

# **Friedrich Dessauer: Biomedical Engineering Pioneer and Model for Involvement in Science, Engineering, Philosophy and Politics**

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**Abstract:** Within an aspirational approach to engineering practice and ethics, the paradigm of learning from example is particularly well suited. In this contribution, learning from biography – a variant of this paradigm – drives a review of the biography and thought of Friedrich Dessauer (1881-1963), a devoted Christian who became one of the pioneers of biomedical engineering and philosophy of technology, leaving to posterity also a remarkable case for learning from biography.

## **Introduction**

This text is about Friedrich Dessauer, a pioneer of biomedical engineering and of philosophy of technology. In this contribution a variant of the learning from example paradigm – learning from biography – drives a review of the biography and writings of Friedrich Dessauer (1881-1963), a Germany born devoted Christian who, though physicist by study, became one of the pioneers of biomedical engineering. The difference between the “scientist-only” and the “engineer” is here understood as implicitly put forward by Einstein: “And here I will say that the scientist finds his reward in what Henri Poincare calls the joy of comprehension, and not in the possibilities of application to which any discovery of his may lead.” [1] The engineer, on the other hand, focuses on discovery and application, with a clear striding towards the second. Dessauer's ground breaking contributions to the development of radiotherapy – he was the inventor of deep-penetration X-ray therapy – and radiotherapeutic equipment follow this pattern.

As a Christian, Dessauer maintained that every invention is a discovery of preformed ideas for finding an optimal technical solution. Thinking in this direction we are able to establish a fundamental relation between technology and God. Moral questions concerning biotechniques, automatization, ecology, internet, etc. lead us to this relation, inviting us to find optimal solutions compatible with Christianity. Dessauer stated that “Christianity knows of need and misery, but it also knows of salvation ... As a result, the Christian tackles life, he does not withdraw from it ... Basically, the ideal of the Christian is a heroic overcoming of all that degrades, ... not only on his own, of course, which is not enough, but with the help of grace.” [2] He thus implied that technology for itself is not a stand-alone tool to solve humanity's problems.

This article is organized as follows. In the next section a brief biographical sketch is given, based on [3]-[7]. Then several of Dessauer's considerations on science, engineering, philosophy, politics and Christian life are put into perspective. Application remarks and conclusions are found in the last section of the text.

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## A summary of biography, contribution and impact

Dessauer was born 1881 in Aschaffenburg, close to Frankfurt, Germany, to a catholic industrialist family. He was the youngest of eleven siblings. As a teenager he read about Conrad Röntgen's (1845-1923) discovery of a new radiation, and – still in high school – started his own experiments on the topic. A manuscript with his results was submitted to his Physics teacher, who decided to forward it to Röntgen. Röntgen encouraged the young student to continue researching. After secondary school, Dessauer started his studies of Physics and Electrical Engineering in Munich and Darmstadt. But because of the early death of his father in 1901, he left the university to secure the support of his (actually wealthy) family. With the support of his brother-in-law, a medical doctor, Dessauer established the *Elektrotechnisches Laboratorium* in Aschaffenburg. The company built X-ray equipment for medical use. Although Dessauer travelled widely to promote his equipment, his main interest lay in research directed at the cure of cancer patients. In 1907 the company expanded to Frankfurt and in 1914 had 500 employees. During this time as industrial entrepreneur, more precisely in 1909, Dessauer married Elisabeth Elshorst. They had three sons and one daughter.

In 1914, Dessauer resumed his studies in Frankfurt. That same year his first skin problems appeared. They were consequences of his experiments and demonstrations with X-rays, many of them performed on his own body. This was the start of a constant, unceasing fight against an issue that would ultimately lead to his death in 1963.

Dessauer concluded his studies in Frankfurt in 1917, earning a doctorate with his thesis “On a high-voltage transformer for the generation of penetrating X-rays.” While he was involved in many entrepreneurial and scientific activities, Dessauer's concern with the social problems of his employees grew, specially after the end of World War I. He decided to become politically active as a member of the Catholic Centrum Party, where he expected to best realize his Christian ideals. He right away became a member of the board and was elected a Frankfurt city councilor. His main political concerns were related to social and economic policies.

