of the things that I was proposing." He decided

that he had no future in a company that already had "hardening of the arteries"--and after less than a year he quit. (Amdahl interviews, 1996 and 1997; Lowell Amdahl, interview with Linda Runyan, March 13, 1992)

Amdahl stayed in Los Angeles, however. Harold Hall had recently joined some other Lockheed engineers in starting a small aerospace company, and it had just been largely acquired by the Ford Motor Company and renamed Aeronutronics Systems, Inc. Hall urged Amdahl to hire on, and he was soon heading the commercial data-processing department and making plans to enter the commercial computing business. Ford, however, eventually converted the company from a subsidiary to a division and made clear that it would only invest in projects for which the capital could be recovered within 24 months. This clearly excluded computers, and after four years at Aeronutronics, Amdahl quit.

A consulting company called Computer Services wanted him to start a computer division for them, and he was also considering starting his own company, when he was approached by Emanuel Piore, the chief scientist at IBM. Amdahl made clear that he wanted to continue living in California, but Piore promised that after a half year back East working on advanced computers he could go wherever he wanted within the company. (Amdahl interviews, 1996 and 1997; Hall, 1995, p. 114; Pugh, *et al*, 1991, p.370)

Back at IBM--New York years (1960-65)

In the end he would spend four years at IBM facilities in New York state. He began as Research Manager for advanced computer design at the Watson Research Center in Yorktown Heights, just north of New York City. The high-end scientific computer that had emerged from the STRETCH project was now beginning production, but Amdahl aimed to design one with ten times the performance--a goal that he was soon pursuing under the name Project X. At the same time Bob O. Evans in the Data Systems Division in Poughkeepsie was asking Amdahl's services for an even larger project. (Pugh, *et al*, 1991, pp. 371, 376, 454)

IBM was at a critical point in its history. It already dominated the market for mainframe computers, but it was like the Tower of Babel. It produced half a dozen distinct lines of transistorized computers--from the fastest and most powerful machines used in designing space ships to the slowest, simplest machines printing paychecks. Each machine had its own sales force and production lines, and each one used different software and

different peripherals, like printers and tape or disk drives. For IBM this meant that it was capturing very few economies of scale in engineering, manufacturing, programming, and marketing. For IBM's customers this meant that upgrading from one line to another meant making major new investments in equipment, software and training. The company needed a radical new approach--"a total cohesive product line," as a top development manager envisioned it. The cohesion would be symbolized by the name--System/360, representing the number of degrees in a full circle. (Watson and Petre, 1990, pp. 347-8; Evans, 1986, p. 164-5; Pugh, 1995, pp. 267-8, 275.)

Piore agreed to let Amdahl transfer to Evans' project in Poughkeepsie--but only if he could take with him the responsibility for Project X. Amdahl soon became manager of architecture for the entire 360 line while still bearing responsibility for the architecture and technology of the enhanced high-end scientific computer. He headed a team of engineers, but Amdahl called most of the shots. When members of his staff seemed doubtful about one of his approaches, some IBM historians report, he often employed "the mechanism of constructive suggestion, using his considerable insight to suggest design avenues that proved cost-effective. The tactic, when used skillfully, leaves little room for escape." (Pugh, *et al*, 1991, pp. 154, 374-6, 386)

The effort to develop System 360 has been described as the most costly research-and-development efforts then yet undertaken in the private sector. In the end it would cost \$5 billion--but in the end IBM would have a single family of computers. In April, 1964 company head Thomas J. Watson, Jr., announced System/360 to the world. There were initially six processors of different sizes and speeds--the largest fifty times as powerful as the smallest. They were the first major computers to eschew individual transistors in favor of integrated circuits--albeit it, early ones fabricated from ceramic and metal. The six processors would all be compatible, using the same software and peripherals, so that customers who bought or rented IBM could plan to grow with IBM. Three more processors would soon follow, including Amdahl's high-end scientific machine, so that the overall range of System/360 became more than five hundred to one. Amdahl had succeeded in developing a single unifying architecture for a highly diverse line of machines--"a prodigious undertaking," some IBM historians have noted.

