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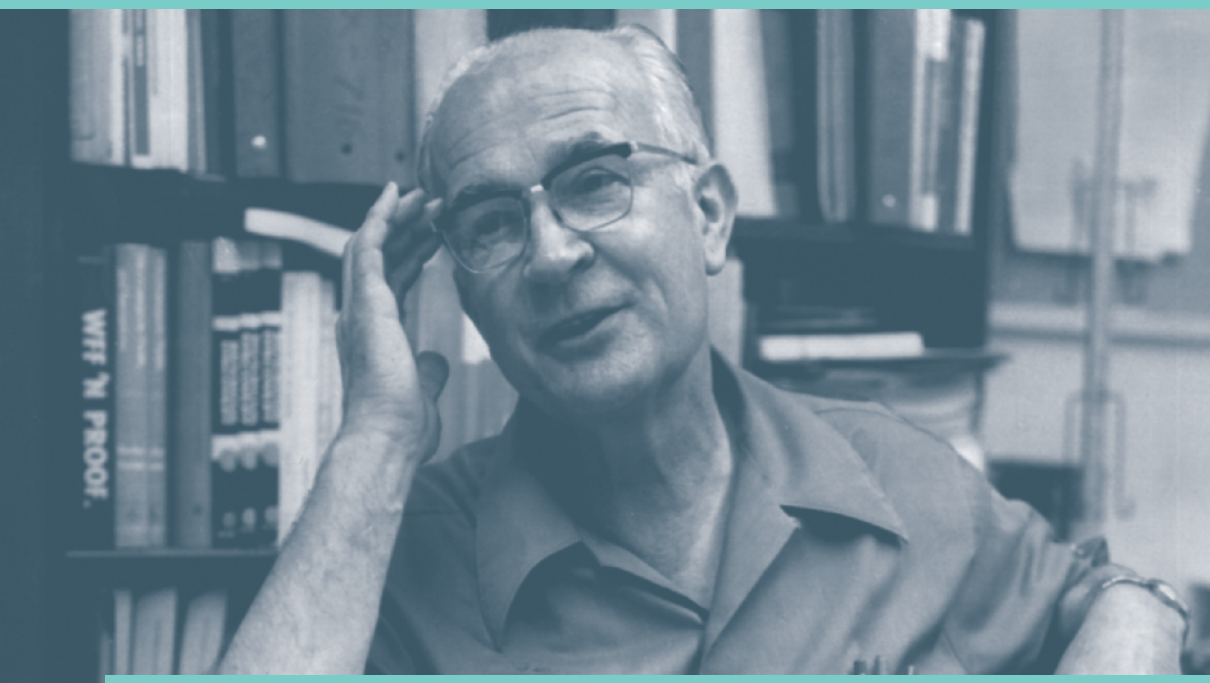

William Shockley: The Will to Think

BO LOJEK

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Bo Lojek

William Shockley: The Will to Think

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To my Mom and my Dad who taught me that life is a true test of intelligence

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My most candid and trusted critic, Mary Martin, spent countless hours with me searching in archives across the country.

My friend and RTA cohort, Jeff Gelpey, provided many constructive suggestions and advice which improved the clarity of the text.

I belong to the older generation for whom, as someone once said, "*A library is not a luxury but one of the necessities of life*." I was fortunate to receive help from librarians belonging to the library system of the University of Colorado. Don Pawl, Interlibrary Loan Librarian, was on many occasions able to obtain items from obscure sources located in generous libraries around the world.

Prof. Arthur Jensen kindly allowed me to study and use the collection of the Foundation for Research and Education on Eugenics and Dysgenics (FREED) documents.

The late Ian Ross shared with me details of Shockley's work on field effect devices and the booklet containing jokes Shockley collected while at Bell Laboratories. Unfortunately, most of them are not suitable for print.

My friends of several decades, the late Esther M. Conwell, Ray Warner, and Morgan and Betty Sparks, provided valuable insight into the Bell Laboratories culture and Shockley's personality.

The beauty of baroque music allows me to be more at ease with myself, so it is appropriate to express my thanks to François Couperin whose music is always in the background during writing.

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Chapter 1
History: An Engineering View

"*History is a chronological record of significant events. An historian is a person who is an authority on history and who studies it and writes about it; a chronicler; an analyst, aware of their inability ever to reconstruct a dead world in its completeness.*"

"*Engineering is the discipline dealing with the art and science of applying scientific knowledge to practical problems. Practitioners of engineering are called engineers.*"

[1913, Webster]

1.1 History: An Engineering View

The modern "wireless" society, where it is almost impossible to stay still and ponder for more than a few seconds, idolizes heroes. For this reason, discoveries of radical inventions are always glorified and given an aura of mystery. Many people still have an idealized picture of the lone inventor in a laboratory, hidden away from the outside world for many years, awaiting his moment of glory. In reality, the lone inventor is rather the exception than the rule. Although the lone inventor still exists, the vast majority of innovation is the result of the work of many individuals, each adding some separate component to the final solution. The label "hero" is then assigned to the individual who contributed the final component leading to a radical innovation. All other contributors and the components they added, although crucial to the final solution, are then forgotten.

Another myth is that radical inventions are always based on completely new knowledge. In fact, in the vast majority of cases, it is some unconventional combination of existing knowledge that is the ultimate source of novelty. Radical inventions are only rarely based on completely new knowledge. Frequently, even a simple rearrangement of facts that are already common knowledge can be the main source for a radical invention.