In 1920 he became a honorary professor at the University of Frankfurt. To support his activities, the university created the Institute for the Physical Foundations of Medicine (which today is the Max Planck Institute for Biophysics). Because the university had not enough resources to support all the scientific staff he needed, Dessauer sold his company and with the yield established a research supporting foundation. Although most of the foundation's assets were lost to inflation in 1929, the institute survived thanks to the loyalty and dedication of its staff.

In 1922, Dessauer became a full professor. That same year the newspaper “Frankfurter Volkszeitung” came into serious financial trouble. Dessauer, who was one of the shareholders, proposed a recovery concept and personally financed the necessary capital increase. The newspaper was merged with another newspaper in financial difficulty, and for 10 years the new “Rhein-Mainische Volkszeitung,” with Dessauer as chairman of the board, gave superregional voice to the young representatives of German socially engaged Catholic Christianity. Dessauer expanded his political engagement, being elected as member of the Reichstag (national parliament) in 1924. There he led the centrum's proposal of guidelines for the economy,

advocating for a cooperative economy consistent with the solidarity principle of Catholic social teaching. He later became one of the main advisors to Chancellor Heinrich Brüning (in office from March 1930 to May 1932).

After the National Socialist German Workers' Party (NSDAP) came to power in 1933, Dessauer was temporarily imprisoned and accused of embezzlement in the context of his involvement in establishing the NSDAP-critical "Rhein-Mainische Volkszeitung." He was acquitted in court in December 1933. Nevertheless, further activity at the university was prohibited to him and, in the aftermath, he was discredited and had his home attacked in one of several nationwide hate campaigns.

In 1934 Dessauer emigrated to Turkey with his wife and two younger children. There he had been appointed a professor at the University of Istanbul, with the task to establish a new radiological institute for physical therapy. The institute was integrated into the department of medicine, and its interdisciplinarity resulted in a difficult standing at the university, mainly because Dessauer – though an expert in radiology and radiotherapy – was not a medical doctor. He already knew this challenge from Frankfurt.

In 1937, mainly for health reasons, Dessauer accepted an invitation of the University of Fribourg, Switzerland. During the time of his exile in Switzerland, his estate was confiscated in Germany and his German citizenship canceled.

Dessauer's German citizenship was reinstated in 1949. The following year he returned to Frankfurt for a first lecture. In 1951 he resumed his lecturing activity in Frankfurt on biophysics and natural philosophy, in spite of University of Fribourg's generous offer of increased long term research funding. Dessauer returned to his former residence in Frankfurt and until 1960 lectured to sizable audiences, which usually overcrowded the university's largest lecture hall.

After his return to Germany, Dessauer was widely honored, e.g. with honorary doctorates in medicine, theology and engineering, and the honorary citizenships of Frankfurt and Aschaffenburg,

Dessauer's manufacturing interests never interfered with his theoretical studies and research. In the earlier years he mainly contributed advances to X-ray generation technology. Later, contributions to radiotherapeutic practice were added. He recognized the importance of homogeneous irradiation to deliver effective subcutaneous doses of radiation without burning the skin and other interposed tissues. His chief principles were summarized in what sometimes has been called "Dessauer's laws of homogeneous irradiation." These were widely spread, being also presented before the American Roentgen Ray Society in 1921. Furthermore he emphasized the advantages of using hard, well-filtered radiations to guarantee adequate radiosensitivity safety margins between normal and malignant tissues. Dessauer's biophysical theory of the effects of radiation on living tissues found mixed response and stimulated research on a world wide scale.

Dessauer's social concerns ultimately led him to involvement in politics, but already in 1908 he wrote on technological culture [8]. From 1926 to 1928, his concern with the course of German society and hostile views of technology lead him to publish on the philosophy of

technology [9]. Later, in 1956, he revisited, deepened, expanded and improved the consolidation and contextualization of his findings in his magnum opus “Streit um die Technik” [10] (*Quarrel on technology*), which was to be recognized by authors such as Monmsa et al. [11], and Mitcham [12]. Dessauer's book on cooperative economy [13] was also well received by more than one generation, having been reprinted posthumously.