The success of the new family was overwhelming. Orders poured in far

faster than IBM could fill them, and within five years its revenues and profits had doubled. The high performance, reliability and compatibility of System/360 made it, *Business Week* wrote, "the most widely used computer line in the world," while one computer historian called it "the most successful product in the history of American business." The new line reshaped the entire industry for the next decade--helping, for example, to drive both General Electric and RCA out of the computer business. More than three decades later the basic architecture of System/360 was still in use for IBM's midrange and mainframe computers--and many American and overseas competitors had mimicked it to make their machines compatible with IBM's. It is difficult, an industry observer wrote, "to think of another single employee who has ever done so much for an employer". (Watson and Petre, 1990, p. 350-1, 354; *Business Week*, March 10, 1973, p. 62; Augarten, 1985, pp. 248-250; Fishman, 1981, p. 92; Amdahl interview, 1996; Pugh, *et al*, 1991, p. 361; Evans, 1986, pp. 174-8; Cortada, 1987, p. 9; Pugh and Aspray, 1996, pp. 14-15; Malone, 1985, p. 315.)

IBM Advanced Computing Systems Lab, Menlo Park (1965-70)

Still, Amdahl was often frustrated by the bureaucratic side of IBM. He noted that the transfer of ideas within the company was often impeded by the mentality in a division that rejected ideas that were "not invented here". He went so far as to propose a special award for those who made the best use of someone else's work. The idea, he recalled, got a "violent rejection" from a top manager as "unAmerican". (Hellerman, 1984, p. 149; Amdahl, 1984, p. 150)

He also yearned to return to the climate and recreational opportunities in California--to once again have "one foot in heaven." He had an offer to be a visiting professor at Stanford, and he told Evans that he intended to go back "either as an individual or as an employee of IBM. You can decide." IBM chose to keep him as an employee but give him the freedom to explore new ideas--as an IBM Fellow and a consultant to the director of its Advanced Computing Systems Laboratory. When he returned to California this time, however, it was to Sunnyvale and then Menlo Park in the emerging Silicon Valley just south of San Francisco, and he liked it even better. He found a vitality, "an entrepreneurial spirit" that had been lacking in the IBM environment, "and that really caught me." (Amdahl interviews, 1991 and 1996)

There Amdahl plunged into the design of a new, far-faster high-end computer. It would use the most modern chips with "~~large-scale~~ *medium-scale* integration" technology but would still be compatible with the architecture of System/360. In 1968 he was promoted to director of the Menlo Park laboratory, but there was growing concern back in the Poughkeepsie laboratory that Amdahl might be encroaching on its turf as "the traditional home of large IBM computers." His computer project was canceled, and at his suggestion the laboratory he headed was closed down. (Pugh, *et al*, 1991, pp. 404-5; *Current Biography*, 1982, p. 6; Amdahl interview, 1996)

Amdahl reflected that the problem was with IBM's basic policies--especially the habit of pricing each processor in direct proportion to its computing power. He was proposing technology that would make large-scale computing less expensive. He concluded that by cutting the price of computing power at the high end--and by spreading some of the development costs to two somewhat smaller machines--IBM could develop a market for the new, large-scale computer. He made his case before the three top executives of the company. They listened attentively but still refused to adjust any of the company's policies. New, less expensive high-end machines might undercut the market for the existing line of 360 machines, which were selling well. In effect, IBM had so large a share of the mainframe market that it could not afford to compete with itself. (Sobel, 1981, pp. 324-5; Slater, 1987, p. 188; Amdahl, 1980, p. 83; Amdahl, 1979, p. 113.)

IBM tried to find other tasks for him, but he was no longer content. Employment there could have been "a sinecure for the rest of my life," but what he really wanted to do, he told an interviewer, was "to work in large computers." If he'd stayed with IBM "I'd have had to change my career"--but that would not have provided the "personal satisfaction" he craved. (*Business Week*, March 10, 1973, p. 62; Pugh, *et al*, 1991, pp. 404-5; Slater, 1987, p. 188)

A more personal incident precipitated the break, however. Several years earlier Amdahl's brother Lowell had started a consulting company, and Gene had received permission from IBM to serve on its board of directors, so long as there was no conflict of interest. When a company with a similar name began selling a minicomputer, his employers became alarmed--but even after the misunderstanding was corrected, they asked him to resign as a director. The national economy was in recession, and

Lowell's company was in financial trouble, so Amdahl felt a responsibility to stay on the board. The conflict, he recalled later, was the final "deciding point for my resolve to resign" from IBM. They had treated him "as though I were trying to put something over on IBM, without ever bothering to ask me. So I felt I was clearly of no value to IBM as an individual." (Amdahl, 1979, pp. 113-4; Amdahl, 1980, p. 86)

This crucial incident suggests two kinds of echoes from Amdahl's childhood. It is one example of what one journalist called his "stubborn, even rigid adherence to principle" and seems to reflect his mother's own strong determination. (Uttal, 1977, p. 107) But it may also have represented some latent rebellion against his past. In the world of the South Dakota farm, where a boy's value was so heavily measured by his performance at chores, young Gene had painfully acquiesced in the verdict of his worthlessness. But he was in the world of computers now, and he had achieved and contributed too much to accept such a verdict again. He had succeeded at developing WISC and System/360, and he could succeed again, if not within IBM then outside it. In September of 1970 he left IBM and announced he would start his own company.