In this sense, a history of engineering might be viewed as a series of incremental technical changes. Most of these changes can be characterized as incremental improvements with limited impact on the economic system. Occasionally, the change might result in a radical or breakthrough invention. Radical inventions are those inventions that serve as a source for subsequent inventions, and they are frequently viewed at the time of conception as being a risky departure from existing practice. Successful radical inventions tend to provide an opportunity for the inventing firm to

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gain a sustainable competitive advantage, with a consequent generation of economic profit. The reality of life, however, demonstrates that top-level managers often lack a deep enough understanding of emerging technologies to be able to develop radical inventions. In contrast, mature technologies are well understood and have been tested and used in many different settings. For this reason, they offer little risk and much greater reliability relative to newly developed and less well-tested technologies. It is safer to prefer mature technologies to nascent technologies. The outcomes of emerging technologies are much less certain, so radical innovations are not always welcome. They thus very seldom result from organized and managed effort. One rather atypical exception was the research carried out at the Bell Telephone Laboratories, which generated many Nobel Prizes and patents, and made major contributions to the information age before its demise in the early 1980s.

There are also cases of radical inventions which are not always publicly known and are sometimes forgotten, not because they are not useful, but because at the time of their development they were so advanced and ahead of their time that they could not be used. When Ferdinand Braun discovered the rectifying effect there was no application for it.

Often the name of the inventor to whom an invention is attributed varies from country to country, depending on the country of origin of the authors. A typical example is the invention of the telephone. Alexander Graham Bell, who filed his patent application "Improvement of Telegraphy" on February 14, 1876 is almost universally recognized as the inventor of the first telephone. If we omit the controversy over whether Elisha Gray's patent application arrived before or after Bell's submission, the historical evidence regarding this invention points to Johan Phillip Reis (1834–1874). Reis imagined that electricity could be propagated through space, as light can, without the aid of a material conductor, and he performed some experiments on the subject. The results were described in a paper, "On the Radiation of Electricity", which, in 1859, he mailed to Professor Poggendorff for publication in the Annalen der Physik. The manuscript was rejected. Reis continued in his work and on October 20, 1861 presented a seminar "On the propagation of tones over arbitrary distances via galvanic currents" in Frankfurt/Main. He demonstrated his apparatus by transmission of the sentence: "*The horse does not eat cucumber salad*". The first prototype of an instrument could transmit a signal over a distance of 100 meters. In 1862, he again tried to interest Poggendorff with an account of his instrument, referring to it for the first time as "*die telephone*". His second offering was rejected like the first, as the editor considered Reis' invention of the transmission of speech by electricity as a "chimera". The Physical Society of Frankfurt rejected the apparatus and saw the instrument as a mere "philosophical toy". But Reis believed in his invention, even if no one else did. He continued his lectures even though he had been stricken with tuberculosis. When he gave a lecture on the telephone at Gießen in 1864, Poggendorff, who was present, invited him to send a description of his instrument to the Annalen. Reis replied: "*Ich danke Ihnen sehr, Herr Professor, aber es ist*

zu spät. Jetzt will ich ihn nicht schicken. Mein Apparat wird ohne Beschreibung in den Annalen bekannt warden" (Fig. 1.1)[1].

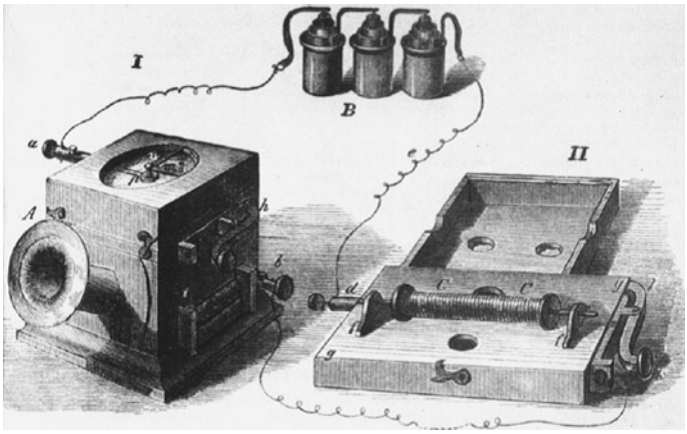

Fig. 1.1 The Reis "telephone" (1861)

Inventions like Ohl's p-n junction, Hoerni's planar process, Frohman-Bentchkowsky's non-volatile memory cell, Craford's yellow LED to name a few, are typical examples illustrating that the personality traits of the contributor are what is of the greatest importance. The common feature of all these inventors was their individualism. Personal individualism and critical thought give people the ability to be creative, while teamwork tends to destroy creativity; team spirit often inhibit thinking and is a perfect hideaway for incompetent members of the team. Every single innovation described in this book is the result of the individual, not the team.

Personal individualism, however, might lead to an extreme form of individualism, better known as egotism. Although almost all contributors to radical inventions tend to be of generous temperament, once a certain innovation becomes a success and looks like it may make history, it is only natural that the egotist should want to be a part of it.

The problem is that such an individual could be someone who has had very little to do with the struggles and hard work that have eventually led to the radical innovation. This is one of the reasons why interpretations of recent history, in which some of the participants of the event are still around, are subject to constant controversy.

