





*Willis Whitfield*

## Vater des Reinraums



Wir danken der M+W GROUP für die Erlaubnis, diesen Artikel zu veröffentlichen. Ursprünglich ist er in einem Buch erschienen, das tiefe Einblicke in die Geschichte dieses Stuttgarter Unternehmens gibt – eine Geschichte, die in weiten Teilen auch die Geschichte der Reinraumtechnologie von den Anfängen der Mikroelektronik bis zur heutigen Halbleiterfertigung ist. Wo Unternehmensgeschichte und Technikgeschichte so parallel verlaufen, gibt es selbstverständlich viel Interessantes und Wissenswertes zu berichten. Die Erfolge fielen schließlich nicht vom Himmel, sondern basieren zumeist auf Erfindungen und Entwicklungen der Ingenieure. Wir werden diese Reihe daher fortsetzen, um den Lesern, vor allem den Jüngeren, aufzuzeigen wie alles begann.

Reinhold Schuster  
reinraum online

1962 ließen sich die Sandia National Laboratories in Albuquerque, New Mexico, den Ultra-Cleanroom patentieren. Erfunden hatte ihn zuvor einer der Ingenieure der Sandia Labors, Willis Whitfield. Damit öffnete Whitfield das Tor für Technologien wie die moderne Halbleiterproduktion, deren Entwicklung damals noch gar nicht absehbar waren.

„Als Kind war mir gar nicht klar, was mein Vater da erfunden hatte. Da war ich grad mal sechs oder sieben Jahre alt“, erinnert sich Jim Whitfield, der wie sein Vater den Beruf des Ingenieurs ergriffen hat. „Ich glaube, ihm war zuerst selbst nicht bewusst, welche Bedeutung der Reinraum bekommen sollte, den er entwickelt hatte.“

Bis zu jenem Tag, an dem Willis Whitfield die Aufgabe übertragen worden war, etwas Besseres für die Forschung zu entwickeln, was Verunreinigungen in Labors aufhalten sollte, gab es nur turbulente Reinräume. Dabei handelte es sich mehr um klimatisierte Räume, in denen die Luft herumwirbelte. „Er hat sich das angeschaut und sofort die Lösung gehabt. Es ist so einfach, wenn man einen geradlinigen Luftstrom einsetzt, der aus der Decke kommt und durch den Boden abfließt, hat er sich gesagt. Es hat keine fünf Minuten gedauert, bis er die Idee hatte“, erzählt Jim Whitfield. Danach wurde dieser Plan in die Tat umgesetzt, was heißt, ein Prototyp von der Größe von acht auf zehn Fuß (rund 2,5 auf 3,3 Meter) wurde gebaut und getestet. Rund 600 Mal in der Stunde konnte darin die Luft ausgetauscht werden. „Die Tests wurden mit Rauch gemacht, damit man den Luftstrom in dem Raum erkennen konnte.“ Das war bereits im Jahr 1961, allerdings wurde das Patent erst ein Jahr später angemeldet. Das Time-Magazin hatte bereits im April 1962 eine Geschichte mit dem Titel „Mr. Clean“ veröffentlicht. Der Whitfield-Ultra-Cleanroom war eine bahnbrechende Entwicklung. Die Luft in dem Reinraum war hundertmal reiner als in bis dahin gebräuchlichen. Ein Foto von 1962 zeigt Whitfield neben seiner Erfindung, wie er mit einem integrierten Telefon mit den Insassen des Reinraums spricht.