Amdahl Corporation (October, 1970-August, 1980)

High-performance computers were to Amdahl "the area of my greatest interest," and he had taken "a great deal of pride in the quality" of the ones he had worked on. If IBM was reluctant to develop new and cheaper, ones for fear of undercutting its own market, no competing company would face that same disadvantage. Amdahl came to feel that this was IBM's "Achilles' heel," that it would be easier for him to build such computers outside IBM than within it--especially now that System/360 (and its fully compatible successor, 370) had been developed and its software had been placed in the public domain. (Amdahl, 1979, p. 113; *Dun's Review*, April, 1977, p. 24.)

One month after resigning Amdahl started the Amdahl Corporation to build mainframes that would be "plug-compatible" with the IBM software and peripheral equipment in which his potential customers had already invested so much money and training time. He started it in California's emerging Silicon Valley, he explained later, because "I was here," and because of "the sense of vitality and the sense of acceptance of entrepreneurial activity" by investors and potential employees. From IBM he took only two secretaries and a young financial expert, Ray Williams,

who helped draft his business plan. (Sobel, 1981, p. 325; Slater, 1987, pp. 188-9; Amdahl interview, 1991; Amdahl, 1979, p. 114; Amdahl, 1980, p. 86.)

It was a time when IBM had such a stranglehold on the mainframe business that even such giants as RCA and General Electric were being forced to drop out. As Amdahl put it later, "almost nobody believed anyone could compete head-on with IBM". He was prepared to try only because he had "a great deal of faith that I could solve the technical problems." IBM had tried and failed to compress 25 to 30 circuits onto a chip at the level called "Medium-Scale Integration." Amdahl thought he could put a hundred circuits on a chip and achieve Large-Scale Integration as the basis of a whole new generation of computers. (Uttal, 1977, p. 106; Slater, 1987, p. 189; Amdahl, 1980, p. 85; Sobel, 1981, p. 325)

On the strength of his reputation and his strategy he was able to persuade Edgar Heizer of a Chicago investment company to provide just enough seed capital--\$2 million--to create the needed circuit technology. "This is a unique opportunity," Heizer concluded, "and Amdahl is the one guy in the country who can carry it off." With the help of engineer John Zasio, who had become available when another IBM spinoff failed, Amdahl was able to compress a hundred circuits onto a chip only one-fourth inch square and to announce it only a year after starting the company. (*Business Week*, May 12, 1975, p. 68; *Current Biography*, 1982, p. 6; Bylinsky, 1976; Amdahl, 1980, p. 86; Slater, 1987, p. 190) might be Edward

Then he was eventually able to raise many millions more--from Heizer and from two overseas computer companies, Fujitsu of Japan and Nixdorf of West Germany. Both agreed to ^{help commercialize} buy several of the new machines when produced, and Fujitsu agreed to fabricate some of the computer's more difficult parts, helping Amdahl to conserve capital. But along the way ~~the~~ Amdahl's company had so many near-death experiences--including payrolls only met at the last minute--that he later compared the process to "The Perils of Pauline." (*Current Biography*, 1982, p. 6; *Forbes*, 1975, p. 24; Rogers and Larsen, 1984, p. 53; Uttal, 1977, p. 107) ←

By 1975 the company was shipping its first computers--called the 470 V/6. Not only were its chips more compact, but they each contained heat-conducting studs that could be cooled by air, eliminating the bulk, weight and cost of the plumbing used to cool IBM machines with water. The 470 V/6 was one-third as large as the comparable IBM machine, half

again as powerful, and one tenth less expensive--"the highest capacity general purpose business computer in the world." (Sobel, 1981, p. 326; *Current Biography*, 1982, p. 7; Uttal, 1977, pp. 110, 112; Malone, 1985, p. 267; *Data Management*, 1976, p. 14)