It is natural that nobody should want to be associated with failure, while everyone is interested in being part of success. When I was doing research for my previous book, I did not find any transcript or recording of an oral interview in which the interviewee acknowledged that he had made or participated in a wrong or incompetent decision. The reader should then ask the following question: Why are companies like Fairchild,

[1] Mr. Professor, thank you very much, but it is too late. I do not want to submit it now. My device will be known even without description in the Annalen.

RCA, Westinghouse, or Motorola, to name but a few, no longer in business, when they were managed by such exceptional individuals as those in the oral interviews would claim?

It is well known that there are a number of problems associated with taking oral histories as a source for historical evidence, as well as limitations associated with their use as an historical record. Deterioration or failure of memory, personal bias (political, social, racial, or religious), reinterpretation of events, and trick or confusing questions that illicit an intended response are typical problems that accompany any oral interview. If there is little or no additional information available, an oral history can only claim to present the interviewee's interpretation, and such an interpretation cannot necessarily be taken as historical evidence.

When the right time comes, the individual's interests usually shift to a second major goal in life, which is worldly success, with its three prongs of wealth, fame, and power. This too is a worthy goal, to be neither scorned nor condemned; the only issue is that one needs to confront the interviewee's interpretation with indisputable historical evidence.

I have often been puzzled as to how and why historians assigned a particular invention to a particular person. Since history deals with people and events of long ago, how do we know if it can be trusted? History is full of stories created by the winners, and by those with a vested interest in one side or the other. Of course, the losers are and were always the bad guys. Everyone is free to examine the past and form their own conclusions. But it has one significant disadvantage: "popular history" and what really happened are rarely the same.

As an engineer, I was always interested not only in the history of science but also in the technical details involved in the invention. Once you understand the solution behind the invention, it is not difficult to recognize what kind of previous efforts led to the invention. Being familiar with history can open minds to discoveries, fascinating people, and different ways of looking at things. If we approach history from this point of view, there are, of course, some historical "facts" that are not and cannot be in dispute.

1.2 About This Book

"*The profoundest of all infidelities is the fear that true will be bad*."

Herbert Spencer (1820–1903)

This book "*William B. Shockley: The will to think*" describes the life and accomplishments of the Nobel laureate William Bradford Shockley in a way that standard biographies often neglect in favor of sensational descriptions of his views of the social problems of his time or salacious lies about his personal life. Although the title might not be specific enough, the book is written for people with an engineering attitude who want to understand where we were and why we got to where we are.

The reader will find that, in the majority of cases, this book differs from common folklore and "ideologically correct" science as portrayed in numerous "fashionable" oral and written histories shared by various institutions and individuals in several publications and especially on the internet. This book may appear superfluous to those readers who purport to already know everything or who are *dramatis personae*. If you fall into this category of readers, this book may hurt your feelings.

William B. Shockley was a very complicated and difficult person to understand. In the first half of his life as a physicist, he frightened with his brilliance. In the second half of his life, he delved into several taboo subjects. It is even more complicated to put such a subject in an historical perspective as we all wish to avoid having a cloud of prejudice hanging over us.

When we meet a difficult person like Shockley, our instinct is to try to change them. Several of Shockley's friends tried but it never worked! The only way to disengage a difficult person is to try to understand where they are coming from. Try to find what drives their decisions. For some people it is money; for others, it is power. For Shockley, it was the search for scientific truth.

The author of this book is not an historian, but rather a witness. In this book I employ a process of reasoning to determine the factual information. But the social sciences Shockley touched upon are not exact sciences, as we in the realms of engineering and physics know them. There are always the issues of opinion and interpretation. A reader may ask "If this book does not support my world view, then why should I read it?" You may have already formed your own opinion about Shockley and his beliefs, and that may be all that is important to you. Then there is no way

that you can be enlightened by this book. Should you continue reading, I am not asking you to accept my opinion. Rather, I invite you to create your own by precision reading, comparing the timeline, and studying the enclosed historical documents.

When a text is considered important, it becomes a critical issue to read it properly and understand it appropriately. This is perhaps one of the most comprehensive ways you can learn about a topic. Almost without fail, the more you read on a topic, the better the understanding you will eventually have of it. Sometimes you might be surprised by elements that you previously overlooked or had not even considered. You may find that the topic is not necessarily black and white and perhaps there are times when you may make an exception to your beliefs.

My students repeatedly tell me "Reading books is a waste of time. All the knowledge you need is online." I do not find Internet to be a reliable source of information and, more importantly, the computer screen constantly diverts the reader's attention by messages not related to the subject of study. Good books make for better sources of knowledge. Longer articles seem to be better read in print. Research on memory tells us that we learn by connecting new information to previous knowledge. Flipping back and forth to connect sections to each other may help us make those connections in the brain more quickly and easily.

The point is intelligent discovery of what is true. If there is nothing to discover that is true then there is no reason discussing, disputing, arguing, making an issue of anything, because there is nothing to believe in. When you read a book you might disagree with, you learn. You may discover one thing or many things, but you will learn something. And it will help you become a more informed person.

Chapter 2
Prologue: The Enigma of Shockley

"What you are trying to do seems to be absolutely essential to the future of the world but I guess that you will get very little thanks for it. I hope your courage would hold up."

