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ORIGINAL PAPER

"The joy that engineers and mathematicians have come together."[1]

Richard von Mises' foundation of ZAMM, and its "Tasks and Goals" (1920/21)

Reinhard Siegmund-Schultze (University of Agder, Kristiansand, Norwegen)

1 | INTRODUCTION, OVERVIEW AND SOURCES

In a special issue of *Zeitschrift für Angewandte Mathematik und Mechanik* (ZAMM) in 1983, devoted to the one hundredth birthday of Richard von Mises (1883–1953), one of his most influential students, Lothar Collatz (1910–1990), said:

> *"Richard von Mises' merits for ZAMM have already been acknowledged. While formerly (before 1920) 'applied mathematics' at best was considered an appendage of 'pure mathematics' and occasionally used in journals and during meetings as an 'advertising sign' [Aushängeschild], the foundation of GAMM and ZAMM stressed both the independence of applied mathematics and its close connection to mechanics." (Collatz 1983, 279)*

FIGURE 1 Richard von Mises (1883–1953). Courtesy Kustodie Technische Universität Dresden (Kind mediation by Klaus Mauersberger)

Although Collatz's article and the two articles by Garrett Birkhoff and G.S. Ludford (Ludford 1983) in the same issue of ZAMM provide valuable, albeit fragmentary, information on von Mises' scientific work, there is – contrary to Collatz's remark – no thorough evaluation in the literature on von Mises' work for ZAMM so far. This remains a task for the present article, which will, however, only fulfill part of the task by limiting the discussion mainly to the founding years of ZAMM, namely 1919–1921. Von Mises' 13 years of activity for ZAMM until his emigration from Nazi Germany in 1933, especially the broader scientific impact of ZAMM under his editorship can only be indicated in section 5 and will have to be discussed later and separately. The

[1] "Freude, dass sich die Ingenieure und Mathematiker zusammengefunden haben." Quoted from a letter written by Felix Klein shortly after the first issue of ZAMM had appeared in 1921. See below Appendix B for the full letter.

journal itself, which is now published in English under the name "Journal of Applied Mathematics and Mechanics" (ZAMM), has – in addition to the 1983 issue for von Mises – already made some efforts to explore its own history.

As examples of the scientific impact, two main areas that were flourishing at ZAMM at the time can be mentioned here: fluid dynamics and plasticity theory.[2] In fluid mechanics at that time, the inviscid flow was calculated with potential-flow theory, and the flow in the boundary layer with the new integral method for solving Prandtl's boundary layer equations, derived by Theodor von Kármán in ZAMM.[3] In plasticity theory, Hencky introduced – after some suggestions by Prandtl [1921] and Nádai [1921] – the "slip line theory" (Hencky 1923), which became generally accepted in engineering practice, e.g. of forming processes, almost three decades later. Prandtl [1923] as well as Carathéodory and Schmidt [1923] supplemented these ideas with graphical solution methods and numerous other statements. Hilda Geiringer and William Prager [1934] contributed to the dissemination of this theory and contributed own ideas as well.[4]

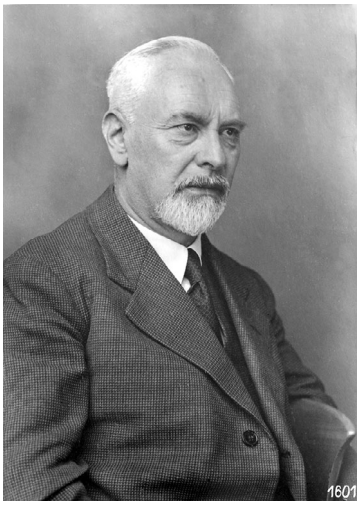

FIGURE 2 Ludwig Prandtl (1875–1953). DLR, CC-BY 3.0, CC BY 3.0 de, https://commons.wikimedia.org/w/index.php?curid=3620095

Von Mises' later relationship with ZAMM during his Turkish and American emigration must also remain outside the scope of this article. Von Mises' journal became a model for international journals of applied mathematics. In 1932/33 the journal of the same name *Prikladnaya Matematika i Mekhanika* was founded in the Soviet Union. Richard von Mises had many followers there among physicists, engineers and mathematicians, not least because of the success of his Handbook on Differential and Integral Equations, the so-called "Frank-Mises" (1925/27),[5] edited with his friend, the Austrian-Czech physicist Philip Frank. The American *Quarterly of Applied Mathematics*, which was founded in 1943 during the emigration of von Mises, also followed the example of ZAMM. Von Mises himself discussed this foundation somewhat critically in (Mises 1944).

The following section 2 gives some basic biographical information on von Mises and attempts to describe briefly the main developments in the institutionalization of applied mathematics first in Göttingen and later, after World War I, in Berlin. The role of Felix Klein (1849–1925), the great reformer of mathematical and technical education in Germany and mentor of Richard von Mises, will be an important point in this section (see also Appendix B).

The next section 3 focusses on unknown and unpublished archival material concerning von Mises' activities mostly in 1919 and 1920 which led to the foundation of ZAMM. A major and hitherto unknown document is von Mises' handwritten "program of a journal of applied mathematics and mechanics" (Programm einer „Zeitschrift für Angewandte Mathematik und Mechanik"). Von Mises' "program" is preserved as a clearly legible handwritten draft in the Von Mises Papers at the Harvard University Archives. It was written for the Association of German Engineers (Verein Deutscher Ingenieure, VDI) and its publishing department, from 1923 officially the "V.D.I .Verlag." The document shows von Mises' versatility and his commitment to all aspects of

[2] The huge role which ZAMM played in these fields is revealed for instance in (Eckert 2006), (Krause 2014), (Osakada 2010), (Popov, Gray 2012), and (Bruhns 2014). The last two historical works appeared in ZAMM.

[3] We follow here (Krause 2014, 331) who refers to (Kármán 1921).

[4] Following here (Bruhns 2014, 188). All contributions to plasticity theory to which Bruhns refers here – except (Geiringer, Prager 1934) – appeared in ZAMM.

[5] One mathematician on the editorial board, N. I. Muskhelishvili, was himself an author in ZAMM in the period, as revealed by his work on elasticity in ZAMM 13: 264 – 282. There was broad recognition of von Mises in the Soviet Union, often combined with reservations against his adherence to the philosopher Ernst Mach. Von Mises was from his time in Strasbourg a good friend of L. Mandelstam. In 1928 von Mises traveled to the sixth congress of Russian physicists in Saratov. On the "Frank-Mises" see (Siegmund-Schultze 2007).

producing[6] and running the prospective journal. Although von Mises proposed in it the nomination of a "scientific commission" to advise the editor (mentioned then on the title pages as "under participation" – "unter Mitwirkung"), the entire program shows that von Mises has ensured his own dominant role within ZAMM. Most of the proposals from von Mises' "program" were realized in ZAMM, for instance the "Summary Reports" (Zusammenfassende Berichte) and the "Short Excerpts" (Kurze Auszüge), the latter essentially being reviews of articles. Von Mises himself wrote many of the reviews of articles and books published in ZAMM, although Goldstein's claim that "he did practically all the reviewing" (Goldstein 1963, xii) seems exaggerated. The "Program" is published below as Appendix A, both in the German original and in an English translation.

Von Mises' "program" must not be confused with his introductory 15-page article to the first issue of ZAMM in 1921, the "Tasks and goals of applied mathematics." This article has often been quoted but never completely translated into English. For reasons of space I cannot do this within the present article either and will restrict my efforts to characteristic quotes with brief commentary. This will form section 4. It remains for the future to systematically compare the introductory article by von Mises with the actual work and results of ZAMM during the 13 years of von Mises' editorial work. In such a future investigation the contribution and assistance of Richard von Mises' student and future wife Hilda Geiringer (1893–1973) – a well-known applied mathematician of independent significance, the creator of the Geiringer equations in plasticity theory – would also have to play a major role. Without jumping too hasty to conclusions we can state that in the publications of ZAMM there was much realized of what von Mises had planned and promised both in the "program" and in "Tasks and Goals". This concerned for example the central role of mechanics, in particular fluid dynamics and plasticity, in the new journal (see above). Also, the still important role of graphical methods in ZAMM corresponds to von Mises' "tasks and goals" while numerical methods gradually assumed a bigger share than von Mises had anticipated in 1920. Some areas such as mathematical optics were not mentioned (but not excluded either) in von Mises' plans but appeared nevertheless on the pages of ZAMM (especially by Max Herzberger*).* Experimental works played a somewhat controversial role in the publications. They were considered underrepresented by some engineers like Ludwig Prandtl.

Some insights into von Mises' editorial policy during his editorial tenure from 1921 to 1933 are given in the last, fifth section of this article. I will try to show the high degree of independence of von Mises in his role as editor. Von Mises did not even shy away from some attacks against "coworkers" like Ludwig Prandtl and their schools (see below). Of particular relevance is von Mises' view of the different, partly coinciding, partly contradicting interests of German engineers, physicists, pure and applied mathematicians and the institutions to which they belonged. The international context and von Mises' somewhat unclear relationship to internationalism are also discussed in part.

Throughout the discussion, especially of the "Tasks and Goals", the reader must be aware of the drastically changed character of applied mathematics today compared to the 1920s, not least because of the computer development in the rather recent past. Von Mises and ZAMM were active in the pre-computer age, even before analog computers like V. Bush's Differential Analyzer appeared around 1930. In particular, modelling, statistical methods, numerical analysis (a name that apparently first appeared in the title of a 1930 book by James B. Scarborough)[7] and, of course, computers and algorithms have now acquired a much broader role within applied mathematics than in the 1920s and 1930s.

As far as the individual contribution and impact of von Mises is concerned, the paper will hopefully be able to show that, through his versatility and energy, he represented exactly the kind of personality needed to combine the efforts of various interest groups into a joint, groundbreaking and far-reaching effort in science, mathematics and technology. This allows us to draw conclusions at the individual, biographical level about what was typical in a broader historical process.

Finally, a few remarks on the sources used and on the technical aspects of this paper. The two main sources are publications in the journal ZAMM itself and von Mises' estate in the archives of Harvard University, his final institution in American exile. Another archival source is the Ludwig-Prandtl papers in the archives of the Max Planck Society (MPG) in Berlin. Smaller sources are mentioned separately in footnotes.

All non-English citations are given in English translation, usually by the author. The German original is added in cases where the source has not yet been published. For example, the German is not added to excerpts from the ZAMM. Within the quotations, notes by the author, e.g. original words to some translated words, are added in brackets. For the sake of brevity, I refer to shorter excerpts from the ZAMM directly by "ZAMM, Volume No.: Page No." without including the source at the end of the article in the references.

[6] It is interesting in this context that for von Mises book binding was a personal hobby (Goldstein 1963, xii).

[7] (Scarborough 1930). See the rather lukewarm review of this book by von Mises' assistant Hilda Pollaczek-Geiringer in ZAMM 11:336. The review puts the pedagogical over the scientific value of the book. This was at a time when Germany was still *the* international leader in applied mathematics.

2 | BASIC FACTS OF VON MISES' BIOGRAPHY, AND BRIEF REMARKS ON THE GÖTTINGEN CENTER AND THE NEW DEVELOPMENTS IN APPLIED MATHEMATICS IN BERLIN AFTER WORLD WAR I

Before we go into the prehistory of ZAMM and its foundation in 1919/20, a few brief remarks on the biography of Richard von Mises[8] and on the rise of applied mathematics in Göttingen and later in Berlin are necessary. Göttingen was the traditional center with which the Berlin School, von Mises, his institute and his journal cooperated and competed (see also Section 5).

Richard von Mises was born in 1883 in Lemberg (Galicia) under the Habsburg Monarchy; the city is today's Lvív (Ukraine). He received his school education in Vienna and studied engineering at the Technical University there from 1901 to 1905. In addition to his keen interest in technology, von Mises developed an early interest in purely mathematical subjects such as geometry (to which his first publication (Mises 1905) belonged even before his doctorate), and he attended lectures by the then leading probabilist Emanuel Czuber. Subsequently von Mises became assistant to the former student of David Hilbert in Göttingen and professor of mechanics at the Technical University in Brno (Moravia), Georg Hamel.