Early machines were sold to large research institutions like a NASA laboratory and the University of Michigan, then to giant corporations like AT&T, General Motors, Ford, and American Airlines. Customers who took a chance with Amdahl passed on the word. The machine was "unbelievably reliable," a Hughes Aircraft engineer told the press, "the most incredible engineering feat I've ever seen." After only two years of production Amdahl had installed fifty machines--usually insisting on meeting personally with leaders of each organization that bought one--and the company soon captured nearly a fourth of the market for high-performance mainframes. It was a small fraction of the total computer market, still completely dominated by IBM, but Amdahl had pioneered a whole new industry segment. The company was soon expanding its product line to include nine mainframe models, communications systems, and software. But he would look back most at his enjoyment at "getting those first computers built and really making a difference, seeing it completely shattering the control of the market that IBM had, causing pricing to come back to realistic levels. I really felt that was the contribution to make." As one observer summarized his achievement, "Amdahl taught the computer industry that companies could make money by building IBM clones." (*Business Week*, May 12, 1975, p. 65; Uttal, 1977, p. 112; Blackburn, 1979, p. 7; Amdahl, 1980, p. 89; Slater, 1987, pp. 189-190; Rogers and Larsen, 1984, p. 53; Sobel, 1981, p. 327; *Forbes*, December 8, 1980, p. 40; Hertle, 1995, p. 36)

Along the way the company faced its full share of growing pains. Amdahl tried to create a a company--presumably in contrast both to IBM and to his own parents' farm--where "each person is considered as an individual" and people can "see the value of their own contributions to the success of the company." But he also tried to focus his personal attention on developing strategy and technology, because "I've never considered myself a chief executive type." Still, he would step in to resolve crises until Heizer persuaded him to share leadership with Eugene R. White, a former manager of General Electric's computer operations. The two worked well together for a time, but soon Amdahl feared that White and Heizer would combine to ^{give} gain control of the company. ^{to Fujitsu} He also feared that Fujitsu's help in building components would lead to a takeover if his own company became

Note: White and Heizer already had control, with Fujitsu's backing.

increasingly unable to "do anything for itself." (Amdahl, 1980, p. 92; Uttal, 1977, pp. 109-110, 120; *Business Week*, May 12, 1975, p. 68; Malone, 1985, p. 318)

Internal problems became accentuated after 1977, when IBM began introducing newer, cheaper high-end machines of its own. Amdahl had high profit margins and could afford to respond with newer technology and lower prices, but within two years the company was hurting. Under the stress of trying to keep control, Amdahl himself developed painful muscle spasms in his back, and the investors--who by now owned almost all the stock of the company--transferred executive power to White. Amdahl resigned as chairman in August, 1979, remaining only as a consultant to the firm with the title of Chairman Emeritus. (Slater, 1987, p. 190; Sobel, 1981, pp. 328-332; Amdahl, 1980, p. 91; *Current Biography*, 1982, p. 7; *Business Week*, May 4, 1981, p. 114; Burrows, 1989, p. 118; Rogers and Larsen, 1984, p. 54.)

Over the winter of 1979-80 Amdahl was confined to bed with the aftermath of a ruptured disk that had laid him low a decade earlier. His back pains were now so severe that the slightest ^{move} ~~most~~ could make him want to scream, but he refused to take pain killers. Instead, an interviewer reported--in terms reminiscent of his earlier retreats from the physical and psychological pain of farm chores--"he retreated into the seemingly limitless reaches of his mind" to consider his next move. He decided to try a new breakthrough in high-end computing through a new company, of which he would be careful to retain control. At the end of August he severed all ties with the corporation that still bore his name. (Sedgwick, 1984, p. 42; Malone, 1985, p. 318)

Many other companies would eventually enter the plug-compatible industry that Gene Amdahl had founded, though the Amdahl company would remain the most successful in the mainframe field. It would go on to attain annual sales fluctuating around two billion dollars by the 1990s, and Fujitsu would buy total control in 1997 at a price that implied a market value for the company of a billion and a half dollars. (O'Donnell, 1984, p. 50; *Value Line*, July 25, 1997, p. 1081; Fisher, 1997.)