„Daraufhin hat Sandia das Patent schnell angemeldet, nicht mein Vater. Nicht auszudenken, wie reich wir heute

wären, wenn er es bekommen hätte“, sagt Jim Whitfield lachend. Seinem Vater habe Geld jedoch nicht viel bedeutet. „Es ist schön, wenn man genug davon hat, dann ist es aber auch schon gut. Er war stolz darauf, was er geleistet hat. Das war seine Einstellung.“ Willis Whitfield wurde 1920 in Rosedale, Oklahoma, geboren und wuchs auf einer Farm auf. „Meine Großeltern hatten ein Homestead-Land, das von der Regierung zur Verfügung gestellt wurde.“ 1863 war der Homestead Act – Heimstättengesetz – von der US-Regierung erlassen worden. Danach bekam jedermann im Alter von mindestens 21 Jahren rund 65 Hektar unbesiedeltes Land. Dieses ging nach fünf Jahren an ihn über. „Unsere Familie hat dort Baumwolle angepflanzt. Mein Vater war es gewohnt, selbst überall mit anzupacken.“ Willis Whitfield studierte Physik und kam 1954 zu den Sandia National Laboratories in Albuquerque, New Mexico, wo in den 50er-Jahren Nuklearwaffen konstruiert wurden. „Es war alles streng geheim, weshalb er uns nichts erzählt hat, aber ich weiß, dass er eine ganze Reihe von Sprengköpfen entwickelt hat“, sagt Jim Whitfield.

Sein Vater sei ein richtiger Wissenschaftler gewesen, ein Mann, der sich für vieles interessierte und den Dingen gern auf den Grund ging. „Bei Sandia haben sie auch mit allerhand verschiedenen Sprengstoffen experimentiert. Diese wurden in Stahlfässern gezündet, damit keine Schäden entstanden. Allerdings waren die Detonationen so enorm, dass es die Fässer zerriss. Deshalb sind sie damit in die Wüste gegangen, was ziemlich umständlich war. Mein Vater hat das mitbekommen und zu ihnen gesagt, sie sollten in den Fässern ein Vakuum erzeugen, dann platzten sie nicht mehr. Als sie es so machten, glaubten sie zuerst, der Sprengstoff habe nicht gezündet, weil scheinbar nichts passiert und vor allem nichts zu hören war. Erst als sie die Fässer öffneten, erkannten sie die Spuren der Explosionen an den Innenseiten. Im Vakuum werden eben keine Geräusche übertragen.“

Neben dem Reinraum hat Willis Whitfield auch eine Arbeitsstation mit einer laminaren Strömung entwickelt. Fünf Jahre nach seiner bahnbrechenden Erfindung arbeitete er in einer Projektgruppe von Sandia, die für die NASA forschte. „Dort wurden die Bauteile für das Raumfahrtpro-