Von Mises wrote his habilitation thesis on water turbines in 1908. One year later he was appointed associate professor of applied mathematics at the university of the German occupied city of Strasbourg. Here he had good relations with the versatile algebraist and analyst Heinrich Weber (1842–1913) and his family. Weber had published revisions of Karl Hattendorff's edition of Bernhard Riemann's Lectures on partial differential equations and their applications in physics in 1900 and 1901. The "Riemann-Weber" was later (1925/27) revised again by von Mises and Philipp Frank, which, as mentioned above, became the "Frank-Mises". In Strasbourg von Mises became advisor to, among others, Erich Trefftz (1888–1937), later his successor as editor of ZAMM. Trefftz' doctoral thesis on circular fluid jets of 1913 belonged to von Mises' main research area, hydrodynamics. In the following year von Mises published a book on the technical aspects of the subject with the Teubner Verlag in Berlin/Leipzig. In 1913, the first full professor of applied mathematics in Germany, Carl Runge (1856–1927) of Göttingen, incidentally Trefftz' uncle and the latter's former professor in Göttingen, presented von Mises' most important paper on plasticity theory to the Göttingen Academy of Sciences (Mises 1913). It contains the Mises yield condition that has subsequently been used in engineering practice on a daily basis and is known to practically all mechanical engineering students. The paper shows von Mises' full awareness of experimental findings which he combined with his rather simple and elegant mathematical model. Although the latter could not be interpreted directly in terms of physics, it proved to be well suited to making predictions for practical applications. The Mises condition therefore made his name better known and more durable among engineers than among mathematicians. Among mathematicians as a whole, von Mises is probably best known for creating ZAMM and – with often uninformed disapproval – for his failure to find the "right" foundations for probability theory.

Since the relationship between the Göttingen and the Berlin schools of applied mathematics is an important background to von Mises' work for ZAMM during the 1920s and 1930s, a short look at the older school in Göttingen is necessary.

Felix Klein was the great organizer and reformer of applied mathematics and mathematical-technical education around 1900 (Tobies 2002 and 2019). He created the professorships for Applied Mechanics (Ludwig Prandtl, 1875–1953) and for Applied Mathematics (Carl Runge) at the university of Göttingen, both in the year 1904, while in the same year the very creative and imaginative engineer Prandtl (Eckert 2017) presented his famous theory of the boundary layer to the International Congress of Mathematicians in Heidelberg. This was to become a paradigm in aerodynamic theory, especially later in the 1920s, as is well documented in many articles in ZAMM. From 1907, von Mises worked with Klein on his *Encyklopädie der mathematischen Wissenschaften mit Einschluss ihrer Anwendungen,* and in 1911 he wrote an influential article on dynamical problems of machine theory for it. Originally von Mises had planned this article together with Karl Heun (1859–1929), who is known in numerical analysis for the Runge-Kutta-Heun methods. In the end, Heun was unable to coauthor the article for health reasons. It is worth quoting from a letter that the established professor from Karlsruhe, Heun, wrote to the 24 years old von Mises when he was not even in possession of a doctoral degree. This was a reaction to von Mises' suggestions for the article, which Heun approved. Heun's letter describes well the almost missionary attitude of people like Klein, von Mises and Heun to spread the gospel of applied mathematics among engineers. He wrote on October 3, 1907:

> *"We must be very careful to ignore the pseudo-authorities in the subject – albeit with the utmost caution – as they deserve. The picture of mechanical engineering in its current state will thus become much clearer. … Every progress in the teaching of mechanics and its recognition and evaluation at the technical universities makes it easier*

[8] For more details see (Goldstein 1963) and (Siegmund-Schultze 2004).

to work in this direction and contributes to the gradual development of genuine scientific activity by the technician, as we see in England with Osborne Reynolds. We want to create a picture of the tools of mechanics that have been ignored until now."[9]

In the course of his collaboration with Klein von Mises met Prandtl's protégé and his and Prandtl's future rival Theodor von Kármán (1881–1963), who was only two years older than von Mises (Hanle 1982).

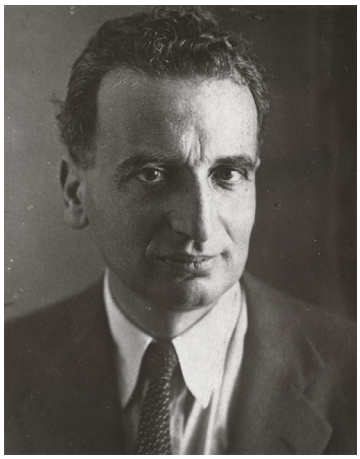

FIGURE 3 Theodor von Kármán (1881–1963). From the collection of portraits at the California Institute of Technology, Pasadena, kind mediation by Judith Goodstein and Bonny Ludt

Later von Kármán became a leading aerodynamicist both in Germany (from 1912 chair in Aachen) and in the United States (from 1929 mainly at Caltech in Pasadena). Early patterns of competition and cooperation between the three men, von Mises, von Kármán and Prandtl, emerged. For example, when von Mises, supported by Klein, criticized von Kármán's article on strength of materials for the encyclopedia, or when von Kármán, supported by Prandtl, was awarded the chair of aerodynamics in Aachen in 1912, while von Mises was unsuccessful (Siegmund-Schultze 2018, 493). During World War I von Mises was an officer in the Austrian Air Force in Vienna. In 1916 he designed a "large aircraft" (Großflugzeug), which was conceived as a bomber, but never went into service due to engine problems. He gave lectures to air force officers in Vienna, which resulted in von Mises' "Theory of Flight" ("Fluglehre") for a wide readership of engineers, and which was published by Springer in Berlin in 1918, when the war was still going on. A more theoretical result was von Mises' two-dimensional theory of the aerofoil, published in two parts in 1917 and 1920, which even had implications for future work on the reversibility theory in fluid dynamics by von Mises' Harvard colleague Garrett Birkhoff after World War II, as the latter testifies in (Birkhoff 1983, 283).

These few biographical facts should suffice to indicate that von Mises was very familiar with the works of the Göttingen school and with the leading figures there, both mathematicians and engineers. He had a boundless admiration for Felix Klein, as evidenced by his contributions to ZAMM, both on Klein's 75th birthday in 1924 and on Klein's death a year later in 1925 (Mises-anon 1925). Klein, for his part, was impressed by von Mises and in 1908 called him "one of the most successful examples to date of a crossbreed between mathematics and technology" (Siegmund-Schultze 2018, 486).

In von Mises' relationship with Runge (born 1856) and Prandtl (born 1875) the difference in age played a role, especially in relation to the former. In fact, no publication by Runge appeared in ZAMM, and only a few of Runge's students, such as E. Trefftz and F.A. Willers, published there before 1933. When Trefftz died in 1937, Willers became his successor as editor of ZAMM.

World War I and especially the defeat of Germany created new appreciation and new conditions for applied mathematics in Germany, but also in many other European countries and in the United States.

[9] Harvard University Archives, Richard von Mises Papers, HUG 4574.5, box 1, folder 1907. „Wir müssen sehr darauf bedacht sein, die Pseudoautoritäten – wenn auch mit der grössten Vorsicht – nach Verdienst unbeachtet zu lassen. Das zu entwerfende Bild der Maschinen-Mechanik in ihrem aktuellen Zustande wird dadurch entschieden klarer. … Jeder Fortschritt in dem Mechanik-Unterricht und seiner Erfassung und Werthung auf den technischen Hochschulen erleichtert das Arbeiten in dieser Richtung und trägt zur allmählichen Herausbildung echt wissenschaftlicher Tätigkeit des Technikers bei, wie wir sie in England bei Osborne Reynolds sehen. Wir wollen ein Bild der … bisher unbeachtet gelassenen Hilfsmittel der Mechanik geben."

At the University of Berlin the plans to create a full professorship (Ordinariat) of Applied Mathematics can be dated back at least to June 1918, when the war was still going on. The application of the Faculty of Philosophy (which included mathematicians, physicists, but also humanities scholars) of June 10th was written by the (pure) mathematician Erhard Schmidt, who later occasionally published in ZAMM. Here you can read:

> *"The increasing penetration of practice with mathematical methods due to the development of technology in the last pre-war years and, above all, the unexpectedly clear need during the war for practically and theoretically trained mathematicians –in the General Staff for questions of cartography, topography, imaging, in the Artillery Proving Commission for ballistic tasks, in the Air Force for static and aerodynamic calculations, etc. – require that applied mathematics is adequately represented at the largest university in the state [Prussia]. This is all the more so as the new examination regulations for candidates for the higher teaching profession, in contrast to the old ones, require from every candidate for the first level teaching qualification in mathematics experience in mathematical calculation and drawing."*[10]

Despite his age of 62 at the time, it was Runge (a good friend of the Berlin physicist Max Planck) who was originally considered by the faculty as a candidate, although it was unlikely that he would accept. In any case, the faculty's application to create the professorship was rejected by the Ministry in January 1919 for financial reasons.

One month later, the name Richard von Mises appeared in the university files for the first time. The Faculty of Philosophy apparently tried to take advantage of the political fact that von Mises appeared on a list of former professors from Strasbourg who had been dismissed by the French after the war and for whom the Reich had the responsibility of securing posts. In a renewed application for a full professorship on 5 July 1919 the Faculty nominated the following three mathematicians in that order: Carl Runge (Göttingen), Gerhard Hessenberg (Breslau) and Richard von Mises (now Dresden). The text of the application states, among other things:

> *"Applied mathematics can be practiced and taught in so many different ways that one cannot demand that one single person takes all possible points of view into account. On the contrary, in order to achieve a worthy representation of this science at a large university, one must strive to ensure that the scholar to be appointed gives a personal touch to his teaching, without of course neglecting the elementary main lectures in the field of applied mathematics. This applies to each of the three men mentioned. For Runge, numerical and graphic calculation would predominate, for Hessenberg the purely geometric methods of drawing, and for von Mises the interest and understanding of technical issues."*[11]

The Ministry did not agree and only allowed the use of a vacancy as an associate professor (Extraordinariat) for the purposes of applied mathematics. Consequently, the two older candidates declined the offer. Eventually von Mises was appointed to the University of Berlin, officially only as an associate professor, but with acceptances which he obtained through negotiations and found satisfactory.[12]

[10] „Die mit der Entwicklung der Technik in den letzten Jahren vor dem Kriege immer weitergehende Durchdringung der Praxis mit mathematischen Methoden und vor allem das ungeahnte, durch den Krieg zu Tage tretende Bedürfnis nach praktisch und theoretisch durchgebildeten Mathematikern – im Generalstabe für Fragen der Kartographie, Topographie, Abbildungskunde, in der Artillerie-Prüfungskommission für ballistische Aufgaben, bei der Fliegertruppe für statische und aerodynamische Berechnungen usw. – machen es aber zur unabweisbaren Notwendigkeit, dass die angewandte Mathematik an der grössten Landesuniversität eine vollwertige Vertretung erhält, umso mehr als auch die neue Prüfungsordnung für Kandidaten des höheren Lehramts in Abweichung von der alten von jedem Kandidaten für die Lehrbefähigung erster Stufe in Mathematik Uebung in mathematischem Rechnen und Zeichnen fordert." (Geheimes Staatsarchiv Preussischer Kulturbesitz (GSA), Berlin-Dahlem, Rep. 76 Va, Sekt. 2, Tit. IV, no. 68c, fol. 59/60.) Another, partly overlapping part of this request has already been quoted in (Biermann 1988, 186).

[11] „Die angewandte Mathematik kann auf so viele verschiedene Weisen betrieben und unterrichtet werden, dass es unmöglich ist, zu verlangen, dass ein einziger sämtliche möglichen Gesichtspunkte berücksichtigt. Im Gegenteil muss, um eine würdige Vertretung dieser Wissenschaft an einer grossen Universität zu erhalten, erstrebt werden, dass der zu berufende Gelehrte seinem Unterricht eine persönliche Färbung gibt, ohne dass selbstverständlich dabei die elementaren grossen Vorlesungen im Gebiete der angewandten Mathematik vernachlässigt werden. Dieses trifft für jeden der drei genannten Männer zu. Bei Runge würde das numerische und graphische Rechnen, bei Hessenberg die zeichnerischen rein geometrischen Methoden, bei von Mises das Interesse und Verständnis für technische Fragen überwiegen." (GSA, Rep. 76 Va, Sekt. 2, Tit. IV, no. 68c, fol. 69-69v.)

[12] GSA, Rep. 76 Va, Sekt. 2, Tit. IV, no. 68c, fol.92-96, „Vereinbarung" (agreement), dated 30 December 1919.