Trilogy Systems Corporation (1980-87)

As Amdahl lay bedridden he conceived a revolutionary new way to create a computer. The chips in a machine were being produced by etching many

transistors onto a silicon wafer that was then sliced into individual pieces, which were then soldered together onto circuit boards. Amdahl decided to try what he called "wafer-scale integration"--etching both the individual transistors and their interconnections onto the same thin slice of silicon. Only 40 of these coaster-sized wafers could then do the work of 4,000 individual, thumbnail sized chips. (*Business Week*, May 4, 1981, p. 114, and June 6, 1983, p. 94; O'Donnell, 1984, p. 46; Magnet, 1986, p. 67)

He founded a new company, Trilogy Systems, along with two other principals. His son Carlton had designed a technologically impressive but financially unsuccessful modular computer for a startup company, and Clifford Madden had been the chief financial officer at Amdahl Computer and was expected to manage the business side. Amdahl confidently predicted that Trilogy's high-performance computers would be far cheaper but more powerful than those of either IBM or the Amdahl Corporation--and that their sales would reach a billion dollars within two years of their first availability. (Pitta, 1991, p. 46; *Business Week*, June 6, 1983, p. 94; *The Economist*, August 23, 1980, p. 64; Slater, 1987, p. 191)

While Amdahl Corporation had struggled to raise capital, Trilogy had no such problem. After so stunning an entrepreneurial success Amdahl reported that "we can get to see whomever we want to see right away." In little more than a year Trilogy had raised an impressive \$86 million, as computer companies and venture capitalists competed to obtain some of the action, and the ultimate total was a breathtaking \$230 million, considered a record at the time for a startup company. (*Business Week*, May 4, 1981, p. 114; *Current Biography*, 1982, p. 7; Alpert, 1984, p. 14; Magnet, 1986, p. 66; Pitta, 1991, p. 45)

Amdahl and his team used the money to start building a highly advanced semiconductor facility and to hire many talented managers from existing semiconductor and computer companies. The large corporate headquarters would be described as "palatial," with Amdahl's office decorated with antique furniture and original art. It would include a special niche for the WISC machine that Amdahl had designed but never seen until it came his way after the University of Wisconsin had discarded when it became obsolete. It seemed to be, an interviewer reported, "his proudest possession." (Malone, 1985, p. 319; *Business Week*, June 6, 1983, p. 96; *Dun's Business Month*, August, 1983, p. 104; Pitta, 1991, p. 45; Caddes, 1986, p. 62; Amdahl interview, 1996)

Trilogy's problems began early. The worst rains in recent California history engulfed the building site in mud, delaying construction and crippling some equipment. For a while Amdahl's attention was diverted from business problems by a tragic accident in which the Rolls Royce he was driving hit a motorcycle and killed the driver. Clifford Madden became ill and died of a brain tumor within two years. The wrong ingredients were used for the early wafers, and millions of dollars of engineering had to be redone. It proved difficult to coordinate the projects--and the egos--of so many top engineers. (Magnet, 1986, p. 67; O'Donnell, 1984, p. 50; *Business Week*, June 6, 1983, p. 96)

The overriding problem, an independent observer noted, was that Gene Amdahl was "way ahead of his time." As he himself put it, "The technology was so advanced it required something new in almost every area of supporting technology." His wafer-scale integration, another observer wrote, required "breakthroughs in design automation, circuit packaging and computer-aided testing" for the chips alone. And every time the chip design was modified to become more realistic, the computer architects had to reconfigure their plans as well. (Alpert, 1984, p. 14; O'Donnell, 1984, p. 50; Magnet, 1986, p. 67)

By 1984 all the original goals dissolved. The company first announced long delays in its target dates, then that it was dropping the computer project to focus on the superchips, then that it was abandoning the chips themselves. While Amdahl was satisfied that his team had devised solutions to all the technical problems, he also came to see that production was at least two years away--and by then all the money would have been exhausted. Along the way Carl Amdahl resigned to go to business school. *Barron's* ridiculed the project as "A \$230 Million Turkey". By the end of the year Amdahl resigned as chief executive officer but stayed on as chairman of the board. (O'Donnell, 1984, p p. 46, 50; Amdahl interview, 1997; Alpert, 1984, p. 14; Magnet, 1986, pp. 67-8; Pitta, 1991, p. 46)

Forbes suggested that Trilogy may have failed because its founder's obsession with besting IBM--"Gene Amdahl's white whale"--drove him to try too much too fast. But the unifying concept of Trilogy was the enticing idea of wafer-scale integration, and its technical problems proved so daunting that no company would attempt it again over the next decade. (Pitta, 1991, pp. 45, 50; O'Donnell, 1984, pp. 48, 50)