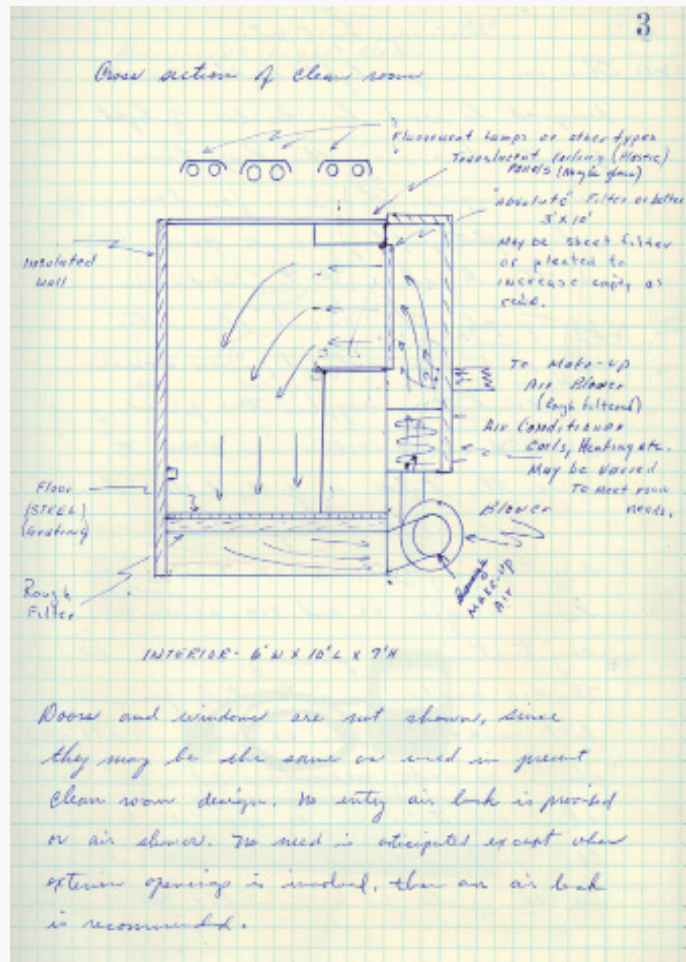


Willis Withfield neben der Statue, die 2007 auf dem Gelände der Sandia National Laboratories enthüllt worden ist. (© courtesy of Sandia National Laboratories)

Willis Withfield next to a statue of himself that was unveiled at Sandia National Laboratories in 2007.



Willis Whitfield in der Tür seines ersten Reinraums.  
(© courtesy of Sandia National Laboratories)  
Willis Whitfield stepping through the door of his first cleanroom.



Original-Skizze von Willis Whitfield zu seiner Erfindung aus dem Jahr 1962.  
(© courtesy of Sandia National Laboratories)  
Willis Whitfield's original outline to his invention, dated 1962.

gramm zuerst noch in nicht reiner Umgebung montiert“, sagt Jim Whitfield, der als Kind den Flughafen von Albuquerque als zweite Heimat empfand. „So oft waren wir dort, um meinen Vater abzuholen. Er war ständig unterwegs.“ Bis 1976 arbeitete Willis Whitfield an Projekten für die NASA, dann von 1977 bis zu seinem Eintritt in den Ruhestand 1984 wieder im Bereich der Nuklearforschung.

In einem Krankenhaus in Albuquerque wurde Whitfields Reinraumprinzip in den 60er-Jahren erstmals in einem Operationssaal eingesetzt. An der Universität von New Mexico hielt er Vorlesungen zum Thema Reinraum. Einer seiner Zuhörer war sein Sohn Jim, der Elektrotechnik studierte. „Ich habe mich unbemerkt hineingeschlichen und ihm zugehört“, sagt der Informatiker, der ein herzliches Verhältnis zu seinem Vater hatte. „Er hatte die Gabe, andere Menschen zu motivieren und ihnen weiterzuhelfen. Er war ein ruhiger, umgänglicher Mann, der mit vielen seiner Kollegen und Mitarbeiter befreundet war. Er war sicher ein guter Boss. Viele haben sich noch regelmäßig mit ihm getroffen, als er bereits im Ruhestand war. Es freut mich, dass mein Vater ein so langes und erfülltes Leben hatte.“

Im Jahr 2007 erwiesen die Sandia Laboratories, für die er 30 Jahre lang gearbeitet hatte, Willis Whitfield eine besondere Ehre. Eine Bronzestatue von ihm wurde auf dem streng

gesicherten Gelände in Albuquerque enthüllt. Diese wurde von Neal McEwen geschaffen, der ebenfalls für Sandia gearbeitet hatte. Am Sockel der Statue steht neben einer Liste der Erfindungen Willis Whitfields ein Satz von Präsident Dwight D. Eisenhower:

„Ingenieure bauen für die Zukunft, nicht nur für die Bedürfnisse der Menschen, sondern ebenso für ihre Träume. Ingenieurleistungen sind der Ausdruck einer unerschütterlichen Zuversicht, dass das Leben sich weiter entwickeln wird und die Zukunft es wert ist, für sie zu arbeiten.“

1  
3,158,457  
ULTRA-CLEAN ROOM  
Willis J. Whitfield, Albuquerque, N. Mex., assignor, by  
mesne assignments, to the United States of America as  
represented by the United States Atomic Energy  
Commission  
Filed May 14, 1962, Ser. No. 194,740  
9 Claims. (Cl. 95-472)

The present invention relates generally to dust-free en-  
losures and more particularly to enclosures having con-  
fined air continuously circulated and cleaned so as to  
provide substantially contamination-free working environ-  
ments within the enclosures.