On 19 January 1920 von Mises wrote from Dresden with some pride to his friend and rival von Kármán:

> *"As you know I am decided to settle in Berlin around Easter and take over a large-scale scientific enterprise [wissenschaftlicher Grossbetrieb]." (Siegmund-Schultze 2018, 500)*

One is probably not mistaken in assuming that von Mises tried to subliminally compensate for the defeat against von Kármán in the competition for the chair in Aachen in 1912. However, a comparison of his rather small institute in Berlin (Bernhardt 1980) with Aachen, let alone Göttingen, was out of place from the outset, if only because of the much larger personnel required to operate the experimental facilities (wind tunnels) there. It soon became apparent that the research grants granted by the "Notgemeinschaft" (Emergency association), the predecessor organisation of the German Research Foundation, in the early years of the Weimar Republic went mainly to the centers in Göttingen, Aachen, and partly Karlsruhe, while applications by von Mises for the expansion of his institute and for support for teaching were rejected (Tobies 1982, 19/20).

In fact, ZAMM was to become much more of a "large scientific enterprise" than the small von Mises Institute at the university.

3 | VON MISES AND THE FOUNDATION OF ZAMM IN BERLIN IN 1920

In April 1921, when his new journal ZAMM had been in existence for a quarter of a year, von Mises wrote a self-advertising review of the first issue of ZAMM in the widely circulated monthly journal *Die Naturwissenschaften*. It begins with the following words:

> *"It can be regarded as a peculiarity of German science that the boundaries between the disciplines are much more sharply drawn here than elsewhere. There is hardly any other country, for example, where such a clear distinction is made between pure 'university' mathematics on the one hand and 'applications' of mathematical theories, especially in the engineering sciences, on the other. …. Efforts to achieve a mutual rapprochement have been made over several decades, especially under the influence of the Göttingen movement under Felix Klein, especially in the* Zeitschrift für Mathematik und Physik*. The latter, however, never found full contact with the circle of scientific engineers." (Mises 1921b, 268)*

This section will show that the separation described by von Mises was felt by various influential mathematicians, engineers, associations and publishers. But it took the peculiar and energetic personality of von Mises to change the situation and create a much-needed meeting place.

In January 1919 von Mises was in Freiburg near the French border, where several German professors who had recently been dismissed from Strasbourg had found temporary asylum. There von Mises, who was still quite young at 35, received a letter from Springer in Berlin, who had just published his "Theory of Flight" (Flugtheorie) in 1918. The letter of 2 January 1919 states:

> *"The plan you mentioned for a 'Zeitschrift für angewandte Mathematik' interests me very much. However, I have serious doubts about the publishing."*[13]

Two months later, on 17 March, Prandtl wrote to von Mises that Springer had told him about von Mises' attempt when he himself came to Springer with "very similar" plans. However, the "poor economic situation, especially in the publishing industry" made such plans seem unrealistic.[14] In any case, at that time Springer was still considering taking over the existing German journal for applied mathematics *Zeitschrift für Mathematik und Physik* from Teubner Verlag, which had been discontinued during the war.[15] As is well known (Remmert, Schneider 2010), Springer developed broad activities for publications in the natural sciences and mathematics after the war, while Teubner scaled back his efforts in these areas. Springer took over Teubner's traditional *Mathematische Annalen* and, among other things, founded a new journal for pure mathematics in 1918, the

[13] „Der von Ihnen erwähnte Plan einer ‚Zeitschrift für angewandte Mathematik' interessiert mich lebhaft. Ich habe aber erheblichen Zweifel bezüglich der verlegerischen Durchführung." (HUG 4574.5. Box 2, Folder 1919).

[14] Prandtl to von Mises, 17 March 1919 (MPA III, 61, no. 2386): „bei der schlechten wirtschaftlichen Lage gerade des Buchgewerbes".

[15] It is worth noting that von Mises published his first paper (Mises 1905) in this journal even before he received his doctorate.

Mathematische Zeitschrift, edited by Leon Lichtenstein. There von Mises published his two fundamental articles on probability theory in 1919.

Richard Courant, the mathematician with applied interests in Göttingen, worked closely with Springer in these efforts to reorganize German mathematical publishing. On 29 March 1919 Courant wrote to his friend from the war, Ferdinand Springer:

> *"As far as the question of the Zeitschrift für Mathematik und Physik is concerned, I have spoken to both Runge and Klein. Runge is confident that a redesign of the journal in your publishing house will succeed with new life in the editorial department. He attributes the decline of the journal to, among other things, his and Mehmke's low activity. He thinks a lot of Mises as editor-in-chief, but what I can't hide is that Klein had a personal objection to Mises, that he often insults people by showing signs of arrogance.*[16] *I'll let you have the verdict in confidence, of course. I can't confirm it, but I would ask you to discuss it again with Lichtenstein. Mises is definitely the right man for the job."*[17]

It is unclear why Springer did not choose to continue Teubner's Journal of Mathematics and Physics at this time. Economic concerns seem to have been the decisive factor. In any case, von Mises apparently did not know about the developments in his other and earlier publisher, Teubner, when he contacted him about the same project. This is evident from his personal diaries, which are written in the German shorthand Gabelsberger.[18] There is an entry in von Mises' diary for 10 July 1919 when von Mises was professor of mechanics in Dresden. It says the following:

> *"Negotiations with Gieseke at Teubner. For hydromechanics, second volume, for strength theory. Finally, for the "Zeitschrift für angewandte Mathematik". The plan for this is becoming more and more decisive for me."*[19]

Apparently von Mises' efforts to publish his book (his books?) and the new journal failed due to Teubner's gradual withdrawal from the natural sciences and mathematics. Nevertheless von Mises did not give up. Almost a year later, when von Mises was established in Berlin, his diaries report for May 15, 1920:

> *"Discussion in the House of Engineers with Matschoss and Meyer concerning the founding of a journal for applied mathematics. Pretty good impression, the cause has been substantially promoted."*[20]

At the meeting of the "Association of German Engineers" VDI on September 19, 1920, the engineer at Siemens, Reinhold Rüdenberg (later on the editorial board of ZAMM), reported on the decision to found ZAMM and to publish it from 1921. Gericke comments on this decision of the German engineers with the following words:

> *"It seems remarkable that they not only talked about the necessity of such an outlet in general, but immediately created it. The VDI publishing house was strong enough to make this possible even in difficult times – after all, this was shortly before the hyperinflation of 1923." (Gericke 1972, 6)*

[16] The judgment is confirmed even by von Mises' widow and former student, Hilda Geiringer. She writes it in a draft for aerodynamicist Sydney Goldstein's obituary of von Mises, where it then appeared (Goldstein 1963, xiii). See also (Siegmund-Schultze 1993).

[17] „Wegen der Frage der Zeitschrift für Mathematik und Physik habe ich sowohl mit Runge als auch mit Klein gesprochen. Runge wird sich von einer Neugestaltung der Zeitschrift in Ihrem Verlage mit neuem Leben in der Redaktion guten Erfolg versprechen. Er schob den Rückgang der Zeitschrift zum Teil auf seine und Mehmkes geringe Betriebsamkeit. Über Mises als Hauptredakteur dachte er recht günstig, dagegen hatte, wie ich Ihnen nicht verhehlen darf, Klein gegen Mises das persönliche Bedenken, dass er öfter Leute durch den Anschein von Hochmut vor den Kopf stiesse. Ich kann dieses Urteil, welches ich Ihnen natürlich ganz vertraulich mitteile, nicht unterschreiben, bitte Sie aber, darüber noch mal mit Lichtenstein zu sprechen. Sachlich ist Mises jedenfalls der gegebene Mann." (29.3.1919, Springer Verlagsarchiv, B, No.67, Courant, Akte 1919, Zentral- und Landesbibliothek Berlin).

[18] HUG 4574.2 Diaries 1903–1952. The following quotes are all from this source in von Mises' papers at Harvard.

[19] „Verhandlungen mit Gieseke von Teubner. Wegen Hydromechanik, zweiter Band, wegen Festigkeitslehre. Schließlich wegen Zeitschrift für angewandte Mathematik. Der Plan dazu wird bei mir immer entschiedener."

[20] „Besprechung im Ingen.haus mit Matschoss und Meyer wegen Gründung einer Zeitschrift für angewandte Mathematik. Ziemlich guter Eindruck, Sache schon wesentlich gefördert." Conrad Matschoss and Diedrich Meyer were both at different times directors of the VDI (Verein Deutscher Ingenieure). From 1914 the "Ingenieurhaus" or "VDI house" was located very close to the Reichstag.

Already on May 29, von Mises had written in his diary: "This morning the program for the Zeitschrift completed." During a stay in Münster, von Mises wrote a note in his diary on September 10th about a "draft for the editorial in the journal (Entwurf für den Leitaufsatz in der Zeitschrift).

The "program" already mentioned in the introduction above and the "editorial" (Leitaufsatz) were two different things. The latter was the very first article to be published in ZAMM 1 (1921) and comprises 15 printed pages. Its translation into English is still a desideratum, because – according to many in the field – it has more than just historical value. It is partially commented on in section 4.

It is interesting that the "Program of a 'Journal of Applied Mathematics and Mechanics'" (Appendix A) shows the complete title of ZAMM for the first time. After failing in negotiations with the scientific publishers Springer and Teubner with his proposal for a "Journal of Applied Mathematics", von Mises apparently had to add "mechanics" for the VDI. The publishing house was to remain the same in the 1930s and 1940s until ZAMM was reissued after the war by Akademie-Verlag in East Berlin in 1947.

Between writing the program in May 1920 and the editorial in September of the same year, von Mises had several discussions with Prandtl in July and August 1920, some of which concerned the title for the new journal. Von Mises responded to a letter from Prandtl in a letter dated August 31:

> *"As for the title of the journal, as you know, I myself am not satisfied with what we have so far. But to say 'Angewandte Mechanik' seems to me to be incorrect, because I do not understand by it anymore – though in contrast to the Göttingen usage – a theory of mechanics, but rather the applied subjects like mechanical engineering or bridge building. It would probably be the right thing to say 'Mechanics and Applied Mathematics', but that again does not sound very good. From the circles of the V.D.I. 'Z. f[ür] wissenschaftliche Technik' or for 'Grundwissenschaften der Technik' have been suggested, but the publisher also considers the title as it is now to be the best one. I believe that your concerns are best addressed by the name of the publisher, which is always mentioned in a journal. The V.D.I. will not easily be expected to be too theoretical, and perhaps even a slight emphasis on mathematics as a counterweight is not undesirable if the journal is not to be limited to engineers alone."*[21]

The discussion of the title for the journal was even more intense when the title-question came up in the context of the foundation of the society "Gesellschaft für angewandte Mathematik und Mechanik" (GAMM) one year later. Then Prandtl would protest against von Mises' suggestion to use the same name for the society as before for his journal and he proposed "Society for technical mechanics" instead. He added on August 9, 1921:

> *"The applied mathematicians, i.e. those who want to do useful mathematics in the spirit of the main task of the society, should be very welcome. What I want to avoid is, however, the dominance of mathematics and the mathematizing treatment of problems. I believe that the experiment has to be stressed as least as much as the theory." (Gericke 1972, p.8)*

Finally, the fact that ZAMM and its name already existed and were successful also seems to have influenced the decision for the name GAMM. From the beginning there were plans for a cooperation between the journal and the society, which further suggested the identity of the names. In fact, this cooperation was to be reflected, for example, in the regular reports on the GAMM meetings printed in ZAMM, including the publication of abstracts of the lectures.

After he had successfully concluded negotiations for the journal with the engineers, von Mises summed up his commitment to the journal. During a visit to Weimar on September 30, 1920, the fervent admirer of Goethe von Mises found words of admiration for the classic sites of German culture in his diary and then wrote the following:

[21] „Was den Titel der Zeitschrift anbelangt, so bin ich selbst, wie Sie wissen, mit dem bisherigen nicht zufrieden. Aber „Angewandte Mechanik" zu sagen, scheint mir unrichtig, weil ich darunter – allerdings im Gegensatz zu dem Göttinger Gebrauch – nicht mehr das Lehrgebäude der Mechanik, sondern eben die angewandten Fächer, wie Maschinenbau oder Brückenbau verstehe. Es wäre dann wohl das Richtigste ‚Mechanik und Angewandte Mathematik' zu sagen, aber das klingt wieder nicht sehr gut. Aus den Kreisen des V.D.I. sind ‚Z. f[ür] wissenschaftliche Technik' oder für ‚Grundwissenschaften der Technik' vorgeschlagen worden, aber der Verlag hält auch noch den bisherigen Titel für den besten. Ich glaube, dass Ihre Bedenken am stärksten durch den Namen des Verlages beseitigt werden, den man doch bei einer Zeitschrift stets mitzunennen pflegt. Dem V.D.I. wird man nicht so leicht zumuten, dass er zu theoretisch ist und vielleicht ist sogar eine leichte Betonung des Mathematischen als Gegengewicht nicht unerwünscht, wenn die Zeitschrift nicht rein auf Ingenieure beschränkt bleiben soll." (Deutsche Gesellschaft für Luft- und Raumfahrt (DLR) Göttingen, archives, no. 3664, thanks to Florian Schmaltz, Berlin). I could not find Prandtl's letter (to which von Mises responded) in the archives.