Dr. John J. Osborn
(letter to W. Shockley, April 18, 1966)

The highest aim of science should be the ultimate search for truth. Today we admire scientists like Galileo Galilei for their intellectual honesty about what they saw, even if the results were uncomfortable to political establishment. Hungarian physician Ignaz Semmelweis was committed to an insane asylum after losing his job for suggesting, in the nineteenth century, the radical notion that infections could be spread by germs on doctors' hands in hospitals. In 1600, philosopher Giordano Bruno was burned at the stake for the heresy of proposing that the universe might be infinite. Dr. Shockley was such a hero who, in the search for true science, paid no attention to moral convention and feelings.

The father of the transistor, and arguably the most influential inventor of the last century, William Shockley was the leader of the team that created the seminal invention of the century. There are those who were offended by his abrasive personality and politically incorrect views, who minimize his role in inventing the transistor. He was the father of Silicon Valley; his company the originator from which virtually all the Valley's dominant companies and technologies would emerge. Modern microelectronics contains the technical descendants of Shockley's work.

He and his friend, James B. Fisk, designed a nuclear reactor several years before the Manhattan Project scientists at Los Alamos. In 1939, much of the physics community was taken by the growing advances toward fission made by European scientists. Shockley and James Fisk were assigned by the Bell Laboratories to examine the potential for fission as an energy source. Shockley came up with an idea: "*if you put the uranium in chunks, separated lumps or something, the neutrons might be able to slow down and not get captured and then be able to hit the U-235.*" In a few months, he and Fisk designed one of the world's first nuclear reactors. Their report went immediately to Washington. The government classified it right away, even keeping it secret from its own scientists. The authorities fought any attempt by Fisk, Shockley, or the labs to take out a patent.

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Shockley may have saved thousands of lives without leaving his desk. When war broke out, P. Morse was recruited to research munitions problems the Navy was having, mostly with its depth charges. Shockley volunteered to join Morse's office, the Anti-Submarine Warfare Operations Group. Under Morse's guidance, Shockley and his team solved the depth charge problem and successful attacks on German U-boats increased by a factor of five. Shockley's main weapon was the science of operations research, then largely ignored in the U.S., but already recruited for the war effort by the British. He then went about changing the way the Navy searched for submarines, again improving the kill-ratio. He devised tactics for the Atlantic convoys to evade German bombers after determining statistically—and without ever seeing either a convoy or a bomber—that the bombers did not carry radar. Shockley eventually wound up in the Army Air Corps. helping train bomber crews in the European theater. He was a leading proponent of the science of operations research in America, beginning in World War II, with desk-bound calculations that probably saved tens of thousands of lives. Although he won the highest possible civilian honor for his work, that work has long been forgotten.

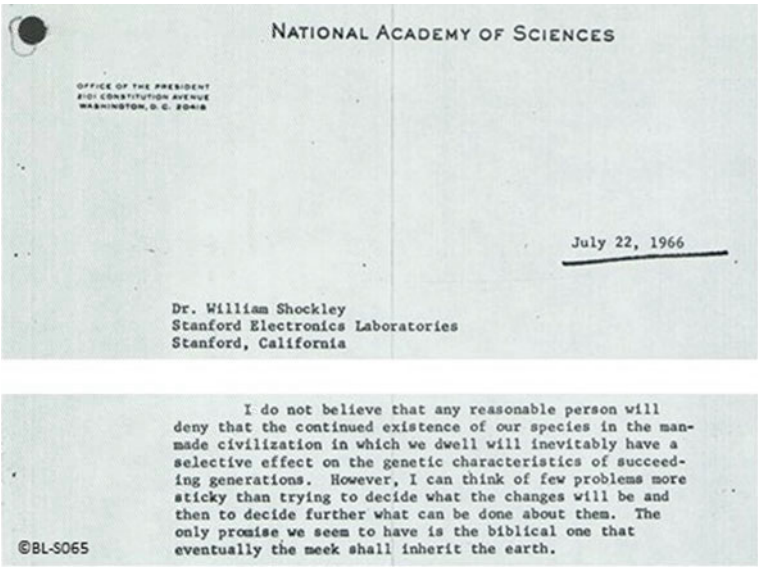
The spotlight was turned upon him later when he became involved in a controversial topic in which he became avidly interested: the genetic basis of intelligence. During the 1960s, he argued, in a series of articles and speeches, that people of African descent have a genetically inferior mental capacity when compared to those with Caucasian ancestry. This hypothesis became the subject of intense and acrimonious debate. The press coverage ignored the scientific basis and data of Shockley's arguments and frequently referred to Shockley's view as "race prejudice".

Shockley did not know what needed to be done, but he thought that first we needed to find out what was the root cause of what he called the heredity-poverty-crime problem and then find a remedy for how to improve this unsatisfactory situation. He sent letters to members of the National Academy of Sciences asking for their support. Shockley contacted his friend, Frederick Seitz, who was president of the National Academy of Sciences, and asked him for help. He urged "*do the research, find facts and discuss them widely.*" Shockley stated in the letter to F. Seitz: "*My position is not that all Negroes are inferior to all whites: I do believe that many Negroes are superior to many whites, in fact my statistical studies show that American Negroes achieve almost every eminent distinction that whites achieve.*"

Shockley in his presentation "*A try simplest cases approach to the heredity-poverty-crime problem*" read before the Academy on April 26, 1967 stated: "*What can be done to make a diagnosis? I have two recommendations: First, I believe that a National Study Group should be set up to do research and find out definitive conclusions. Second, a study of drastic changes in environment on the most disadvantaged children should be taken.*"

F. Seitz in a letter to Shockley dated July 22, 1966 stated "*I can think of few problems more sticky than trying to decide further what can be done about them*" (Fig. 2.1).