When Trilogy stopped developing computers and chips, it still held some \$70 million in cash, and it used much of this in 1985 to acquire another struggling computer company, Elxsi, which was exploring the gap in the field of scientific and engineering machines between supercomputers and minicomputers, like the VAX series of the Digital Equipment Corporation. Amdahl again ^{remained chairman} became CEO of the merged company, but he served, a journalist reported, as its "elder statesman, not its chief designer." He hoped to salvage some of the massive investment of his shareholders, but this reborn venture soon fizzled, and he left Elxsi within a few years. ← SP ←

The ultimate failure of the dream weighed heavily on him. Not only had he lost a major share of his own wealth, but he became "haunted by guilt feelings" over the losses that others had incurred. He took solace in the confidence that he had not violated the ethical principles he had learned from his parents. "I sometimes thought I could do things I couldn't do--but I came close," he remarked later, "but I wasn't out ever to try to sell something that I didn't think would work, or I didn't think was the right thing to do." (Magnet, 1986, pp. 66, 68-9; Miller, 1985, p. 22; Kindel, 1986, p. 13; Pitta, 1991, p. 46; Slater, 1987, p. 193; Bozman, 1992, p. 11; Amdahl interview, 1996)

Andor Systems, Inc. (1987-93)

The entrepreneurial fires still burned, however, and in 1987 Amdahl founded a new Silicon Valley venture, Andor Systems, also in Cupertino. He invested a good share of his remaining available wealth and raised a modest amount of outside capital, much of it from those who had lost their money in Trilogy. By 1988 he was designing another computer to compete with IBM, but this time at the smaller end of the mainframe spectrum. He hoped to beat IBM into the use of very large-scale integration on chips (VLSI)--a step beyond the large-scale integration he had pioneered at the Amdahl Corporation but well below the wafer-scale integration he had attempted at Trilogy. Once again he aimed to produce cheaper, cooler, and smaller machines. His chip supplier shipped defective products, however, delaying production for a full two years, and in the meantime IBM offered a much improved of its own in the same market segment. (Levine, 1988, p. 88; Pitta, 1991, p. 50; Paré, 1988, p. 139; Hertle, 1995, p. 37)

By 1991 Amdahl was forced to fall back on a peripheral device he had

helped invent--a backup system to preserve computer data at a remote location as an insurance against a disaster like a fire or an earthquake. Andor sold a few of the devices to large corporations, but in the end Amdahl could not attract enough capital to compete in a mainframe market already being overshadowed by personal computers, and the company failed. (Pitta, 1991, pp. 45, 50; Hertle, 1995, p. 37; Bozman, 1992, p. 11; Amdahl interview, 1996)

Commercial Data Servers, Inc. (1994-)

In 1994 Amdahl founded Commercial Data Servers, Inc., along with Ray Williams, who provided the initial capital, and Bill O'Connell, another veteran of both IBM and the Amdahl Corporation. The new company also sought to sell IBM-compatible products, using its own software, but with off-the-shelf major components--including the latest Complementary Metal Oxide Silicon chips--assembled by outside jobbers. The first product to come to market was the CDS 2000 server^r for computer ← SP networking or the remote storage of data. It was built from a high-level IBM personal computer augmented with peripherals to enable it to approach mainframe power at much smaller size. The company's ultimate aim, however, was to produce a supercooled mainframe-on-a-chip to process more than a billion instructions per second. Amdahl began with the company as chairman of the board and a self-styled "kibbutzer". He retired from the formal position in 1997, but as Chairman Emeritus and a board member he continued to come to the office every day and to contribute technical and business ideas. (Commercial Data Servers Web Page, 1997; Amdahl interviews, 1996 and 1997.)

Conclusions

Gene Amdahl has been acclaimed as "a legend"--both for his role in System/360, which did so much to confirm IBM's dominant position, and for his virtual creation of the "plug-compatible" or IBM-clone industry. At the height of his career one business magazine after another described him as a "computer genius," a "technological genius," or "an engineering genius". He had come a long way for a farm boy whose house did not even have electric lights until he was a teenager. (*Current Biography*, 1982, p. 5; Slater, 1987, p. 185; *Forbes*, December 8, 1980, p. 40; *Dun's Business Month*, July, 1984, p. 19; Levine, 1988, p. 88; Malone, 1985, p. 312)

He has readily admitted that luck played a large role in his initial success.