> *"Many plans for the immediate future, some things clearer now: focus on fewer topics in my own writings, thereby consideration for my health. Working first for organizational aspects, later returning to science, in the long run not ruling out political activity."*[22]

This seems to me a key quote for understanding the man and the scientist von Mises, including his entire activity for ZAMM and his many other efforts for the organization of science and engineering, combined with a tinge of hypochondria.

Three days later, on 2 October 1920, von Mises noted in his diaries the final confirmation of the founding of the journal by the VDI. On the same day he writes a letter to his mother Adele von Mises in Vienna:

> *"I also have to tell you that I will have to develop a new activity from next time on: I have founded a 'Zeitschrift für Angewandte Mathematik und Mechanik', which will be published by the Verein Deutscher Ingenieure from 1921 on. It cannot be changed that this will again be a great strain on my time and work. But objectively it was absolutely necessary to do so and I could not evade this task. I am the sole editor and have a very favorable contract with the publisher, who pays me a fixed sum of 3000 M and for each contribution 400 M per sheet [comprising 16 pages], moreover I am reimbursed for all costs of my management. In any case I will hire a secretary for the afternoon hours."*[23]

Two months later, on December 1, 1920 von Mises reports in his diary about his visit to the printing office (Druckerei Schade) and the delivery of the first manuscripts.

In an unsigned note in the ZAMM on the death of Felix Klein in 1925, von Mises quotes from Felix Klein's "private letter to the editor" from about 1921:

> *"Your journal completely realizes what I once had in mind, but which I could only prepare organizationally, no longer through my own production. It is a special satisfaction for me that the many suggestions made in the Encyclopedia of Mathematical Sciences, which were hardly followed at the time, are now being realized."*[24]

In alluding to their close collaboration in the Encyclopedia, Klein adopts a personal tone towards von Mises and acknowledges – despite any reservations he may have had about his aggressive personality – that the latter acted in the spirit of his own unfulfilled ambitions. Not quite as personal was Felix Klein's more official letter to the VDI at about the same time, after he had seen the first issue of the journal in February 1921. This letter is reproduced in translation in Appendix B. But even there Klein expresses his "joy … that engineers and mathematicians have come together". The two letters from Klein close the circle to von Mises' advertisement for ZAMM in the *Naturwissenschaften* (above), which among other things expressed the mood in defeated Germany at the time to develop "science as a substitute for power".

To conclude this section with von Mises' personal account of the year 1921, when his journal began to appear, we quote from an entry in his diaries from New Year's Eve 1921/22:

> *"For myself, as a significant progress compared to the previous year: the journal and the securing of the financial situation. But little or no scientific return."*[25]

[22] „Mannigfache Pläne für die nächste Zukunft, etwas Klärung: stärkere Zusammenfassung der eigenen Schriften unter möglichster Schonung der Gesundheit. Richtung zunächst aufs Organisatorische, später wieder zum Wissenschaftlichen zurückkehrend, in weiter Ferne politisches Wirken nicht aus dem Auge lassend."

[23] „Ich muss Dir auch noch erzählen, dass ich von nächster Zeit an eine neue Tätigkeit werde entwickeln müssen: Ich habe eine ‚Zeitschrift für Angewandte Mathematik und Mechanik' begründet, die von 1921 an im Verlage des Vereines Deutscher Ingenieure erscheinen wird. Dass damit wieder eine neue grosse Belastung meiner Zeit und Arbeitskraft verbunden sein wird, lässt sich nicht ändern. Sachlich war es aber durchaus notwendig, das zu unternehmen und ich durfte mich dieser Aufgabe nicht entziehen. Ich bin alleiniger Herausgeber und habe einen sehr günstigen Vertrag mit dem Verleger, der mir ein Fixum von 3000 M und für jeden Beitrag 400 M pro Bogen zahlt, überdies alle Kosten meiner Geschäftsführung ersetzt. Ich werde mir jedenfalls für die Nachmittagsstunden eine Sekretärin engagieren." (HUG 4574.5.2, box 3, Letters and postcards to his mother).

[24] (Mises-anon 1925). This letter must have been particularly dear to von Mises, although I could not find the original in von Mises' papers in the Harvard University Archives.

[25] „Für mich selbst, als wesentlicher Fortschritt gegen dem Vorjahr: die Zeitschrift und die Sicherung der finanziellen Verhältnisse. Aber wenig oder gar kein wissenschaftlicher Ertrag."

ZEITSCHRIFT FÜR ANGEWANDTE MATHEMATIK UND MECHANIK

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Inhalt:

ZUR EINFÜHRUNG

Über die Aufgaben und Ziele der angewandten Mathematik

Von R. v. MISES in Berlin.

FIGURE 4 First page of the first issue of ZAMM (1921) with von Mises' "Tasks and goals of applied mathematics"

4 | EXCERPTS FROM RICHARD VON MISES' "TASKS AND GOALS OF APPLIED MATHEMATICS"[26]

Translated into English and briefly commented by Reinhard Siegmund-Schultze

Table of contents of von Mises' paper

Von Mises started the very first page of his new journal ZAMM in late February 1921 with a 15 page article "Zur Einführung. Über die Aufgaben und Ziele der angewandten Mathematik," which can be translated as „As an introduction. On the tasks (problems) and goals of applied mathematics" with the German word "Aufgaben" having both a general (tasks) and a more specific (problems) meaning. What strikes the reader immediately is that von Mises reduces the title of the journal ZAMM (appearing on the top of the same page) to his specific field "Applied mathematics", thus stressing the latter's core function within the journal.

Before entering his point **"1. External Delineation"** of "Tasks and goals" (as it will be abbreviated henceforth) von Mises mentions the traditional division of mathematics into "pure" and "applied" mathematics. He stresses that this is problematic even for the work of historically rather recent figures such as Gauß. Accordingly, he continues in 1. with a relativizing definition of applied mathematics, revealing his own, broader and tolerant, almost philosophical standpoint:

[26] The original (Mises 1921a) has never been published completely in English translation. A draft of a translation by the American Daniel Kane (unknown to me) is contained in the von Mises Papers in the Harvard University Archives (HUG 4574.22.3, folder "On the problems and goals of applied mathematics by R.v.Mises"). It was apparently commissioned by von Mises' widow Hilda Geiringer, who left a note on the handwritten draft asking for a typewritten version, which is also in the archives. The draft refers to the page numbers of the new edition of the German original in (Mises 1963/64, II, 454–477) and must therefore have been produced between 1964 and 1973, the year of Geiringer's death. The quality of the translation, especially the scientific vocabulary, is rather poor, which might explain why Geiringer did not consider publishing it. In the following I have used a few selected formulations from Kane's draft. The numbers in parentheses indicate the page numbers in the German original in ZAMM.

> *"From the abstract-logical investigations, which reach into the field of philosophy, to the rational, number- and measure-oriented considerations of everyday life, a chain of intertwined links is stretched out, which encompasses what we call mathematics in the most general sense of the word. Each one of us, according to profession, disposition or inclination, is placed at a certain point in this chain, from which we usually only have a view of a more or less small part of the whole. Within this part of the whole he arbitrarily draws a boundary and calls what lies to the left of it the 'pure' mathematics, what lies to the right, which mediates the transition to practical life, the 'applied' mathematics." (Mises 1921a, 2)*

Perhaps to the surprise of the publisher of ZAMM, the Association of German Engineers (VdI), von Mises uses the term "scientific engineer" in a very broad sense:

> *"It goes without saying that we seek our foundation in the present, taking the position of the scientific engineer … This word should be understood here further than in its usual meaning to include all those who carry out a practical profession at the level of available scientific knowledge. The economist, the actuary, the doctor are all 'engineers' in this sense." (3)*

Von Mises then explains that "mechanics in the broadest sense" is today almost exclusively developed by engineers and is at the same time (compared to thermodynamics, electrical engineering, probability theory and statistics) the largest field of application. This is the reason for the separate mention of "mechanics" in the title of the journal.

Point **2 "Inner characterization"** of his keynote article begins von Mises with a tribute to the Göttingen mathematician Felix Klein, who "like no other has contributed to the recognition of the engineer's point of view within mathematics and mathematics within culture as a whole". (3) In the course of his article von Mises repeatedly uses Klein's tentative and mainly methodological classification of mathematics into "precision and approximation mathematics" (Präzisions – und Approximationsmathematik), which was originally proposed by Karl Heun (see him mentioned in section 2). He insists, however, on "simplification and idealization" by the precise terms of mathematics, which in his opinion "the engineer can do without even less [than other users of mathematics], because he can only use a limited amount of his strength and time for mathematical studies". (3)

Von Mises continues by commenting on the value of graphical methods:

> *"Another characteristic trait of engineering mathematics, which is often emphasized by those who went through the drawing lessons of a technical university, is the preference for graphical methods over analytical ones." (4)*

Von Mises immediately warns against a one-sided interpretation of this alleged "preference": "Many right and wrong things have been said in favor of the 'language of the engineer'". He continues, however, with a somewhat surprising statement:

> *"Graphical computing [graphisches Rechnen] can adapt to anything [all dem gerecht werden][27] numerical computing can do.". (4)*

This is in line with Ludwig Bieberbach's report on "textbooks for practical analysis" in the same first issue of ZAMM, in which he talks about the dominance of graphical methods (ZAMM 1921: 61–67). The remarks of von Mises and von Bieberbach, his well-known colleague of a "purer" Berlin mathematics, with whom he frequently collaborated on applied questions, are worthy of comment. Only three years later E.T. Whittaker and G. Robinson wrote in the preface to their influential book *Calculus of Observations. A Treatise on Numerical Mathematics* of 1924:

> *"One feature which perhaps calls for a word of explanation is the prominence given to arithmetical, as distinguished from graphical, methods. When the Edinburgh Laboratory was established in 1913, a trial was made, as far as possible, of every method which had been proposed for the solution of the problems under consideration, and many of these methods were graphical. During the ten years which have elapsed since then, the graphical methods have almost all been abandoned, as their inferiority has become evident, and at the present time the work of the Laboratory is almost exclusively arithmetical.*

[27] However, von Mises does not seem to be talking about equal performance, let alone equal accuracy of graphical and numerical calculation (computing).

> *A rough sketch on squared paper is often useful, but (except in Descriptive Geometry) graphical work performed carefully with instruments on a drawing-board is generally less rapid and less accurate than the arithmetical solution of the same problem." (Whittaker, Robinson 1924, p.vi)*

Whittaker and Robinson mention in their book – based on information from the Russian A.N. Krylov – for the first time J.C. Adams' multi-step method of 1857 for the numerical solution of ordinary differential equations (Tournès 1998, 66). This method had been published in England in 1883 but had escaped the attention of mathematicians. Thus, it was obviously the rudimentary state of the development of numerical algorithms – apart from certain standard methods such as the one-step method of Runge-Kutta-Heun from around 1900 – that was partly responsible for von Mises' somewhat surprising statement. At the same time, von Mises' remark seems to have been an expression of the lack of sufficient instruments for calculating in the pre-computer age,[28] combined with a certain personal preference for geometric methods in applied mathematics. Indeed, von Mises printed a number of works on graphical methods during his time as editor for ZAMM, in particular a comprehensive four-part report by Alexander Fischer on nomography (ZAMM 7:211–227, 7:383–408, 8: 309–335, 9: 402–419).

Later on von Mises himself apparently changed his opinion on numerical methods or was influenced by the general trends. In 1930 he published in ZAMM "On the numerical integration of differential equations" where he writes at the beginning:

> *"By far the most convenient method for the calculation of the integral of an ordinary differential equation is the procedure of continued extrapolation which apparently[29] has been published first by J. C. Adams in 1883 … we give here an estimation of the error limits." (Mises 1930, 81)*

In one of his last publications in ZAMM, a "short communication" of 1933 titled "On mechanical quadrature" (Mises 1933), one can find one of the first approaches to what is today known as "optimal algorithms for numerical integration".[30]

Anyway, von Mises certainly did not undervalue the importance of analytic tools in applied mathematics, as already mentioned in connection with the Frank-Mises-handbook.