Shockley, motivated by repulsion of his peers at the National Academy of Sciences, and using data taken primarily from U.S. Army IQ tests and from the U.S. Office of Education, drew the conclusion that the genetic component of a person's



NATIONAL ACADEMY OF SCIENCES

OFFICE OF THE PRESIDENT
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

July 22, 1966

Dr. William Shockley
Stanford Electronics Laboratories
Stanford, California

I do not believe that any reasonable person will deny that the continued existence of our species in the man-made civilization in which we dwell will inevitably have a selective effect on the genetic characteristics of succeeding generations. However, I can think of few problems more sticky than trying to decide what the changes will be and then to decide further what can be done about them. The only promise we seem to have is the biblical one that eventually the meek shall inherit the earth.

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Fig. 2.1 Seitz letter to W. Shockley (July 22, 1966)

intelligence was based on genetic heritage. A similar hypothesis was earlier advanced by James Watson and Francis Crick, who in 1953 marked a milestone in the history of science and gave rise to modern molecular biology, a discipline largely concerned with understanding how genes control the chemical processes involved in copying genetic material. Their model enabled explanation of the molecular structure of nucleic acids, and also pinpointed DNA as the carrier of genetic information.

Textbooks on molecular biology or molecular genetics emphasize[1,2] "*with the exception of some viruses, almost all organisms on this planet store their cellular blueprints for life in double stranded DNA molecules.*" Amongst eminent psychologists and behavioral geneticists,[3,4] it is a nearly incontrovertible fact that intelligence is highly heritable and one of the single best predictors of long-term educational and occupational success, lending modern-day credence to Shockley's conclusions regarding the heritability of intelligence.

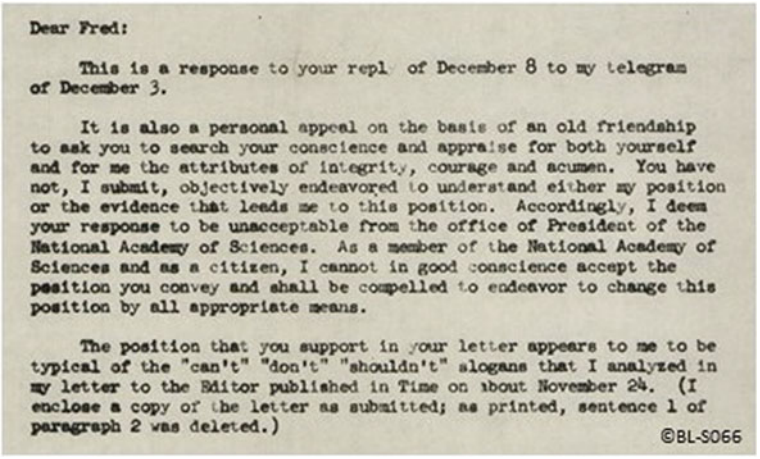
Although Shockley made the data he used and their statistical analysis public, up to now no one has offered an earnest rebuke of the Shockley data pointing out fundamental errors in his statistical analysis. In fact, some of the latest data collected

[1] R. L. Miesfeld, "*Applied Molecular Genetics*", J. Wiley & Sons, NY 1999.

[2] O. Brandenberg et al., "*Introduction to Molecular Biology and Genetic Engineering*", UN Rome 2011.

[3] R. Plomin, S. von Stumm, "*The new genetics of intelligence*", Nature Reviews Genetics, Vol 19 (2018), pp. 148–159.

[4] I. J. Deary, W. Johnson, L.M. Houlihan, "Genetic foundation of human intelligence", Human Genetics, Vol. 126 (2009), pp. 215–232.



Dear Fred:

This is a response to your repl of December 8 to my telegram of December 3.

It is also a personal appeal on the basis of an old friendship to ask you to search your conscience and appraise for both yourself and for me the attributes of integrity, courage and acumen. You have not, I submit, objectively endeavored to understand either my position or the evidence that leads me to this position. Accordingly, I deem your response to be unacceptable from the office of President of the National Academy of Sciences. As a member of the National Academy of Sciences and as a citizen, I cannot in good conscience accept the position you convey and shall be compelled to endeavor to change this position by all appropriate means.

The position that you support in your letter appears to me to be typical of the "can't" "don't" "shouldn't" slogans that I analyzed in my letter to the Editor published in Time on about November 24. (I enclose a copy of the letter as submitted; as printed, sentence 1 of paragraph 2 was deleted.)

©BL-S066

Fig. 2.2 W. Shockley's reply to F. Seitz dated December 15, 1956

by the U.S. Department of Education still report[5,6] the same trend in the gap in educational achievements as Shockley's analysis concluded some fifty years ago. It is interesting to note that these disparities have persisted over a span of some five decades, a period which has seen rapid and extensive societal, economic, and technological change both in the US and across the globe. Yet, despite all of the aforementioned progress, it seems that little has been accomplished to effectively close the achievement gap.