Right after World War II, people throughout Europe reflected on the future of the West in the wake of such debacle that left much of the people and their continent in graves and ashes. Dessauer contributed actively to the discussions. On at least two occasions he was a speaker on the radio about “Inheritance and destiny of the West”, the first one as early as 1948 with Studio Radio Bern, Switzerland, and years later on the same topic with Radio Bremen, Germany. Both radio talks have been printed ([2] and [14]). Therein Dessauer gave a cultural and historical portrait that acknowledged Christianity's role in the making of the Occident. His conclusion in Bremen was: “We are Westerners. We know how we became Westerners. We want to preserve our inheritance. We do not want to sacrifice it to the skepticism of our time, to a nihilistic, desperate mindset, to the loss of meaning. The danger of the West is not so much its outward wreckage, but its inner ambiguity.” He then commented on technology and its relevance in shaping human destiny, pointing out that much of it happened in distance from God and that keeping such distance would not be sustainable. Talking about continuity, he called for renewal: “Being human means to strive, every day, to become human. Being a Christian means to start anew every day in the quest to become one. Every evening the past day dies away from us. And we must let go what has been called off, and daily the new flows towards us, and we must grasp it whenever it leads us up; this demands strength. And such strength is called trusting faith.” This faith was the ground for Dessauer's remarkable resilience and legacy.

### **A brief on Dessauer's thought**

Dessauer saw technology as an instrument of general improvement of mankind's standing. He saw it providing liberty, time, improved resources for culture, and making these available to masses who previously had no access to them. Technology takes the human environment from the survival challenges set by nature to an ever-higher sphere of the mind, and – in principle – gives all people access to culture, entailing humanization through technology. But, thus far, too much of it happened in disconnection from God.

Although Dessauer in his writings touched specific ethical issues entailed by technology, such as those related to the environment or the development of atomic weapons, he avoided discussing them extensively. This did not come out of a lack of concern, but rather from his focus on a framework to consider transdisciplinary issues (without actually coining this post-Dessauer term) related to technology, culture, Christian faith, society and nature. Such framework would then enable the grasp and tackling of specific ethical issues.

Dessauer proposes his own definition of technology, with the goal to capture its essence. “Technology is real being out of ideas / through final design and processing / from natural resources.” [10] The first part establishes an ontological definition of technology that acknowledges human creativity and imagination as originators. The second part refers to the

means of realizing technology. The third part acknowledges technology's connection to and limitations due to nature.

He wrote in defense of technology, contesting those who condemn technology because of their lack of understanding or out of an (alleged) legitimacy obtained from misunderstandings. He also pointed out that the Christian longing for redemption has been distorted by men of technology of modern times into a passionate endeavor towards self redemption. Technical innovation and activity can thus often be observed as a religious endeavor, even if the agent – the technical men of modern times – is not explicitly aware of it as such.

As is not surprising, Dessauer devoted a chapter of *Quarrel on Technology* to the religious and theological aspects of technology. There he points out that technology shows the universe, i.e. creation, as being infinitely richer than anyone had ever imagined. Furthermore, technology, the bigger it gets, the more it points beyond itself towards its background, thus fostering natural science. Dessauer then points out Bible passages that encourage technology (such as Genesis 1:28 and Genesis 6) as well as passages that warn against idolatrous faith in technology, and against self redemption efforts (which may include technology). He also endorses Emil Brunner's understanding of Genesis as “Magna Charta of Technology,”<sup>2</sup> and points out that our Lord incarnated, as a carpenter, was seen in his time also as a man of his technical profession (Mark 6:3) and thus of technology. The life and example of our Lord Himself, as a person of technology and of concern with His “kingdom that is not from this world” (John 18:36), can therefore be seen as endorsement and encouragement of the Christians' professional of technology. He summarized: “The Christ-believing professional of technology takes his commission from Genesis' creation account and finds his distinction, example, consolation and support in Christ's technical career.”

Dessauer then proceeds to analyze the impact of “Erblast” (literally burden of heritage, meaning the inherited consequences of the fall and sin) on technology. “Man has fallen from the nearness to God into the tendency to rebellion and thus to abuse, and it is harder for him – and possible only with the help of grace – to succeed in the positive, constructive.” This of course fully applies to technology, because technology, like all human activity, is open to the abuse that follows from human freedom and hence theologically has the “Erblast” at its root.