Von Mises continued his "Tasks and Goals" of 1921 by stressing that in applied mathematics the solution of problems takes precedence over the refinement of methods and theories. In this context he quoted "the successful founder of technical physics", the Scottish engineer J.M. Rankine (1820–1872):

> *"The question for the engineer is this: What do I have to do? And he must make a decision immediately. The question for the mathematician is: How should I think? And he can allow himself unlimited time." (5)*

In **"3. Problems from Analysis"** von Mises emphasizes that many problems of applied mathematics are "inverse" (Umkehrprobleme) and that even for systems of linear equations no sufficient general method has yet been developed. He considers it necessary to explain that the methods of "practical" mathematics are as "general" as those of pure mathematics and that they differ only in their outward appearance. He discusses this in the context of the "practical integration" of equations and says:

> *"Only when this observation (which was certainly still current with older mathematicians such as Euler or Cauchy) becomes generally known to mathematicians again, can we expect more support for this branch of practical mathematics." (6)*

Again in terms of the close connection between pure and applied mathematics von Mises then says:

> *"One very fertile idea for applications is that of 'successive approximation' or 'approximating sequences,' that emerged originally from the theoretical field (to the advancement of so-called proofs of existence)." (7)*

[28] Von Mises reported repeatedly about the insufficient equipment of his institute in Berlin with instruments for calculation (Bernhardt 1980, 25).

[29] Von Mises refers here to a talk given by Krylov on the international applied mechanics congress Delft 1924, which he himself attended. He seems not aware that the Adams method originally dates back to 1857.

[30] Kind personal communication by Erich Novak (Jena) in an email 10 July 2016.

Von Mises connects this to the calculation of eigenvalues and predicts that successive approximations could possibly to solve finite "systems of linear equations with very many unknowns."[31]

He also emphasizes boundary value problems and their solution in the form of a variational problem, as with the Ritz method, which in his opinion, like the integral equation approach, has a somewhat limited scope compared with the "always applicable method of finite differences." (7)

In point **4. "Geometrical questions"** von Mises emphasizes once again Felix Klein's contribution, in particular his "Erlangen program" of 1872 for classifying various geometries whose properties remain invariant under specific groups of transformations. In particular, von Mises distinguishes metrical, projective and topological properties of geometries, commenting on applications in geodesy (metrical properties), descriptive geometry (projective properties), and – "with all necessary caution" as to possible future applications – on metallurgic technology of founding/casting (for topological properties). With respect to geodesy von Mises deplores its growing isolation from applied mathematics "which in the long run is never advantageous."(8) On descriptive geometry – which from the times of Gaspard Monge around 1800 had been a central field of teaching at technical schools – von Mises says that projective geometry (through V. Poncelet) "has heavily alienated the field [descriptive geometry] from its original objectives, through its all-too-theoretical approach." (8) However, von Mises finds that recent cuts in geometrical teaching have gone over the top and he hopes for a revitalization of this important part of the scientific foundations of technology.

In order to achieve this revitalization, von Mises hoped to considerably expand geometry towards the basics of mechanics (vectors, tensors, rotor, etc.) and "graphical computing" (graphisches Rechnen). In the latter context von Mises emphasizes the newly developed nomography (see above), especially by the Frenchman M. d'Ocagne, although "almost all the main problems of it are still unsolved." (9)

In **5. "The field of mechanical problems"** von Mises again refers to the central position of mechanics within ZAMM which – according to von Mises – would make it impossible to touch even cursorily on all important questions in this introductory essay. Von Mises divides the mechanical problems in three major areas, Newton's classical mechanics of free points (Mechanik der freien Punkte), mechanics of constrained point systems (Mechanik der gebundenen Punktsysteme), also named "mechanics of finitely many degrees of freedom," developed by Euler, Lagrange and others, and, thirdly, continuum mechanics (mechanics of "stetig deformierbare Körper"), based on Cauchy's new notion of a force (tension), which is distributed over planes. Von Mises doubts that the construction of mechanics by this tripartite structure was complete "in view of the failure so far of hydromechanics vis-à-vis the most common phenomena of motion" (10). Von Mises, the author of an influential article on the theory of machines in Felix Klein's encyclopedia, which he quotes in a footnote, then complains that the possibilities of Lagrangian "system mechanics" (Systemmechanik) in civil engineering still remain unused despite the efforts of engineers "with systematic-theoretical interests" such as the German Christian Otto Mohr (1835–1918).

According to von Mises, Euler and Cauchy's general concept of stress treated the linear theory of elastic bodies with sufficient precision. The continuing misunderstanding between mathematicians and engineers, however, led to the parallel development of "technical mechanics … which is largely opposed to the theory of elasticity and has replaced the correct starting point by supposed 'approximation theories'" (11). Von Mises specifies that he does not include building (or structural) mechanics (Baumechanik) in a narrower sense under this criticism. In any case, elasticity can only be assumed within narrow limits of stress. The theory of plasticity, which owes much to the "intuitive formulations" (anschauliche Formulierungen) of Saint-Venant and Mohr, has –according to von Mises – only recently led to explicit applications for specific problems. Von Mises refers in this context to a work by Ludwig Prandtl from the year before (1920). Although he mentions his own work (Mises 1913) in a footnote, he seems to underestimate its future practical importance (see section 2 above). In any case, von Mises finds in 1921 that a general theory of plasticity would have to cover phenomena such as Strain hardening (Verfestigung), which should be treated in hereditary mechanics (Gedächtnis-Mechanik), as the Italian mathematician Vito Volterra, among others, suggested in 1914. Von Mises mentions as a further proposal with great potential the book by the brothers E. and F. Cosserat on the theory of deformable bodies (Paris 1909). For the time being, however, and since "today's physics is not very interested in these problems" (11), the most important task of the engineer working on the further development of mechanics should be the collection of observational data.

In contrast to the theory of elasticity, in hydrodynamics "even for the most important and apparently simplest cases, such as that of the uniform flow of water in a straight pipe, there is still no clue (approach) that leads to conclusions that agree with the observations to an acceptable degree". (11/12) Von Mises mentions the two prevailing theories of "ideal" and "viscous"

[31] Von Mises would elaborate on this in his lectures on numerical mathematics on which he published a report in ZAMM (Mises, with H. Pollaczek-Geiringer 1929).

fluids, but expresses doubts about the general applicability of the latter, the refined theory, and thus also of the Navier-Stokes equations:

> *"Therefore, according to the current state of theory, it must be left open whether the approach based on viscous liquids – with sufficient mathematical sophistication – can provide an explanation of turbulence, e.g. taking wall roughness as a limiting condition [Grenzbedingung]. Otherwise, it should be considered whether the solution can be achieved by breaking the framework of classical mechanics and moving to a statistical approach. In view of the astonishing success that physical statistics has achieved in recent years, one might be inclined to the latter opinion.". (12)*[32]

With the last remark von Mises refers to his primary subject area of mathematics, probability theory and statistics, which in his opinion, however, cannot be a main topic for ZAMM due to the underdeveloped state of mechanical theories. Rather von Mises delegates it to **6. Other Problems. Conclusion**, which is the last section of his "Tasks and Goals".

There von Mises puts mathematical statistics first, but primarily for its applications in population theory, actuarial sciences and physical statistics (physikalische Statistik). In von Mises' opinion, the lack of discussion of the fundamentals of probability theory and a lack of solutions to individual problems leads to the conclusion that "most of physical statistics makes a highly unsatisfactory impression on the logical thinker and causes the greatest reservations among everyone – physicists and mathematicians alike". (13)

Von Mises sees the development of technical thermodynamics as the second major topic to be summarized under "other problems", which is neither dealt with in "pure" (reinen) physics (not in its theoretical, and not in its experimental part) nor is it covered by the current state of "technical physics". The latter – according to von Mises – has not yet proven its ability to build machines and is still limited mainly to inner-physical applications (carrying out experiments) and special fields of technology, such as apparatus engineering and the construction of electron tubes.

With regard to the third field of "other problems", electricity, von Mises emphasizes those fields which lead to differential equations which can then be solved with the approximate methods of applied mathematics:

> *"In this way, 'practical analysis' wraps a single band around all the problems that lead to the systems of partial differential equations as we know them in their simplest form, that of the ordinary [gewöhnlichen] potential equation. We believe that it can lead to the further development of all the areas touched by these problems if we create an opportunity to study the common aspects of the different phenomena, which is contrary to the – in itself useful – specialization." (14)*

Von Mises' concluding remarks in his editorial reiterate the relative and incomplete state of the field of "applied mathematics" and the dominance of the practical need that led to its cultivation. He admits:

> *"Surely it would be more elegant and aesthetically pleasing if we did not consider it necessary to collect what lies between the subjects of the mathematician, the physicist, and the engineer/technician and is not dealt with by any of them." (14)*

With reference to the effects of the recent world war, alluding to the many threats to the future of humanity, and claiming that applied mathematics is still underestimated, von Mises finds words which today, almost a century later, do not sound unknown or irrelevant to us:

> *"Surely we do not want to overestimate the intrinsic importance of our task if we look at it from a far-sighted historical perspective. But when we try to create a concrete external framework*[33] *for the work initiated by eminent and insightful men in recent decades, we act in the knowledge that we are doing something that is neither useless nor trivial, and that we are also doing something that exceeds the powers not only of the individual but also of a single generation. Just as the master builders of the Middle Ages began their constructions without worrying that they would not be able to finish them, so we too believe that despite the tremendous upheavals of our time, despite*

[32] Von Mises alludes here to a possible statistical approach to the turbulence problem, which should not receive much attention in ZAMM. When this approach was developed more systematically by others in the 1930s (G.Taylor and A.N. Kolmogorov), von Mises did not participate. (Siegmund-Schultze 2018, 504–508).

[33] By "concrete external framework" (festen äußeren Rahmen) von Mises obviously means his new journal ZAMM.

all the developments that threaten the future of our civilization, there will always be forces that will continue what has been started in one form or another as long as it is necessary. But to those who look down on us with suspicion or contempt from a world of 'purer' research, we invoke the words that an ancient tradition attributes to Heraclitus of Ephesus: 'Entroite, nam et hic dii sunt; enter, for gods live here too'." (14/15)

5 | GLIMPSES OF VON MISES' EDITORIAL POLICIES IN ZAMM,[34] IN PARTICULAR CONFLICTS BETWEEN THE GÖTTINGEN AND THE BERLIN SCHOOLS, AND INTERNATIONALISM

With regard to editorial principles in the narrower and formal sense, the classification of articles etc., von Mises largely followed his own "program" of 1920 (Appendix A). Von Mises was "editor" (Herausgeber), and for the entire period (1921–1933) he had the following six co-workers ("unter Mitwirkung"): L. Föppl (Munich), G. Hamel (Berlin), R. Mollier (Dresden), L. Prandtl (Göttingen), H. Reissner (Berlin) and R. Rüdenberg (Berlin). In 1929 Th.v.Kármán (Aachen) joined this "scientific commission", as von Mises called it in his "program" (Figure 5).


ZEITSCHRIFT FÜR ANGEWANDTE MATHEMATIK UND MECHANIK

INGENIEURWISSENSCHAFTLICHE FORSCHUNGSARBEITEN

HERAUSGEGEBEN VON PROFESSOR R. VON MISES, BERLIN

Unter Mitwirkung von L. FÖPPL-München, G. HAMEL-Charlottenburg, Th. v. KÁRMÁN-Aachen, R. MOLLIER-Dresden, L. PRANDTL-Göttingen, H. REISSNER-Charlottenburg, R. RÜDENBERG-Berlin

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V·D·I-VERLAG G. M. B. H., BERLIN NW 7
1929

FIGURE 5 Title page ZAMM from 1929 showing the scientific commission supporting von Mises ("Unter Mitwirkung von") with von Kármán being a new member

[34] This topic would need a much more detailed elaboration, particularly connected to the scientific content of publications in ZAMM under von Mises' editorship from 1921 to 1933. For some more details see (Siegmund-Schultze 2018).

There is – to my knowledge – no special archive that documents the editorial work for ZAMM. All material that I have used beyond the journal itself comes from preserved individual correspondence, especially from the estates of von Mises and Prandtl. There is no indication in the correspondence that anything like a formal "reviewing process" in the modern sense has taken place at the ZAMM. In principle, von Mises personally decided on the acceptance; however, there is no indication in the files that von Mises rejected manuscripts that were sent to him with the support of a member of the "scientific commission". One occasionally finds in the correspondence that von Mises corrected the style of the authors. Several articles have a first footnote with editorial comments. There are examples in the correspondence of advice given by von Mises that were followed or not followed by the author.

