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History of mathematics through collaboration: Toward a composite portrait of Oswald Veblen

Organized by
Sloan Despeaux, Cullowhee
Della Dumbaugh, Richmond
Jemma Lorenat, Claremont

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Abstract. Oswald Veblen played a pivotal role in the history of American mathematics in the twentieth century. His life, however, remains largely unstudied. This conference was designed to redress this issue by exploring Oswald Veblen and his contributions to the history of American and international mathematics in an interactive workshop that used the Veblen Papers from the US Library of Congress as a foundational and shared resource. With this frame, the conference raised queries and discussed issues related to Veblen, his mathematical contributions, and his collaborative initiatives, including his critical work aiding refugee mathematicians in WWII that helped establish long standing programs at American institutions that continue to advance mathematics at the highest level. The workshop echoed Veblen's collaborative focus and brought together historians of mathematics and mathematicians to work alongside one another during the conference. This content and collaborative approach combined to advance our understanding of Veblen's collaborations and the history of twentieth-century mathematics more broadly.

Mathematics Subject Classification (2020): 01A60; 01A70; 51-03.

Introduction by the Organizers

Oswald Veblen earned his PhD in mathematics in 1903 from the University of Chicago under the direction of E. H. Moore. He was, then, among the first internationally-recognized American mathematicians educated in his home country. Woodrow Wilson invited Veblen to Princeton as a Preceptor in 1905 and Veblen remained at the institution and advanced through the ranks, ultimately becoming the first H. B. Fine Professor. While at Princeton, he served the broader

American mathematical community in his role as AMS President (1923-1924) and in his work to secure funds for mathematics (most notably in the form of National Research Council Fellowships). In 1932, he left Princeton University, but not the town, to join the newly formed Institute for Advanced Study as its first faculty member. Saunders Mac Lane has described Veblen's contributions to the Institute as "legendary."[1] Veblen helped hire the first faculty members at the Institute, including Albert Einstein, Hermann Weyl, and James Alexander. He served as a fierce advocate for immigrant scholars. He recognized the value of young scholars and helped establish structures at the IAS that allowed these mathematicians a regular and ongoing place there. He remained on the IAS faculty until 1950 when he segued to Professor Emeritus. As with many mathematicians, this title was a shift in name only, as he continued to pursue his interest in the development of mathematics. He died in 1960, having lived a life fully devoted to mathematics, advancing colleagues through various initiatives and mathematical ideas in geometry and topology.

In terms of style, this workshop followed the successful conference strategy employed by "Women in Numbers" to create project-based interactive workshops with measurable outcomes. Drawing on the archives from the Veblen papers at the US Library of Congress, this workshop began with six talks on topics related to Veblen and his contributions to American and international mathematics in the early- to mid-twentieth century. These talks comprise the first six abstracts below. For the remainder of the time participants worked in small groups on themes in the life and professional contributions of Veblen using his papers from the Library of Congress as a shared resource. The five groups were initially focused on Veblen's foundations of geometry, Veblen and Princeton University, Veblen and the American Mathematical Society, Veblen and World War II, and Veblen and the Institute for Advanced Study. As the workshop continued these topics were refined and revised, as can be seen in the abstracts that follow. At the end of each working day, groups reported on their progress, stumbling blocks, and unexpected discoveries. The abstracts from each group point to research conducted during the workshop, as well as how the collaborative projects will continue and what additional archival resources will be incorporated. This large-scale collaboration on the same corpus served as a novel approach to historical scholarship. The final talk reflected on the process of the workshop, notable achievements, and possible next steps.

The amenities and resources of MFO were particularly conducive for this collaborative conference strategy. In particular, conference participants appreciated the ability to access the MFO library's physical and online resources, the space to meet as a whole as well as in subgroups at any time, beautiful blackboards and chalk, and, of course, bountiful coffee. The organizers would like to extend a generous thank you to Petra Lein for her helpful ideas and assistance in making arrangements for excursions for the group to enjoy Black Forest torte in the

[1]Saunders Mac Lane, "Oswald Veblen: 1880-1960," Biographical Memoirs, National Academy of Science, 1964, pp. 323-341, on p. 333.

town of Oberwolfach and the Christmas Market and Living Advent Calendar in Gengenbach.

Workshop: History of mathematics through collaboration: Toward a composite portrait of Oswald Veblen

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A brief introduction to Oswald Veblen

Della Dumbaugh, Stephen Kennedy

Oswald Veblen (1880–1960) was born in Decorah, Iowa to Andrew and Kirsti (Hougen) Veblen. His father, Andrew, brother of social theorist Thorstein Veblen, was teaching at Luther College. After study at Johns Hopkins University in the early 1880s, Andrew moved to the University of Iowa to teach mathematics and physics. Oswald earned a bachelor's degree from Iowa and later, in 1900, a second bachelor's degree from Harvard. In 1900 Veblen began graduate work at the University of Chicago earning a PhD, under the supervision of E.H. Moore, in 1903 for work in the foundations of geometry. He remained at Chicago for two more years, moving to Princeton as one of Woodrow Wilson's preceptors in 1905.