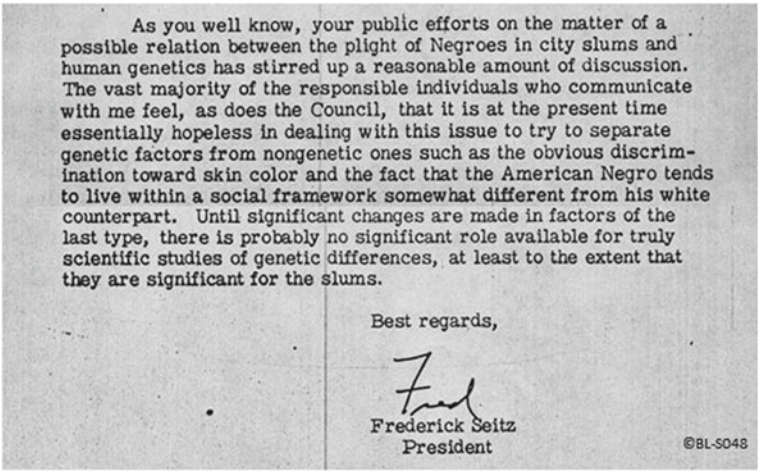
It is worth pointing out the obvious emotion-laden nature of this highly controversial issue, oftentimes preventing a purely objective and rational look at the data, from either end of the ideological spectrum. For many, sadly, racial differences are unpleasant matters that should not be discussed in polite society and, if ignored, might hopefully disappear. Even in Shockley's day, various political and ideological pressures aroused pushback on his proposed research studies.

Leveraging his personal friendship with Academy president F. Seitz, Shockley repeatedly provided him with documents relevant to his concerns and asked for research to be carried out to find out the root cause of these problems (Fig. 2.2).

Seitz delayed his replies to Shockley's letters or did not reply at all. Finally, on January 8, 1968 Seitz sent Shockley a letter explaining that because "…the American Negro tends to live within a social framework different from his white counterpart … there is probably no significant role for truly scientific study" (Fig. 2.3).

[5] Achievement Gaps: How Black and White Students in Public Schools Perform in Mathematics and Reading on the National Assessment of Educational Progress Statistical Analysis Report, U.S. Department of Education NCES 2009-455, July 2009.

[6] School Composition and the Black-White Achievement Gap, National Center for Education Statistics, U.S. Department of Education, September 2015.



As you well know, your public efforts on the matter of a possible relation between the plight of Negroes in city slums and human genetics has stirred up a reasonable amount of discussion. The vast majority of the responsible individuals who communicate with me feel, as does the Council, that it is at the present time essentially hopeless in dealing with this issue to try to separate genetic factors from nongenetic ones such as the obvious discrimination toward skin color and the fact that the American Negro tends to live within a social framework somewhat different from his white counterpart. Until significant changes are made in factors of the last type, there is probably no significant role available for truly scientific studies of genetic differences, at least to the extent that they are significant for the slums.

Best regards,

Frederick Seitz
President

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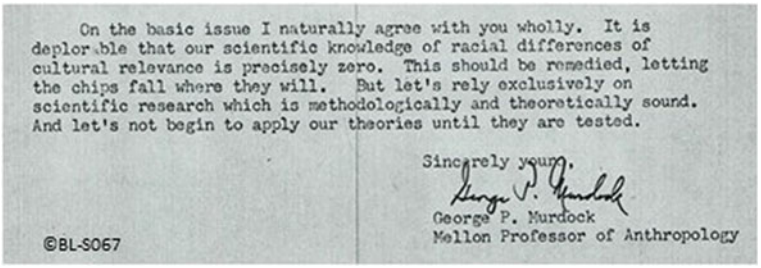
Fig. 2.3 F. Seitz's last letter to W. Shockley (January 8, 1968)



On the basic issue I naturally agree with you wholly. It is deplorable that our scientific knowledge of racial differences of cultural relevance is precisely zero. This should be remedied, letting the chips fall where they will. But let's rely exclusively on scientific research which is methodologically and theoretically sound. And let's not begin to apply our theories until they are tested.