There is little doubt that von Mises' position as editor-in-chief in a historical period very different from ours gave him direct and indirect opportunities to promote his own mathematical, technical, philosophical and political agendas. "Direct" proactive influence by editors was probably more common in the 1920s than it is today. However, given the rules of the journal ZAMM, as proposed in von Mises' 1920 "Program", one cannot easily speak of "abuse" in the case of von Mises, even if he actively promoted his cause in book reviews and comments on competing schools (see below) or if his collaborators, especially Hilda Geiringer, supported his controversial paradigm in probability theory. However, one may find it somewhat in bad taste that von Mises chose his article "On the present crisis of mechanics" (Mises 1921c) as the leading article in the December 1921 issue, because this article – in contrast to von Mises' "Tasks and Goals" from the same year 1921 – had little to do with engineering mechanics, but was much more concerned with the foundations of physics. But, as already mentioned, von Mises was an individual with many nuances and interests, and the article on crisis, a reprint of which appeared in *Die Naturwissenschaften* a year later, was important to him as a testimony to his statistical worldview. His friend, the physicist Philip Frank, was later to write, in a book about the limits of causality published in 1932:

> *"Richard von Mises was perhaps the first to point out in his lecture 'On the present crisis of mechanics' that there are also in the field of mechanics in the narrower sense observable processes in liquid and solid bodies which cannot be easily represented with the help of causal laws." (Frank 1998, 72)*

As far as von Mises' editorial principles in general are concerned, his strong commitment to international visibility and dissemination, including sales figures, is very evident, for example from editorials and reviews of foreign literature. Numerous articles by foreigners have been published in ZAMM during von Mises' time as editor, almost all of them in German. Among the authors were: The American-Ukrainian S. Timoshenko (1923,1928 and 1933), the Dutchmen C.B. Biezeno (1924) and J.M. Burgers (1930, 1933), the Englishman G. Taylor (1925, 1930, 1933), the Pole M.T. Huber (1926), the Indian K. Bose (1927), the Norwegian V. Bjerknes (1927), the Soviet Russians Nikolai Bernstein (1927, later a famous neurophysiologist) and A. Khinchin (1933), the Swedes C.V. Oseen (1930) and H. Cramér (1933), the Japanese A. Ono (1931), Y. Ikeda and M. Mori (joint article 1931), and K. Sezawa (1932), the Italian T. Levi-Civita (1931), the English-Danish W. Hovgaard (1931), the Soviet-Georgian N. Muschelisvili (1933), the Hungarian L. Fejér (1933) and the French J. Hadamard and M. Fréchet (joint article 1933).

On November 24, 1923, von Mises sent a one-page advertising letter in English to a broad unidentified circle of recipients beginning with the following words:

> *"Dear Sir, I beg to call your attention to the Journal of Applied Mathematics and Mechanics which as far as I am aware is not yet included in your library."*[35]

In an editorial of April 1924, von Mises, who signed anonymously as editor, welcomed the first international congress of applied mechanics organized in Delft (Netherlands) that same month (ZAMM 4: 85). He called ZAMM "the only journal for this field" – obviously worldwide – and said that it was "in this sense international and … addressed to a readership in all countries". There have been several efforts to translate ZAMM completely into English.[36]

It is worth mentioning that von Mises' scientific "internationalism" was not in every respect accompanied by a "political internationalism" on his part. Indeed, two years earlier, in 1922, the former Austrian von Mises had opposed an unofficial

[35] Harvard University Archives, HUG 4574.5, box 2, f. 1921 (!). This seems to be the first appearance of the title of ZAMM in today's English translation.

[36] The professor at MIT, Hunter Rouse, reported to von Mises on 23 April 1932 about unsuccessful negotiations for such an English version. (Harvard University Archives, von Mises Papers, HUG 4574.5. Box 2, folder 1932).

international congress of applied mechanics organized by von Kármán in Innsbruck (Austrian part of Tyrol). Von Mises protested against the participation of Italy, a country that had occupied the southern part of Tyrol as a result of the war. (Siegmund-Schultze 2004, 351) As late as 1928 there were occasional remarks from von Mises' pen in the ZAMM which were directed against the participation of German mathematicians in the International Congress of Mathematicians in Bologna that year. The congress was controversial at the time because some German mathematicians expected apologies for the post-war boycott of German science by Western science organizations. In the same year, 1928, it was discussed that the International Congress of Applied Mechanics planned for 1930 in Stockholm should be moved to Liège in Belgium. Von Mises, Prandtl, Reissner, and Hamel, all on the board of ZAMM, opposed this transfer for similar reasons as von Mises did with regard to Bologna, and Stockholm was finally confirmed.[37]

In addition to internationalism, ZAMM has also repeatedly discussed the allegedly insufficient coverage of experimental work. Most revealing in this respect is von Mises' editorial at the beginning of volume 3 of 1923, where one reads the following self-critical remark:

> *"On one point, the first two volumes did not fulfill the editorial program: The equality of experimental and deductive research has not been sufficiently expressed in the publications so far. The deeper reason lies in the economic conditions that have imposed great restrictions on all places of experimental research in Germany." (ZAMM 3: 1)*

Von Mises added that in order to clarify the general objectives, the journal now had the subtitle "Engineering research" ("Ingenieurwissenschaftliche Forschungsarbeiten"). This subtitle was now actually to appear on the cover for many decades. However, the same 1923 editorial made it clear that the gap between experiment and theory was not only caused by limited economic conditions, which were less noticeable in centers like Göttingen and Aachen anyway. Von Mises admitted this:

> *"Readers have repeatedly complained that many publications are difficult to understand and require mathematical knowledge that the scientifically trained engineer does not have." (ZAMM 3: 2)*

In this context von Mises appealed to his authors for more "clarity and simplicity" in their works. However, the gap between the experimental and the mathematical remained undoubtedly a concern of engineers like Ludwig Prandtl in Göttingen. Prandtl wrote to von Mises on May 16, 1930: "Your journal has basically always been the journal of the theoreticians."[38]

Prandtl's remark, which by the way clearly pointed out that ZAMM was "von Mises' journal" and not Prandtl's, arose in connection with the plan to found another journal within the VDI publishing house, entitled "Technische Mechanik und Thermodynamik" ("Technical Mechanics and Thermodynamics"). The prospective editors of this journal suggested to work more on a "physical-experimental than on a mathematical basis" but did not exclude to accept theoretical contributions.[39] Von Mises' correspondence and diaries show his great concern about this competitor for ZAMM in the same publishing house. He wrote a nine-page statement, dated January 1930, against the project. Interestingly, in this statement he welcomed the new journal "Ingenieur-Archiv" at Springer, because (!) it was aimed at the "same relatively small circle of those who want to contribute productively to the progress of the sciences fundamental to technology."[40] Von Mises said:

> *"The Ingenieur-Archiv obviously has the same goals as ZAMM, it has the same field and aims at the same readership. The Springer-Verlag only draws conclusions from the undeniable fact that scientific production in this field has become so extensive that it justifies a second publication option."*[41]

[37] Prandtl to von Mises, 1 March 1928. (Archives MPG, Prandtl papers, Rep. 61, III. Abt., no. 1079).

[38] „Ihre Zeitschrift ist doch im Wesentlichen immer die Zeitschrift der Theoretiker gewesen." (Archives MPG, Prandtl papers, Rep. 61, III. Abt. no. 1082.)

[39] Two-page memo concerning „Technische Mechanik und Thermodynamik. Monatliche Beihefte zur VDI-Zeitschrift." (Archives MPG, Prandtl papers, Rep. 61, III. Abt. no. 1081).

[40] "verhältnismässig kleinen Kreis derjenigen, die an dem Fortschritt der für die Technik produktiv mitarbeiten wollen." R.von Mises „Stellungnahme zur Neugründung der Monatsschrift Technische Mechanik und Thermodynamik", 9pp, p.3/4. (Archives MPG, Prandtl papers, Rep. 61, III. Abt. no. 1081, 3/4)

[41] Ibid. :„Ganz offenkundig verfolgt das 'Ingenieur-Archiv' die gleichen Ziele wie ZAMM, hat das gleiche Arbeitsgebiet und wendet sich an den gleichen Leserkreis. Der Springersche Verlag zieht nur die Folgerung aus der unleugbaren Tatsache, dass die wissenschaftliche Produktion auf diesem Gebiet umfangreich genug ist, um ein zweites Publikationsorgan zu rechtfertigen." (7/8) The *Ingenieur-Archiv* appears today as *Archive of Applied Mechanics*.

At the same time, von Mises emphasized the peculiar character of his journal, which also contained reviews, reports, etc. and did not exclude experimental work, while the *Ingenieur-Archiv* had "not a single experimental work" (p.7) in its first issue. The "statement" (Stellungnahme) therefore describes better than any other document available to me that the editor of ZAMM pursued the goal of creating a meeting place between engineers and mathematicians in the vicinity of the VDI, not excluding experimental work but nevertheless imposing the standpoint and rigor of mathematics on those engineers who had only a rudimentary mathematical education.[42]

The undeniable differences in the points of view of engineers, experimental physicists and applied mathematicians also had a personal dimension for von Mises. As I have argued elsewhere, the relative lack of experimental facilities in Berlin and particularly at Berlin university compared to those in Göttingen and the resulting stronger theoretical orientation of his work should limit von Mises' recognition as a fluid dynamist throughout his career and also his posthumous reputation. For example, when von Mises published a short note in ZAMM in 1922 (Mises 1922), he had to refer to the Göttingen experimental facilities and to data collected there as confirmation of his two-dimensional wing theory (Siegmund-Schultze 2018, 500).

For his part, and particularly after Runge's death in 1927, von Mises felt that the training of applied mathematicians in a more theoretical sense – which was the main focus of his institute in Berlin – was increasingly neglected in Göttingen. He blamed Göttingen's dual focus on pure mathematics on the one hand and engineering sciences (Prandtl School) on the other.[43] On the pages of ZAMM, especially in short communications and reviews, von Mises published several critical remarks about an alleged "decline" of applied mathematics in Göttingen (Siegmund-Schultze 2018, 503). At one point in 1930 von Mises speaks of "the unfortunate development in Göttingen, where the legacy of Felix Klein is quickly wasted." (ZAMM 10: 104). This also testifies to von Mises' independence as editor and to the marginal position of the official "staff" of the journal ZAMM.

Personal jealousy on the part of von Mises was another reason for his occasional criticism of developments in Göttingen. In his review of volume VII "Mechanics of liquid and gaseous bodies" of the German *Handbuch der Physik* (Handbook of Physics), published in the ZAMM in 1928, von Mises criticized the article by the Göttingen aerodynamicist Albert Betz, Prandtl's deputy at the Kaiser Wilhelm Institute for Fluid Dynamics (founded in 1925), on wings and hydraulic machines. Alluding to the neglect of his own contribution to fluid mechanics (especially turbine and wing theory) von Mises wrote in this article:

> *"One is now accustomed to the fact that original Göttingen papers (not only in mechanics) present everything as if no significant science 'extra Gottingiam' [outside Göttingen] is being pursued." (ZAMM 8: 76/77)*

Ignorance in Göttingen and other engineering centers about some of von Mises' publications was partly associated with reservations about "too much mathematics" in his approach. In fact von Kármán later in 1935 – without mentioning his name – would call von Mises' methods in his two-dimensional wing theory of 1917/20 "a rather elegant presentation of the subject, which explains their popularity, especially with mathematicians". (Siegmund-Schultze 2018, 499). In a discussion on boundary layer theory between Prandtl, (indirectly) von Kármán, and von Mises, which was connected to von Mises' paper "Bemerkungen zur Hydrodynamik" (Mises 1927), the claims were clearly defined in the discussion. An engineer with superior "physical tact" (Prandtl) was opposed by another engineer (von Mises) with superior mathematical training. Von Mises' contribution from 1927 which contains the "von Mises transformation" for boundary layer theory has recently found a renaissance in Computational Fluid Dynamics (Siegmund-Schultze 2018, 510–513).

While von Mises had his battles with engineers and physicists, he also had to be concerned about the recognition of his field among the "pure" mathematicians in his own institution, at the University of Berlin. In 1926/27 the habilitation procedure for his assistant, collaborator at ZAMM and later wife Hilda Geiringer was challenged by his colleagues in Berlin and the teaching permit was restricted to explicitly "applied mathematics", while the pure mathematicians reserved the right to teach about anything mathematical.[44]

[42] This reminds of Heun's letter to von Mises from 1907, quoted about in section 2.

[43] In 1927 *Die Naturwissenschaften* published a dispute between von Mises and Richard Courant, the successor to Klein in Göttingen. Similar criticism by von Mises is in ZAMM 10: 103–104. See also (Siegmund-Schultze 2018, 503).

[44] See (Siegmund-Schultze 1993). Anti-feminist, anti-Semitic and other political motives were involved. Geiringer eventually became an internationally recognized specialist in statistics and plasticity.