There has for some time been a problem of cleanliness  
in working environments such as in hospital operating  
rooms and in industrial work areas where complex and  
unlubricated components are assembled. For example,  
in industry some intricate and delicate mechanisms in  
use today require such extremely tight specifications that  
contamination by dust particles and the like may render  
the components inoperative.

Another object of the present invention is to provide  
an air circulating system for the clean room that is ca-  
pable of circulating an unprecedented volume of ultra-  
clean air through the working area in the clean room.

A further object of the present invention is to provide  
an improved clean room in which the circulating air  
continuously "sweeps" the work area to remove dust  
contamination.

A still further object of the present invention is to  
provide a portable clean room capable of being moved  
as a unit or dismantled, moved in parts and reassembled.

Other and further objects of the invention will be ob-  
vious upon an understanding of the illustrative embod-  
iments about to be described, or will be indicated in the  
appended claims, and various advantages not referred to  
herein will occur to one skilled in the art upon employ-  
ment of the invention in practice.

FIG. 1 is a perspective view of the clean room in its  
closed position, showing the clean room in its closed  
position, showing the clean room in its closed position.

FIG. 2 is a cross-sectional view of the clean room in  
its closed position, showing the clean room in its closed  
position, showing the clean room in its closed position.

FIG. 3 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 4 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 5 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 6 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 7 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 8 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 9 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 10 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 11 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 12 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 13 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 14 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 15 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 16 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 17 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 18 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 19 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 20 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

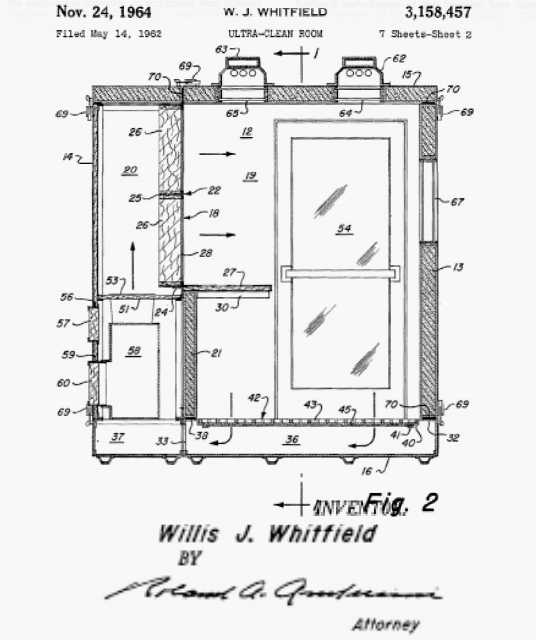
FIG. 21 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 22 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 23 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 24 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.

FIG. 25 is a cross-sectional view of the clean room in  
its open position, showing the clean room in its open  
position, showing the clean room in its open position.



Jim Whitfield. After that, the plan was implemented, meaning that a prototype measuring eight by ten feet (about 2.5 by 3.3 meters) was built and tested: it made it possible to exchange the air about 600 times an hour. "The tests were done with smoke, in order to see the airflow in the room." This was back in 1961, although the first patent application was not filed until a year later. By April 1962, Time Magazine had already published a story with the title "Mr. Clean." The Whitfield Ultra-cleanroom was a groundbreaking innovation. The air in the cleanroom was 100 times more pure than anything before. A photo from 1962 shows Whitfield next to his invention, speaking to the people in the cleanroom on an integrated telephone.

"Then Sandia quickly registered the patent – not my father. No telling how wealthy we'd be today, if he would have gotten it," says Jim Whitfield with a grin. But money didn't matter much to his father. "It's good to have enough of it, but enough is enough. He was proud of what he had accomplished. That was his attitude."