Sincerely yours,

George P. Murdock
Mellon Professor of Anthropology

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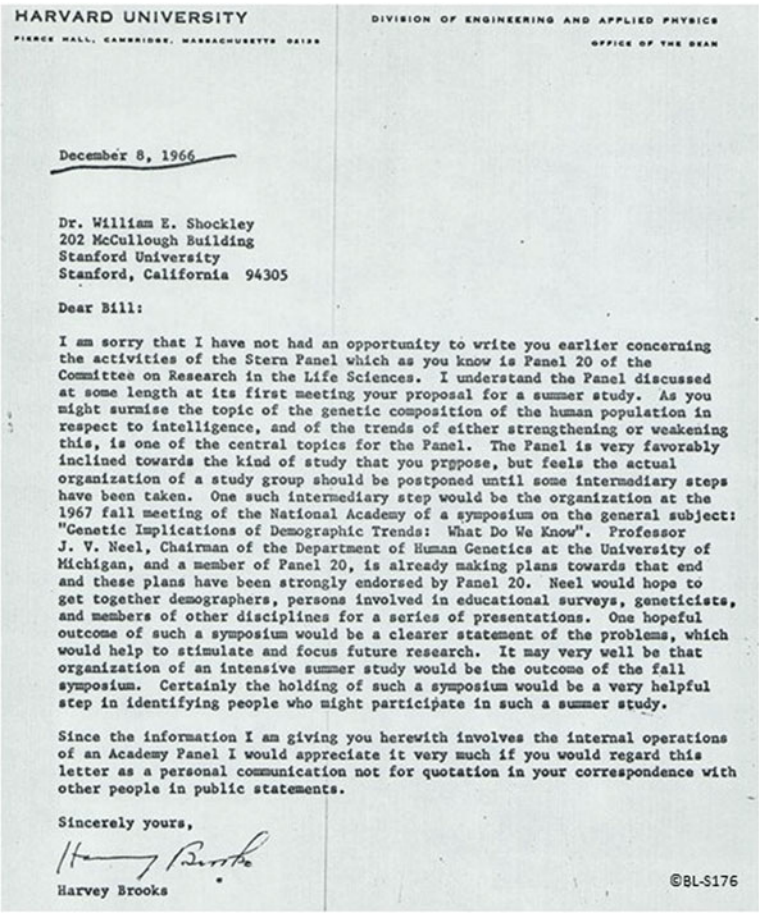
Fig. 2.4 G.P. Murdock's letter to W. Shockley (January 13, 1967)

Although Shockley did receive support from several members of the Academy and across academia, many advocates expressed their support in personal letters only and refused to stand up in public (Figs. 2.4 and 2.5).

While not all members of the Academy shared Seitz's position, the Academy Social Science Research Council was, in the end, loyal to its President, and Shockley's proposal for a research study was repeatedly rejected.

Shockley repeated his appeal again on April 28, 1969 in a scientific presentation "A Polymolecular Interpretation of Growth Rates of Social Problems" accompanied by charts and statistical data. In this presentation he also stated: "*Eugenics is a shunned word because it was a feature of Nazi-Aryan supremacy. But the lesson of Nazi history is not that eugenics is intolerable. One hundred and forty years before Hitler, the lesson to be learned from Nazi history was incorporated into our Constitution as the First Amendment guaranteeing freedom of speech and of the press. Only the most anti-Teutonic racist can believe that the German public would*



HARVARD UNIVERSITY
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DIVISION OF ENGINEERING AND APPLIED PHYSICS
OFFICE OF THE DEAN

December 8, 1966

Dr. William E. Shockley
202 McCullough Building
Stanford University
Stanford, California 94305

Dear Bill:

I am sorry that I have not had an opportunity to write you earlier concerning the activities of the Stern Panel which as you know is Panel 20 of the Committee on Research in the Life Sciences. I understand the Panel discussed at some length at its first meeting your proposal for a summer study. As you might surmise the topic of the genetic composition of the human population in respect to intelligence, and of the trends of either strengthening or weakening this, is one of the central topics for the Panel. The Panel is very favorably inclined towards the kind of study that you propose, but feels the actual organization of a study group should be postponed until some intermediary steps have been taken. One such intermediary step would be the organization at the 1967 fall meeting of the National Academy of a symposium on the general subject: "Genetic Implications of Demographic Trends: What Do We Know". Professor J. V. Neel, Chairman of the Department of Human Genetics at the University of Michigan, and a member of Panel 20, is already making plans towards that end and these plans have been strongly endorsed by Panel 20. Neel would hope to get together demographers, persons involved in educational surveys, geneticists, and members of other disciplines for a series of presentations. One hopeful outcome of such a symposium would be a clearer statement of the problems, which would help to stimulate and focus future research. It may very well be that organization of an intensive summer study would be the outcome of the fall symposium. Certainly the holding of such a symposium would be a very helpful step in identifying people who might participate in such a summer study.

Since the information I am giving you herewith involves the internal operations of an Academy Panel I would appreciate it very much if you would regard this letter as a personal communication not for quotation in your correspondence with other people in public statements.

Sincerely yours,

Harvey Brooks

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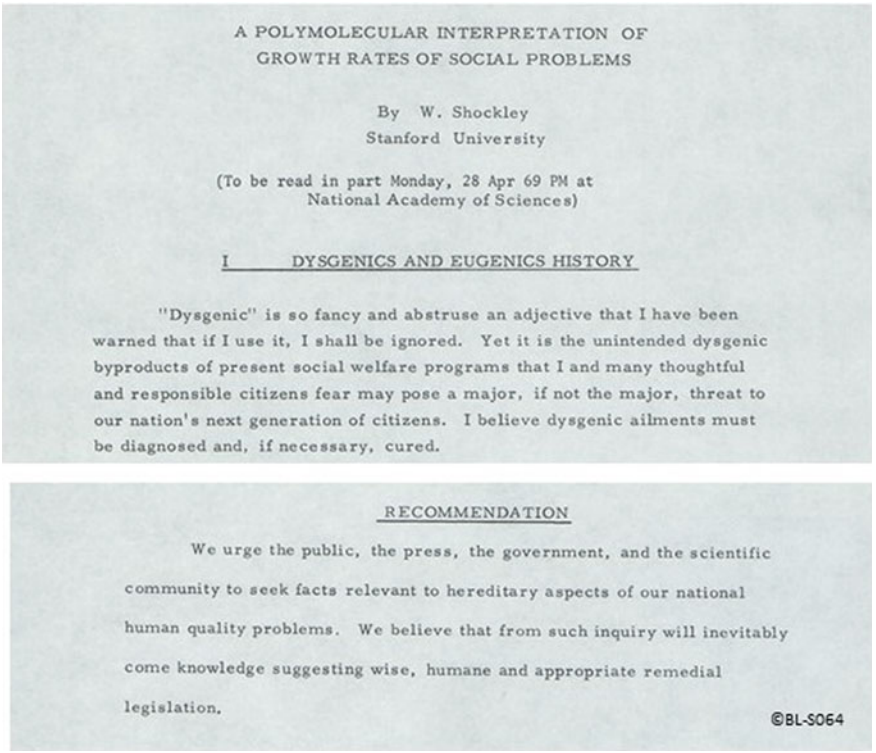
Fig. 2.5 Harvey Brooks' letter to W. Shockley (December 8, 1966)