He was lucky that, just as his mind was turning from theoretical physics to computing, he was in the hands of a thesis advisor with the insight, interest, connections and courage to foster that transition. He was lucky to have been at IBM at a time when his talents could do so much to set new directions for the company and the industry. "Without question I was at the right time at the things that I was thinking about. And then what I'd see would stimulate again, so I could see where I thought we ought to go next." At the same time there were many other capable engineers at IBM at that time, and he became "an intellectual leader" among them. (Amdahl interview, 1996) He was lucky again to obtain vital injections of capital for the Amdahl Corporation a few days before rather than after it would have been necessary to shut down. But he was able to seek that capital only because no one else of his reputation showed the vision or the fortitude to leave a secure job to compete with the colossus of the industry that IBM had become.

Luck, as Pasteur put it, "favors only the mind that is prepared," and we have seen how Gene Amdahl's mind became prepared for a career of spectacular achievement in designing things and making them work. He moved from one childhood tinkering to another--from repairing a rusty rifle to demonstrating why a machine could not lift itself by its own bootstraps. He also moved from one daydream to another--from conceiving that the family's cream separator could be used to recycle motor oil to adding a second large rotor to a helicopter while maintaining its aerodynamic stability.

"Always the things that I perceived doing," he told Linda Runyan, turned out to be "more complicated than anything I had done in the past. I guess it's because you are always taxing yourself by the degree of complexity you can deal with. You can deal with a little more each time you go through." (Gene Amdahl, interview with Linda Runyan, March 21, 1992) In the process he did not always receive the acclaim of family and friends. He did, however, always obtain the satisfaction of escape from the mental and physical pain of his chores--and the vague hope that his dreams could lead him to a more satisfying way of life. His skills and his motivation grew apace. At the same time the chores taught him lessons in self-reliance--and farm life as a whole illustrated the elements of entrepreneurship.

One irony in Amdahl's life is that on the farm that daydreaming earned him a reputation for being lazy. When he looked back on his career in

computing, however, he concluded that he had "worked just as hard"--but "at things that I enjoy doing," not the "unsatisfying" duties of the farm. (Amdahl interview, 1991) His brother Lowell confirmed that he didn't know of any time during his career "when Gene wasn't intense about his work, whether it was research or whatever. Products, though, were always really his first love." (Lowell Amdahl, interview with Linda Runyan, March 13, 1992.)

Throughout his career the products he loved to conceive were aimed at expanding the horizons of high-end computing. Several times he quit well-paying jobs--including two at IBM--when he felt he would no longer be given that chance. "I really want to contribute to the world," he explained. "That's what has significance to me." Though he could not see decades into the future, he reflected, he could clearly see "the logical next couple of steps" ahead--and then he would want to jump in and do something about it. "I see this, I think that it's something that's good and useful, of value to the world, and I want to see that done." Whether it was designing computers or starting companies, "I just want to see them *happen*." He always wanted "to push the envelope," but to do "it in such a way that it saw the light of day. I wanted to be able to get it to the post office." With some twenty patents to his credit, that drive still kept him actively at work on new computer developments even beyond his 75th birthday. "As long as I can think of things that are better and I don't do anything about making them happen, I don't feel productive." (Amdahl interviews, 1996 and 1997; Hertle, 1995, p. 37; Gene Amdahl, interview with Linda Runyan, March 21, 1992)

In thinking of better things, the powers of creative dreaming that he began cultivating on the plains of South Dakota still served him well. While still at Trilogy he told an interviewer of how he might

wake up in the middle of the night and I'll be going sixty miles an hour on the way to a solution. I see a mental picture of what is going on in the machine, and I dynamically operate that in my mind. Sometimes I am in the middle of a conversation that triggers a bright idea, and for a while there I completely forget about the conversation. (Slater, 1987, p. 188)

Even in designing a computer he would use his powers of visualization: "I see it doing all these things. I see the data moving. I see where there are traffic jams or conflicts of one sort or another." While alone at home or

his office at Commercial Data Servers he comes up with ideas for products, develops them in his head, and only "quite a bit later" writes them down. "You can turn things over so much faster in your head than you can on a piece of paper." (Gene Amdahl, interview with Linda Runyan, October 12, 1991; Amdahl interview, 1996)

This kind of idea-generating, not pure management, has always been his interest. "When it gets to be a steady thing, then it becomes less fun" and offers "no personal satisfaction". He enjoyed "managing things, but not people." Still, he could look back on the creative stages of starting a machine or a company as having provided real enjoyment. "There is fun when you're trying to do it, fun when you're first doing it," while "getting it going, and seeing that it really is a success." In that stage "we kind of ride the wave. It's sort of like surfing, I guess." (Amdahl interview, 1996)