Over the next dozen years Veblen built an increasingly distinguished reputation for his research in geometry and topology. During the First World War Veblen was put in charge of ballistics research at the Aberdeen Proving Ground [1]. Postwar, Veblen assumed positions of national leadership including delivering the prestigious AMS Colloquium Lectures and serving as AMS president in 1923–24. In 1932 he was tapped by Abraham Flexner to assist Flexner in the initial organization of the Institute for Advanced Study (IAS). As Nazism and Fascism rose in Europe in the early 1930s, Veblen became a nexus of American efforts to find positions for mathematicians (and other academics) displaced by these political movements. During the Second World War, Veblen again served at Aberdeen. In the late 1940s and 1950s Veblen assisted refugee mathematicians fleeing Communism in Eastern Europe and China while, simultaneously, providing aid to mathematicians subjected to the persecution of US anti-Communist authorities.

Deane Montgomery in [2] described Veblen as, "...one of the most influential mathematicians of this century, partly through his contributions to the subject and partly through the effect of his remarkable judgment and character." Throughout his career colleagues relied on Veblen's judgment and character as he exercised his large vision for American mathematics in the building of the department at Princeton, the founding and staffing of IAS, and working to secure the organizational structure of the AMS by fundraising and incorporation. And yet, we do not have an authoritative biography of Veblen. This workshop aims, by constructing small research partnerships and giving them access to the Veblen papers [3], to generate new scholarship into the life and work of this central figure in the flourishing of American mathematics that occurred in the first half of the twentieth century.

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FIGURE 1. A young Oswald Veblen, courtesy Carleton College.

Working with manuscripts

Emmylou Haffner

In this talk, my aim is to give a number of methodological elements and tips to navigate archival material, and in particular private manuscripts (e.g., notebooks, drafts, etc.). In doing so, I was guided by two main considerations: the aspects which intrigued and interested me most when I first started working with private manuscripts, and – what I hope to be the main takeaway of the talk – the idea that in studying such manuscripts, *everything matters*, no detail is insignificant.

To give a number of theoretical pointers, I use examples of manuscripts from a selection of authors from the eighteenth to the twentieth century: G. W. Leibniz (Leibniz-Archiv, GWLB), Bernhard Riemann (Cod. Ms. B. Riemann, SUB Göttingen), Richard Dedekind (Cod. Ms. R. Dedekind, SUB Göttingen), David Hilbert (Cod. Ms. D. Hilbert, SUB Göttingen), Élie Cartan (Fonds 36J, Académie des sciences de Paris), and Oswald Veblen (MSS 44016, Library of Congress), as well as Georges-Louis Le Sage [3], and Gabriel Cramer [17]. The talk addresses mainly modern manuscripts (as opposed to ancient and medieval ones). It relies largely on the assumption that we are taking texts to be historical objects, situated in space and time. Mathematical texts are not mere means of transportation for an abstract, fixed meaning, but tools on and with which mathematicians work,[1] which is particularly true of manuscripts.

To work with manuscripts, it is useful (maybe even indispensable) to use methods from textual studies and material history. Although developed outside of history of mathematics, methods from philology and codicology are particularly fruitful for the analysis of manuscripts. There is no (so far!) developed theory of philology or codicology for scientific texts,[2] and it is the historian of mathematics' task to appropriate these methods so as to make the best use of them for our work. This talk highlights some of the main points worth paying attention to from that point of view.

1. Material and codicological analysis of manuscripts

Material, formal, spatial, scriptural elements are all important to interpret a manuscript. While they are just steps in the analysis and description of the document, they are important ones, as they can give clues about dating, chronology, or circulation of the manuscript.

The structure and format(s) of the document testify of specific practices, and constrain the writing and the writing choices. A (far from exhaustive) selection of examples gives an idea of the variety that can be encountered, and the many interesting issues that can arose. A very peculiar example, [3], is provided by G.-L. Sage's use of playing cards for his notes. While more standard, the case of

[1] See [8] for such methodological statements.