tolerate the concentration camps if a working First Amendment had permitted public exposure and discussion of the genocide".

The Harvard geneticist David Reich[7] emphasizes the arbitrary nature of traditional racial groupings, but still argues that long periods of ancestry on separate continents have left their genetic marks on modern populations. These are most evident for physical traits like skin and hair color, where genetic causation is entirely uncontroversial. However, Reich asserts that all genetic traits, including those that affect behavior and cognition, are expected to differ between populations or races. To overemphasize the genetic factors, you may ask yourself the question in which

[7]D. Reich, "*How Genetics is Changing Our Understanding of 'Race'*", The New York Times, March 23, 1918.



A POLYMOLECULAR INTERPRETATION OF
GROWTH RATES OF SOCIAL PROBLEMS

By W. Shockley
Stanford University

(To be read in part Monday, 28 Apr 69 PM at
National Academy of Sciences)

I DYSGENICS AND EUGENICS HISTORY

"Dysgenic" is so fancy and abstruse an adjective that I have been warned that if I use it, I shall be ignored. Yet it is the unintended dysgenic byproducts of present social welfare programs that I and many thoughtful and responsible citizens fear may pose a major, if not the major, threat to our nation's next generation of citizens. I believe dysgenic ailments must be diagnosed and, if necessary, cured.

RECOMMENDATION

We urge the public, the press, the government, and the scientific community to seek facts relevant to hereditary aspects of our national human quality problems. We believe that from such inquiry will inevitably come knowledge suggesting wise, humane and appropriate remedial legislation.

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Fig. 2.6 Transcript of Shockley's presentation at NAS (April 28, 1969)

environment you need to live if you want to change your eyes or hair color. What environment can change our mental abilities?

Pinker wrote[8] "*The profound questions are about what, precisely, are the non-genetic causes of personality and intelligence.*" Unfortunately, the public does not get most of its information about genetics from molecular biologists but instead from popular media with no or vague definitions of the technical words used in arguments and discussions amongst experts. Many popular media authors are, in fact, unaware of theoretical advances in the field, long after the new way of thinking has become common in the field. To answer Pinker's question, thus, requires not only overcoming ideological biases, but also an insistence that media professionals act as facilitators—not interpreters—of scientific evidence to the general public. This, however, can only be achieved through thought, or rather, a will to think.

Shockley described an early meeting with Enrico Fermi, the wartime A-bomb physicist. Fermi said that one of the most important things is the "*will to think*." Shockley wrote later: "*A competent thinker will be reluctant to commit himself to the effort that tedious and precise thinking demands—he will lack "the will to think"*

[8] S. Pinker, "*Why Nature & Nurture won't go away*", Daedalus Vol. 133 (2004), pp. 5–17.

unless he has the conviction that something worthwhile will be done with the results of his efforts—and, of course, there is always also the risk that his hard thinking may not produce any creative ideas". Thinking is one of the most difficult things a man can do. People understand investing time for farming and gardening that yield harvests months later. People readily invest money in a bank that yields interest years later. But people resist investing time in thinking because, unlike farming and banking, rewards in harvesting knowledge are delayed; there is no immediate or predictable payback.

Shockley's unusual personality had a major effect in shaping the personality of Bell Laboratories, and by extension, that of the microelectronics industry. In later years he fell from grace because of his views on the genetic basis of intelligence. Shockley argued that the higher rate of reproduction among the less intelligent had a dysgenic effect that would ultimately lead to a decline of civilization. The issue with William Shockley is that his scientific achievements outweigh by far any of his views we might see as objectionable. On the 50th anniversary of the invention of the transistor Isaac Asimov called Shockley's junction transistor "*perhaps the most astonishing revolution of all the scientific revolutions that have taken place in human history.*"

I met William Shockley and his wife, Emmy, for the first time as a boy. He was a wise and decorated man, and to me, of course, seemingly an old man. Shockley's teaching methods were severe, sometimes brutal. Equally severe and ruthless was his criticism. But I was fascinated with the exquisite way he explained complicated problems and with his specific humor. He was very bright and truly ingenious, with a quick grasp of new ideas.

I have passed that age now and I cannot escape the desire to see him again. Once, Shockley told me "*you do not need to agree with me, just admit for a moment, what if this is true*". I often ponder about his statement and I ask myself the question "*Is knowledge of certain kinds dangerous or undesirable*"*? Can certain knowledge hurt us?* If you continue reading the following chapters, ask yourself questions, confront the time sequence of events, check the reproduced documents and imagine "what if". The world can be made better by knowledge, not by ignorance.