Role of Money

Money does not seem to have been a driving force in Amdahl's career. At one time his holdings in the Amdahl Corporation were estimated at \$10 million. But, a journalist at the time observed, "he does not flaunt the wealth his company has brought him," and his leisure pursuits focused heavily on "reading, Sunday golfing, and his family." (Uttal, 1977, p. 107) His greatest extravagance was a large home for his family--a "mansion," his longtime friend Harold Hall called it, with a foyer "substantially larger" than the whole little house that he built with his own hands during college. But he maintained only one residence, he explained, and it was "meant to be a home not to be a showplace." (Harold Hall, interview with Linda Runyan, October 12, 1991; Amdahl interview, 1996)

He took pride in his clothes from the days when his mother made them so carefully, and when he emerged as a successful entrepreneur he was known for dressing stylishly in well-tailored suits. He also took pride in his cars from the days of his "Orange Crate," and he happily fulfilled his promise to the Rolls-Royce company to buy an automobile from them if they would buy an Amdahl computer from him. Still, he considered himself as "definitely a product of the Depression" and "rather frugal", not wanting "to squander my money at any time in my life". He would buy "good things" but not "things for show"--and not many things "that I didn't feel I had a real use for." (Sedgwick, p. 44; Amdahl interview, 1996; Gene Amdahl, interview with Linda Runyan, February 15-26, 1992.)

From early in his career he has made large charitable donations--based on his parents' example of making "gifts for appropriate purposes". Once during his early IBM years he received a bonus and immediately sent Professor Sachs in Madison a substantial check to aid a worthy graduate student in physics. He endowed the Reinhart Scholarship at South Dakota State in memory of his first physics professor and a similar donation to the University of Wisconsin to honor his thesis advisor. He also gave a block of his Amdahl Corporation stock toward the building of a local Lutheran Church. (Amdahl interview, 1996; Sachs interview, 1997)

and also to the Lutheran Seminar in St. Paul

Not money but "accomplishment was the thing" that drove him on:

Money was helpful, and it was a measure that what you were doing was a success out there. I view money as what the world is willing to provide you as a resource to do what you can--and those who can do more have more access to this resource, so they are able to do more. I view it not as something for me to consume but for me to *build* with. (Amdahl interview, 1996)

Adapting his parents' goals

Amdahl rejects the notion that he keeps on dreaming and inventing in response to the internalized wishes of his parents. In continuing to work at Commercial Data Servers long past a traditional retirement age he was like his father, who "wanted to keep doing what he was doing for as long as he could". But he does it because "I get excited about what I'm doing," which "is quite a bit different" from still trying somehow to please his late parents.

It's true that I like to succeed in what I do, but I have things that I want to accomplish, and I get a big feel of excitement out of the pioneering activities that we do, particularly in a young company, where there are young people and fresh ideas. (Amdahl interview, 1996)

This unhappy misfit of a farm boy did eventually fulfill many of the ultimate expectations of his parents--but he did it strictly on his own terms. His parents sent him to two dismal years at a Lutheran high school to absorb a traditional piety, but he ended up devoted to a gentler version of the same faith. They wanted him to go to college for a liberal education, but instead he went for engineering and became deeply absorbed

in it and in physics. They set an example of charitable contributions to Boys' Town, but he became an important donor to physics education at his two universities. They had hoped he would contribute to society--if not as a farmer, then as a schoolteacher or a minister--but instead he made his signal contributions as a computer designer and entrepreneur. He did not rebel against his parents so much as he pursued his own dream of building new things. That dream began as early as when he took apart an alarm clock and put it back together with parts left over, and in tinkering and daydreams it developed through increasing levels of complexity and achievement.

As it turned out, then, Gene Amdahl pursued not a different set of ultimate goals but a different set of means--his own kind of Lutheranism, his own kind of education, his own kind of charity, his own kind of work, and, above all, his own kind of contribution to society.

Note: Both the U. of W. and S.D.S.U. nominated me for Centennial alumnus (each Land Grant college nominated one). U. of W. had suitable alternatives, but not S.D.S.U., so I was granted the honor from S.D.S.U. (1987). The centennial of their founding, also a surprising honor from the London Times, they included me in their list of "A Thousand Makers of the Twentieth Century" (1991).