FIGURE 6 Hilda Pollaczek-Geiringer (1893–1973), from 1943 married to von Mises. Private possession and courtesy of Geiringer's daughter, Magda Tisza (Boston)

Always insisting on the peculiarities of applied mathematics, von Mises spared his good friend Leon Lichtenstein, now in Leipzig, not a critical review of his "Grundlagen der Hydromechanik". In connection with this review, Lichtenstein's student Ernst Hölder was to write later, in 1972:

> *"In his elegant review, which deeply offended Lichtenstein, von Mises wrote: 'We recognize the value of Lichtenstein's book, although it ends at mechanics as of 1870. But its real value lies in having used mathematics from 1930."*[45]

To sum it up: I have argued elsewhere (Siegmund-Schultze 2018), using fluid dynamics as an example, that von Mises was forced to fight in various directions (engineering, pure mathematics, pure physics, both experimental and theoretical, "technical physics") to establish his concept of "applied mathematics". Traces of this struggle can already be found in von Mises' famous, still untranslated "Tasks and Goals of Applied Mathematics", with which the first issue of ZAMM of February 1921 begins (see previous section 4). This impression is confirmed at various places within ZAMM.

But at the same time there were many common interests between engineers and applied mathematicians. They found that their common field of interest was connected to classical mechanics in a different way than the theories of modern physics, which were more visible to the public. This can perhaps best be seen from the foreword to the April 1933 issue of the journal, which was dedicated to the fiftieth birthday of von Mises. At a time when von Mises might still have hoped to stay in Germany, his colleagues from the VDI, the GAMM (Prandtl) and the editorial staff of the ZAMM (Hans Reissner) signed the preface and said, among other things:

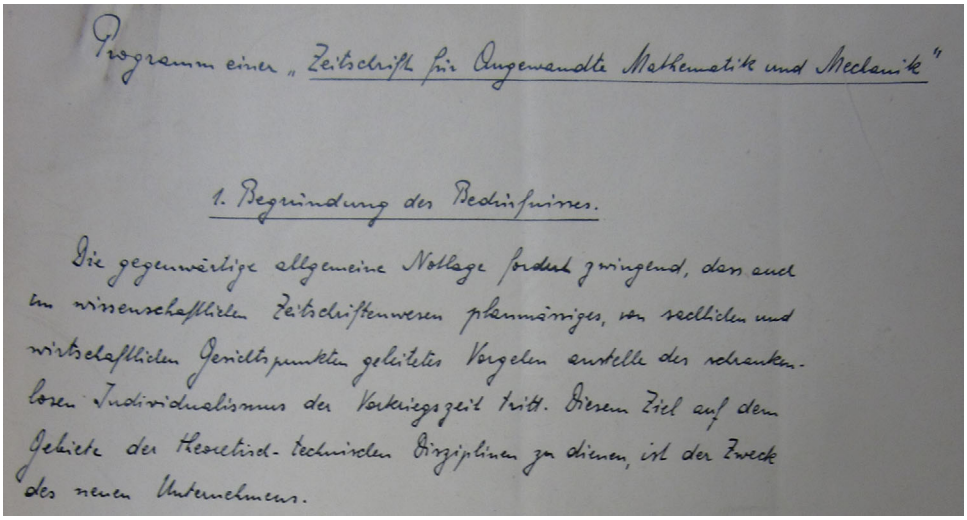
> *"This issue shows that applied mathematics and mechanics work on less virgin soil than, say, the theories of atoms and relativity in neighboring fields. They do not have as strong a public appeal as these revolutionary [umstürzende] theories. But the issue also shows that a calmer, yet international [weltumspannende] scientific community is also advancing on this classical ground, achieving and communicating new important results and possibilities". (ZAMM 13: 65)*

On a more personal level, the ambivalent relationship of Richard von Mises to the engineers cooperating with ZAMM was perhaps best described by his widow, who wrote in 1959, six years after von Mises' death in American exile:

> *"He said that he knew that he had not as much scientific (mechanics) influence as Kármán and Prandtl. He thought very highly of both of them, particularly Prandtl. Kármán was a lifelong friend. He spoke of Prandtl's sleepwalking instinct for mechanics. He had a theory that a certain amount of 'Verworrenheit' [confusion] (Prandtl) was*

[45] Quoted from the translation in (Siegmund-Schultze 2018, 481). Von Mises' review was of L. Lichtenstein's "Grundlagen der Hydromechanik" of 1928 (ZAMM 9: 516/17).

attractive. He said 'Ich bin zu klar.' [I am too clear] On the other hand, he had almost contempt for the 'activity' in Göttingen, the conscious effort to quote each other, etc." (Siegmund-Schultze 2004, 364)


Programm einer „Zeitschrift für Angewandte Mathematik und Mechanik"

1. Begründung des Bedürfnisses.

Die gegenwärtige allgemeine Notlage fordert zwingend, dass auch im wissenschaftlichen Zeitschriftenwesen planmässiges, von sachlichen und wirtschaftlichen Gesichtspunkten geleitetes Vorgehen anstelle des schrankenlosen Individualismus der Vorkriegszeit tritt. Diesem Ziel auf dem Gebiete der theoretisch-technischen Disziplinen zu dienen, ist der Zweck des neuen Unternehmens.

FIGURE 7 Handwritten excerpt from von Mises' "Program of a "Journal of Applied Mathematics and Mechanics". Courtesy Harvard University Archives

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APPENDIX A

Richard von Mises:
Program of a “Journal of Applied Mathematics and Mechanics”[46]

1. Justification of the need

The current general emergency situation makes it imperative that in scientific journals, too, a planned approach guided by objective and economic considerations should replace the unbridled individualism of the pre-war period. The purpose of the new enterprise is to serve this goal in the field of theoretical-technical disciplines.

Scientific work, which belongs to the area under consideration here (see point 2 below), has so far partly been published in Teubner’s “Journal of Mathematics and Physics” (occasionally also in “Archive of Mathematics and Physics”), but mainly they were scattered in the leading technical journals, especially in the Journal of the Association of German engineers, the Journal of Aviation Technology and Motorflight, the Journal of All Aspects of Turbines, etc.. The two Teubner journals mentioned above have been terminated during the war. The technical journals are increasingly forced to reject contributions of a purely scientific kind due to lack of paper and due to high production costs. They rightly base their decision on the opinion that in view of the comparatively very small readership for such works their distribution in high editions cannot be justified economically.

The present situation is therefore the following. Technical-scientific works do not find opportunities for publication in Germany. In addition, the extraordinary high prices of foreign journals hinder their broad distribution in Germany. What dangers these two circumstances imply for the future of German technology does not need further explanation here.

The new journal is intended to collect all relevant German works and all the essentials of foreign literature and to supply them in the shortest possible form directly to the scientific circles interested in them. The aim stated at the beginning of this article is to be achieved by extracting and combining all the material written for a specific, narrow circle of readers, by an

[46] HUG 4574.5. box 28 “Holograph Manuscripts. Man. Div.” Handwritten draft unsigned, 6pp. Emphasis from the original. Translated by Reinhard Siegmund-Schultze. The German original is printed below.

economically reasonable [important?] way of disseminating the results of foreign research, by a thoughtful connection between the various productive forces in the individual disciplines, and finally by the gradual development of a concise style suitable for such publications – for example following the English model.

2. Subject area and title of the journal

First of all, the journal should take into account all parts of applied mathematics, especially general and technical mechanics, elasticity and strength, hydraulics, aeronautics, problems of machine theory; then also descriptive geometry, graphical and numerical methods, probability theory and statistics. The extent to which works from the fields of structural analysis [Baustatik], electrical engineering and other parts of technical physics will be considered will depend on possible agreements with the organizations or editorial offices under consideration here. In any case, scientific content is considered an essential condition for acceptance, which characterizes the contribution as a research result, whereby experimental investigations can be given equal status alongside purely deductive ones.

It will be hard to find a title for the journal that would briefly describe all the areas mentioned here. The one used above, which is certainly not flawless, has been chosen in accordance with the language in use today and could be subject to change if necessary.

3. Type of content, editing

In contrast to most purely scientific journals, only about half of the content of the new journal will consist of original papers in the narrower sense. However, the aspect of scientific novelty would be strictly adhered to, in contrast to the majority of purely scientific journals, so that articles with a more reporting character, which serve the further education of the reader or the dissemination of things already known, would be excluded. The remaining content would be reserved for reports, which would have to be tightly managed by the editorial staff. They would have to contain summary reports on the individual research areas to be chosen by the editors, detailed and systematically selected reports on all relevant foreign literature, reports from German journals in neighboring areas and finally book reviews.

From the very beginning, the editors will pay the greatest attention to the style of all contributions. The editors will attempt to create a sufficiently concise, comprehensible and clear style, which is more necessary for scientific work in Germany today than ever before.

Under these circumstances, the editorial staff or the editors of the new journal must have a larger scope of activity and a greater workload than is otherwise the case with scientific journals. This should be achieved by the publisher by providing the external aids, such as setting up the management, obtaining copies of articles and books to be reviewed, etc.

4. Scope, appearance, edition

The sum of the annual contributions is estimated to be initially 30 printed sheets [47] of Royal Octavo. The format similar to the current Research Contributions [Forschungshefte] of the Association of German Engineers. Printing should be in one column for the original contributions and longer reports, in two columns for smaller reviews and communications.

Ideally, an issue of 5 sheets would be published every two months (with fixed publication dates). Each issue would contain about half original articles, half reports, etc.

A final decision on the number of copies to be produced would have to be taken as soon as the discussions with the various organizations were completed. From the outset one can expect about 1000 copies.

Of the larger original articles, a small number, about 100 to 200, could also be produced as offprints for sales purposes.

This provides a certain amount of propaganda for the journal, while avoiding a reduction in the number of subscribers, since the value of the complete issues lies in the reviews.

5. Management, Financial

As can be seen from the foregoing, the management of the journal will, at least in the initial period, be burdened with a not inconsiderable amount of work. For the purely business matters, the publisher would have to provide the external framework for the execution, everything else would be united in the hands of the editor, who can call in appropriate younger auxiliary staff. In addition, a scientific committee would have to be formed from among the more renowned coworkers, which would have certain powers with regard to the factual content and would also have to fulfil the role of a supervisory board.

[47] One printed sheet comprises 16 pages, eight on the front and eight on the back.

As far as the costs[48] for the literary content is concerned, an average fee of 200 Marks per printed sheet for the author or reviewer and half of this for the work of the editorial staff (including the remuneration of the assistants) can be assumed, i.e. a total of 9000 Marks for 30 printed sheets per year. It must be assumed that the publishing house initially has no profit motives and, if possible, does not charge the young enterprise for the costs of management. With a production price of 1200 M for the printed sheet for a circulation of 1000 copies intended for sale, an annual amount of 36 000 plus 9 000, i.e. 45 000 M, would thus be required.

Under all circumstances, an effort must be made to bring in a considerable part of these costs through advertisements. If the publishing house succeeds in placing about ten pages of advertisements for each issue through planned and energetic advertising work, so that a surplus of about 25,000 M is generated from the advertising business, the costs for the annual copy would only amount to about 20 M for the publishing house. But even with a publishing price of 30 M, or a little more, a sales volume of 1000 copies would – in view of the current level of all book prices – probably be possible and to be expected, if only the program described above is seriously carried out and the realization of its great benefit for the further development of German technology, yes, the indispensability of the whole enterprise, is brought to the attention of the relevant circles.

German original of von Mises' "program":
Programm einer „Zeitschrift für Angewandte Mathematik und Mechanik"[49]

1. Begründung des Bedürfnisses.

Die gegenwärtige allgemeine Notlage fordert zwingend, dass auch im wissenschaftlichen Zeitschriftenwesen planmässiges, von sachlichen und wirtschaftlichen Gesichtspunkten geleitetes Vorgehen anstelle des schrankenlosen Individualismus der Vorkriegszeit tritt. Diesem Ziel auf dem Gebiete der theoretisch-technischen Disziplinen zu dienen, ist der Zweck des neuen Unternehmens.

Wissenschaftliche Arbeiten, die dem hier inbetracht kommenden Stoffbereich angehören (s.u. Pkt. 2), wurden bisher teils in der Teubnerschen „Zeitsch. f. Mathematik u. Physik" (hie und da auch im „Archiv der Mathem. u. Phys.") veröffentlicht, hauptsächlich aber waren sie in den führenden technischen Zeitschriften verstreut, vor allem in der Zeitsch. d. Ver. Deutscher Ingenieure, in der Zeitsch. f. Flugtechnik und Motorluftschiffahrt, Zeitsch. f.d. ges.[samte] Turbinenwesen usf. Die erwähnten beiden Teubnerschen Zeitschriften sind während des Krieges eingegangen, die technischen Zeitschriften sehen sich übereinstimmend angesichts der Papierknappheit und der hohen Herstellungskosten genötigt, Aufsätze rein wissenschaftlicher Richtung mehr und mehr abzulehnen. Sie stützen sich mit Recht auf die Auffassung, dass der verhältnismässig sehr kleine Leserkreis, an den sich derartige Arbeiten wenden, eine Verbreitung in so hoher Auflage wirtschaftlich nicht rechtfertigt.