Willis Whitfield was born in Rosedale, Oklahoma, in 1920 and grew up on a farm. "My grandparents had a homestead – land made available by the government." In 1863, the Homestead Act was passed by the U.S. government. Under the law anyone who was at least 21 years old could get about 65 hectares of unsettled land. After five years, they got title to the land. "Our family planted cotton there. My father was used to pitching in everywhere." The young Willis Whitfield studied physics and joined the Navy in 1944, where he was assigned as a specialist for Aircraft Experimental Systems at the Naval Proving Grounds at Dahlgren, Virginia. Then, in 1954, the physicist came to Sandia National Laboratories in Albuquerque, New Mexico, where nuclear weapons were being designed in the 1950s. "It was all top secret, which is why he never told us anything, but I know that he developed a whole series of warheads," says Jim Whitfield.

His father was a real scientist, a man of many interests, who liked to get to the bottom of things. "At Sandia, they also experimented with all kinds of different explosives, which were ignited in steel barrels to avoid damage. Of course, the detonations were so enormous that they tore the barrels apart. As a result, they went out into the desert, which was quite an operation. Well, my father heard about all this and told them they should create a vacuum in the barrels – then they wouldn't burst anymore. When they tried that out, they initially thought that the explosives had not ignited because it seemed like nothing had happened, especially since they hadn't heard anything. But when they opened the barrels, they saw the signs of the explosions on the inside. In a vacuum, of course, there is no transmission of sound."

In addition to the cleanroom, Willis Whitfield also developed a workstation with laminar flow. Five years after his groundbreaking invention, he worked in a project group at Sandia that did research for NASA. "There, the components for the space program were initially still being assembled in a non-clean environment," says Jim Whitfield – who, as a child, considered the Albuquerque airport as his second home. "We went there so often to pick up my father. He was always on the go." Until 1976, Willis Whitfield worked on projects for NASA. And from 1977 until he retired in 1984, he was back in the area of nuclear research.

In a hospital in Albuquerque, Whitfield's cleanroom principle was used in an operating room for the first time in the 1960s. He also gave lectures on the topic of the cleanroom at the University of New Mexico. One day his son Jim, who was studying electrical technology at the time, was also in the audience. "I slipped in unnoticed and listened to him," says the computer scientist, who had a very close relationship with his father. "He had the gift of motivating other people and helping them move ahead. He was a quiet, affable man, who was friends with many of his colleagues and coworkers. I'm sure he was a good boss. Many of his colleagues still met regularly with him after he retired. I'm glad that my father had such a long and fulfilled life."

In 2007, Sandia Laboratories – for which he had worked for 30 years – gave Willis Whitfield a special honor. A bronze statue of him was unveiled at the facility in Albuquerque. It was created by Neal McEwen, who also worked for Sandia. At the base of the statue, next to the list of Willis Whitfield's inventions, there is a quote from President Dwight D. Eisenhower:

**"Engineers build for the future, not merely for the needs of men, but for their dreams as well. Thus, inherently, the engineer's work is a fearless optimism that life will go forward, and that the future is worth working for."**

Das erste Patent (Auszug) auf einen Reinraum, angemeldet von Willis Whitfield. (© courtesy of Sandia National Laboratories)  
The first patent (extract) of a cleanroom, filed by Willis Whitfield.

# Willis Whitfield Father of the Cleanroom

In 1962, Sandia National Laboratories in Albuquerque, New Mexico, obtained a patent for the "Ultra-Cleanroom," which had been invented earlier by Willis Whitfield, one of the engineers working for the national security laboratory. This event helped to spur on technological developments including modern semiconductor production which, at the time, had not even been envisioned yet.

"As a child, I didn't really know what it was my father had invented. I was just six or seven years old," recalls Jim Whitfield, who – like his father – became an engineer. "I don't even think he realized just how important the cleanroom he had invented would become."

Up to the day on which Willis Whitfield received the assignment to develop an improved solution for keeping contaminants out of laboratories, only turbulent cleanrooms existed; these were basically air-conditioned rooms in which the air swirled around. "He took a look at them and came up with the solution right away. It's simple if you use laminar airflow that comes from the ceiling and flows out the floor, he said to himself. It didn't take him five minutes to get the idea," explains