In the last part of this chapter in *Quarrel on Technology*, Dessauer discusses relations of “pastoral care” to technology, addressing a mix of several issues he deemed of relevance to priests / pastors involved with people in the technical professions. He recalls that the Great Commission is “go... and teach...” He stresses that going means “not remaining” in one's own familiar circle of thought and life, but reaching out to others, to their “place of residence.” As the intellectual place of residence, to a large extent, he sees one's profession, in the engineer's case the technical profession. There the person lives, has his attitude shaped, daily receives substance and horizon definitions for his mindset, for his behavior towards fellow human beings, the environment, etc. The challenge, thus, is to show – within “technological reality” - how to see the Creator, the Father, to whom Christ always points anew. It is true that God the Creator is mentioned in the first sentence of the Christian creeds. But then He disappears from sight. No day in the sequence of Christian festivals is consecrated to Him, who can be (but most often is

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2 A term coined by Brunner during ETH Zürich-jubilee commemorations [15].

not) met daily within creation by the researcher and engineer. It was not always like this. Joule and Maxwell felt Him, proclaimed Him; Nicholas of Cusa, Giordano Bruno, Kepler and Augustine did the same much before them. If – for historical reasons – the Creator appears so little in Christian thinking of modern times, it is understandable that professionals involved in research and technology fell into the distance from God in their “secular professions.” With their growth and multiplication this expanded to society. Dessauer identified an “external re-approximation” throughout the first decades of the 20<sup>th</sup> century, but still saw need for recovery. His closing of the chapter is: “How far are we away from the old demand to look *uno aspectu* – in one glance – through nature and society at the divine background.”

Dessauer also tackles epistemological issues, though with less emphasis. Technology can contribute to epistemology, and Dessauer stresses that none of the famous schools of epistemology until the 20<sup>th</sup> century has taken this seriously into account. Natural science and technology always accepted the intelligibility of the universe, initially for theological reasons, and one cannot deny that they did very well with such presupposition. Objections to this “naive realism” of researchers and engineers have been widely spread, and Dessauer's work has been criticized on such grounds as well [16].

### **Application remarks and conclusions**

An understanding of technology similar to Dessauer's is found in a belletristic and self-contained form in Herbert Hoover's memoirs (not mentioned by Dessauer). More specifically on engineering, Hoover writes:

“It is a great profession. There is the fascination of watching a figment of the imagination emerge through the aid of science to a plan on paper. Then it moves to realization in stone or metal or energy. Then it brings jobs and homes to men. Then it elevates the standards of living and adds to the comforts of life. That is the engineer's high privilege... Every time he [the engineer] discovers a new application of science, thereby creating a new industry, providing new jobs, adding to the standards of living, he also disturbs everything that is. New laws and regulations have to be made and new sorts of wickedness curbed.” [17]

Dessauer's understanding of engineering – or more generally technology – along these lines has been called “optimistic” (e.g. in [18]). However, it is difficult to see how such (mis)reading can be reconciled with a rational approach to Dessauer's contextualized writings (i.e., without taking individual phrases out of context). Possible abuse of technology is clearly acknowledged by Dessauer. Roots for it, as well as for any other abuse, he finds in the sinful nature of men. Needed response lies in the realm of the individual's and the society's responsibilities. Proper practice and regulation are expected to succeed whenever they are informed by case specific application of Christian principles, although such application may not be straightforward. Hence, the ethical foundation needed for technology is not found within technology. Dessauer finds it within Christian theology and philosophy.

On a more motivational level, Dessauer endorses that a commission for work in the technical professions can be taken from Genesis' creation account, and that in Christ the professional of technology can find distinction, example, consolation and support. This understanding drives his integration of faith, profession and personal life. Dessauer's broad, courageous and selfless engagement for and within society underscores his insights and teaching with powerful testimony and has enduring example value.

Finally and fortunately, it remains to be said that Dessauer's pioneering engagement for a much needed philosophy of technology has found expert continuators (e.g. in [19] and [20]). He started by reviewing what had been said on technology, and captured the essence and foundations of the methods of technology. On such grounds he built his contributions. This brings to mind the remark of Karl Popper at the end of his notable paper "What is dialectic?" [21]. Popper addresses the philosophers of science stating: "The whole development of dialectic should be a warning against speculative philosophy. It should remind us that philosophy must not be made a basis for any sort of scientific system and that philosophers should be much more modest in their claims. For their task, which they can fulfill quite usefully, is the study of the methods of science." Not surprisingly, the methods of technology Dessauer so competently used in professional practice lay at the foundation of his successful push towards a philosophy of technology.

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