Der augenblickliche Zustand ist also der, dass die technisch-wissenschaftliche Produktion in Deutschland keine Möglichkeit der Veröffentlichung [1] findet. Dazu kommt, dass die ausserordentlich hohen Preise der ausländischen Zeitschriften ihrer grösseren Verbreitung in Deutschland hindernd im Wege stehen. Welche Gefahren diese beiden Umstände für die Zukunft der deutschen Technik in sich schliessen, braucht nicht näher ausgeführt zu werden.

Die neue Zeitschrift soll alle einschlägigen deutschen Arbeiten und alles Wesentliche aus der ausländischen Litteratur [sic] zusammenfassen und in knappster Form den hieran interessierten, wissenschaftlich arbeitenden Kreisen unmittelbar zuführen. Durch dieses Herausziehen und Vereinigen des ganzen für einen bestimmten engeren Leserkreis geschriebenen Stoffes, durch diese wirtschaftlich richtige [wichtige?] Form der Verbreitung ausländischer Forschungsergebnisse, durch ein verständiges Aneinanderschliessen der verschiedenen, in den einzelnen Fachrichtungen produktiven Kräfte, endlich durch die allmähliche Ausbildung eines für derartige Veröffentlichungen geeigneten konzisen Stils – etwa nach englischem Vorbild – soll das eingangs ausgesprochene Ziel erreicht werden.

2. Stoffgebiet und Titel der Zeitschrift

Zunächst sollen in der Zeitschrift berücksichtigt werden: Alle Teile der Angewandten Mathematik, insbesondere allgemeine und technische Mechanik, Elastizität und Festigkeit, Hydraulik, Flugtechnik, Probleme der Maschinenlehre; dann auch Darstellende Geometrie, graphische und numerische Methoden, Wahrscheinlichkeitsrechnung und Statistik. Wie weit auch Arbeiten aus dem Gebiet der Baustatik, der Elektrotechnik und anderer Teile der technischen Physik Berücksichtigung finden sollen, wird von

[48] The purchasing power of the German mark M in 1920 was about the same as today, when setting 1 Mark = 0.5 Euro. The devaluation of the German mark would however set in soon with the hyperinflation being on its peak in 1923.

[49] HUG 4574.5. box 28 "Holograph Manuscripts. Man. Div." Handwritten draft unsigned, 6pp. Orthography and emphasis follows the German original, [x] marks page turn from number x to (x+1).

etwaigen Verabredungen mit den hier inbetracht kommenden [2] Organisationen bezw. Redaktionen abhängen. Als wesentliche Bedingung für die Aufnahme gilt jedenfalls wissenschaftlicher Inhalt, der den Beitrag als Forschungsergebnis kennzeichnet, wobei experimentelle Untersuchungen neben rein deduktiven gleichberechtigt Platz finden können.

Ein Titel für die Zeitschrift, der alle hier angeführten Gebiete kurz kennzeichnen würde, wird sich kaum finden lassen. Der oben verwendete, gewiss nicht einwandfreie, ist im Anschluss an den heute eingebürgerten Sprachgebrauch gewählt worden und könnte gegebenenfalls noch einer Änderung unterzogen werden.

3. Art des Inhaltes, Redaktion

Im Gegensatz zu der Mehrzahl der rein wissenschaftlichen Zeitschriften soll nur etwa die Hälfte des Inhaltes der neuen Zeitschrift aus Original-Arbeiten im engeren Sinne bestehen. Bei diesen würde allerdings – dies wieder im Gegensatz zu den meisten technischen Zeitschriften – der Gesichtspunkt der wissenschaftlichen Neuheit auf das strengste gewahrt werden, sodass Aufsätze mehr unterrichtender Art, die einer Fortbildung des Lesers oder einer Verbreitung an sich schon bekannter Dinge dienen, ausgeschlossen bleiben. Der übrige Teil des Inhalts würde einer von der Redaktion straff geleiteten Berichterstattung vorbehalten bleiben, die zu enthalten hätte: Zusammenfassende Berichte über den Stand einzelner Forschungsgebiete nach Auswahl der Redaktion, ausführliche und planmässig nach einheitlichen Gesichtspunkten geleitete Referate der ganzen einschlägigen Auslands-Literatur, Referate aus deutschen Zeitschriften der Nachbargebiete, endlich Buchkritiken [3].

Der stilistischen Fassung aller Beiträge wird die Redaktion von allem Anfang an die grösste Aufmerksamkeit zuwenden. Sie wird versuchen, auf die Bildung eines hinreichend knappen, verständlichen und übersichtlichen Stiles hinzuwirken, der den wissenschaftlichen Arbeiten in Deutschland heute mehr nottut als jemals.

Unter diesen Verhältnissen muss der Redaktion, bezw. den Herausgebern der neuen Zeitschrift, ein grösserer Wirkungskreis und grössere Arbeitslast zufallen als dies sonst bei wissenschaftlichen Zeitschriften der Fall ist. Dem hätte der Verlag durch Bereitstellung der äusseren Hilfsmittel, wie Einrichtung der Geschäftsführung, Beschaffung von Rezensions- bezw. Referats-Exemplaren usf. Rechnung zu tragen.

4. Umfang, Erscheinungsform, Auflage

Als Grundausmass der jährlich herauszugebenden Beiträge wird zunächst etwa 30 Bogen Gross-Oktav anzunehmen sein. Format etwa wie die jetzigen „Forschungshefte“ des Vereins deutscher Ingenieure. Satz einspaltig für die Originalbeiträge und längeren Berichte, zweispaltig für die kleineren Referate und Mitteilungen.

Zweckmässigerweise würde alle zwei Monate (mit festen Erscheinungsdaten) ein Heft von 5 Bogen ausgegeben werden. Jedes Heft hätte etwa zur Hälfte Originalaufsätze, zur Hälfte Berichte usf. zu enthalten.

Über die Höhe der herzustellenden Auflage müsste man endgültig entscheiden, sobald die Besprechungen mit den verschiedenen Organisationen abgeschlossen sind. Von vornherein wird man etwa mit 1000 Stück rechnen können.

Von den grösseren Originalaufsätzen könnte auch eine geringe Zahl, etwa 100 bis 200, von Sonderdrucken für Verkaufszwecke hergestellt werden [4].

Damit wird eine gewisse Propaganda für die Zeitschrift betrieben, während eine Beeinträchtigung der Abonnentenzahl dadurch vermieden bleibt, dass der Wert der vollständigen Hefte in den Referaten begründet ist.

5. Geschäftsführung, Finanzielles

Wie aus dem Vorstehenden hervorgeht, wird der Leitung der Zeitschrift, wenigstens in der ersten Zeit, ein nicht unbeträchtlicher Arbeitsaufwand aufgebürdet. Für die rein geschäftlichen Angelegenheiten müsste der Verlag den äusseren Rahmen für die Erledigung abgeben, alles andere würde in der Hand des Herausgebers vereinigt, der entsprechende jüngere Hilfskräfte heranziehen kann. Daneben wäre aus dem Kreise der namhafteren Mitarbeiter ein wissenschaftlicher Ausschuss zu bilden, dem gewisse Befugnisse hinsichtlich des sachlichen Inhaltes zustehen und der im übrigen etwa die Rolle eines Aufsichtsrates zu erfüllen hätte.

An Geldaufwand für den literarischen Inhalt kann ein Honorarsatz von durchschnittlich 200 Mark pro Bogen für den Autor bezw. Referenten und die Hälfte davon für die Arbeit der Redaktion (einschl. Entlohnung der Hilfskräfte) angenommen werden, also insgesamt 9000 M für 30 Bogen im Jahr. Es muss vorausgesetzt werden, dass der Verlag zunächst keine Gewinnabsichten verfolgt und auch nach Möglichkeit die Kosten der Geschäftsführung dem jungen Unternehmen nicht anrechnet. Bei einem Herstellungspreis von 1200 M für den Druckbogen bei einer Auflage von 1000 verkäuflichen Exemplaren wäre somit ein jährlicher Betrag von 36 000 plus 9000 gleich 45 000 M erforderlich [5].

Es muss unter allen Umständen angestrebt werden, einen namhaften Teil dieser Kosten durch Inserate hereinzubringen. Wenn es dem Verlag gelingt, durch planmässige und energische Werbearbeit für jedes Heft etwa zehn Seiten Anzeigen zu vergeben, sodass ein Überschuss von rund 25 000 M aus dem Inseratengeschäft entsteht, so würde sich das Exemplar des Jahrganges für den Verlag nur auf etwa 20 M stellen. Aber selbst bei einem Verlagspreis von 30 M, oder etwas darüber, würde – angesichts der heutigen Höhe aller Bücherpreise – ein Absatz von 1000 Stück wohl möglich und zu erwarten sein, wenn nur das im Vorstehenden ausgeführte Programm ernsthaft durchgeführt und der Erkenntnis von seinem hohen Nutzen für die Weiter-Entwicklung der deutschen Technik, ja von der Unentbehrlichkeit des ganzen Unternehmens, in den massgebenden Kreisen Eingang verschafft wird.

APPENDIX B: A LETTER WRITTEN BY FELIX KLEIN TO THE VDI (FEBRUARY 1921)

Göttingen, end of February 1921

To the director of the Association of German Engineers[50]

Mr. D[iedrich] Meyer

You kindly asked me to give the new journal a few accompanying words [Geleitwort][51]. I am happy to comply with this request, because it is a great satisfaction and a special joy for me that the engineers and mathematicians have come together. I have nothing special to add to the detailed remarks made by Hr.v. Mises in his foreword. However, I would like to emphasize one more general point, no doubt in full agreement with the editor. If one compares the discussions of even the most outstanding authors, one usually only finds that the task of mathematical natural sciences is to determine the further course of the phenomena according to the laws of nature under given premises, say the path of a bullet which is hurled [geschleudert] in a certain direction at a certain speed, or also the path of a light beam which passes through a given optical instrument. But there is a problem that goes beyond this, which is also subject to mathematical considerations: the projectile should be hurled in such a way that it reaches a certain target, the instrument should be constructed in such a way that the image produced with its help is as perfect as possible. Thus, in addition to the causal explanation under the given data, there is a requirement for appropriate fixing of the initial conditions according to the point of view of maximum expediency. It seems to me that this is a special task of all applied mathematics, a task that is particularly close to the way of thinking and the professional activity of the creative engineer. To speak in the language of our pedagogues: it is actually functional thinking that is required here: the full overview of the connection between the results and the respective data of the task.

If your journal also wants to devote itself intensively to the question outlined above, I believe it will serve the interests of the general public in a special way. There is so much talk about the fact that the maintenance and development of science is a very important matter for the reconstruction [Wiederaufbau] of our bowed fatherland [gebeugtes Vaterland], and everyone is thinking of the crucial help that will be given from there to the quality performance of our industry. This idea, which I wholeheartedly support, may be made more precise than usual by the preceding lines in certain directions. The goal of theoretical natural science should not only be a passive understanding, but an active mastery [Beherrschung] of nature. This formulation does not, of course, contradict the ethical demands[52] which are made by other parties for the rebirth of our efficiency. Rather, it is intended to apply only in connection with these demands and to mark the special obligation that we theorists have within the overall task.

Yours sincerely

Klein

[50] First published in the VDI journal 65 (1921), p. 332, reprinted by Mises in ZAMM 5 (1925), 358/59, after Klein's death. Reprinted again in (Gericke 1972, 7). Since it had already appeared earlier in the VDI journal, Klein probably would not have had any objections to the publication of his letter. Translation into English by R. Siegmund-Schultze. Emphasis as in the original.

[51] Because Klein's letter was not printed in the first issue of ZAMM in 1921 the translation of "Geleitwort" as "foreword" would not be fitting.

[52] By "ethical demands" Klein seems to mean the stipulations of the Western powers vis-à-vis defeated Germany, in particular the ban on chemical weapons and the restrictions on Germany's army and the production of airplanes. The latter restriction was not approved by von Mises who occasionally opposed it. (Siegmund-Schultze 2004, 351). Klein's remark can also be explained as a somewhat apologetic gesture because of his signature to the infamous nationalistic appeal "To the civilized world!" of 1914.