[2] This is not to say that no codicological analysis have ever been done scientific texts, of course. See [9] for a fascinating example.

notebooks is also quite rich: are the notebooks organized thematically? chronologically? Examples, here, focus on Cartan[3] but [1, 16, 15] (among others) can provide additional insights. Finally, authors working on slips of paper and loose sheets are considered, with cases from Leibniz's and Dedekind's archives.[4]

Such material elements are important to complement the contentual analysis that historians of mathematics know well how to do. They can give clues about a vast number of questions, such as:

- Who is writing? Are there changes in pens and/or handwriting?
- When was the manuscript written? Dating clues can be observed in reused papers or watermarks, for example, but this should be used carefully.
- For who was it written? "Private manuscripts", not intended for anyone's eyes but their author's, are a particular type of manuscript to work with, as they often do not obey all the norms of writing to which we are used. As such, they can be more difficult but also more interesting. Here, methods from genetic criticism can be useful.[5]
- What is the chronology of writing? Leong [17] provides a beautiful example.

2. Focus on lecture notes

Reading notes and lecture notes are a specific type of private manuscript which is of interest to us, since we are working on (at least one of) Veblen's lecture notebooks on the foundations of geometry from 1901. History of science has investigated the question of reading and lecture notes rather extensively (although history of mathematics is noticeably absent from most of these studies) and provides great methodological insights.[6]

The first, and maybe most important, aspect of such notes is what [18] calls "several enunciative instances," namely the fact that there are at least two voices: that of the person who takes notes, and that of the text or speaker on which notes are taken. In addition, it should be underlined, still following [18], that what should guide the analysis of lecture (or reading) notes is the study of "the writing operations that govern the processes of formation, transmission and appropriation of (...) concepts."

A number of specifics should be taken into account when analysing lecture notes – some relevant to Veblen's notebook, some less so. For example:

- Who is writing? Are there several scriptors?
- What is the lecturer's status?
- What are the scriptor's objectives?
- Which writing acts can be observed? (e.g., underlining, titles, numbering, modifications of the text, rewriting, annotations, ...)

[3]See [12].

[4]See [13, 14] on Dedekind, [10] (among others) on Leibniz's mathematical manuscripts.

[5]See [11], for example.

[6]See, for example, [2, 4, 5, 6, 7, 18, 19].

– What formal diversity can be observed?
– Is there a publication planned?

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"The patriarch of the Judeo-Italian intellectuals longing for the embrace with Uncle Sam": Veblen and the Italian refugees

Erika Luciano

The so-called *Measures for the defense of the race* (5 September-17 November 1938) in Italy led to mass migrations, not only of scholars and intellectuals, but of some 6,000 individuals of Jewish descent from all walks of life, forced to leave because of the impossibility of providing for one's self and family and of tolerating the loss of civil and political rights, along with the reduction to a caste of pariahs (social and professional downgrading, marginalization, the injury to their own dignity as men and citizens, etc.). The exodus involved the academy particularly, which in 1938 counted almost 200 university professors and lecturers of Jewish origin out of 1250. The loss of their human capital in some sectors slowed down, and even halted, Italy's cultural, technological and economic progress, with serious short- and long-term implications.

Jewish academic emigration from racist Italy quite largely differed from the flight of scholars from Central and Eastern Europe. Facilitated by networks of solidarity which were grounded on the web of international relations interwoven in the years of the Belle Époque of scientific internationalism, this exodus had to face various specific obstacles.

- Linguistic difficulties, all the more important for people who worked with knowledge and words, and who wanted to express their thoughts with a certain precision and lexical finesse. In a country like Italy where the learning of English had not been promoted at all by the fascist regime, the language handicap was painfully felt.
- Competition with refugees from other totalitarian regimes, and in particular with those fleeing the Third Reich, who in the five years preceding the racial laws had occupied many positions in English-speaking academia.
- The (understandable) perplexities of foreign institutions in welcoming into their staff men who had been notoriously fascist until 1938 and sometimes remained so.
- The embarrassment of the newcomers in interacting with Italians who had left the country before 1938 for political reasons (the so-called *fuoriusciti*).
- The difficulty in entering scientific and institutional contexts characterized by forms, methods and dynamics of organization of research and teaching significantly different from the Italian ones. (Segré called it "the university minuet that one danced at Berkeley, as one did in all universities.")

Globally, it must be frankly said, Italians struggled to adopt new ways of thinking and making culture. They were very able to export their know-how, but rarely re-targeted their profiles to detach from the traditions of study in which they had been trained and in which they had worked until expatriation.

The choice between leaving or staying, and the success or failure of the migration project, were conditioned by many factors: individual financial possibilities, age of the potential exile, gender, breadth and effectiveness of the social and relational

capital which he or she could raise. Adaptability and flexibility of the migration project were central, as were prestige, skills and competencies. In particular, those who had scant or distant connections with the English-speaking intellectual world, saw their opportunities reduced to a minimum.

Veblen is a main actor in the story. For Italian mathematicians who wanted to leave, Veblen was a reference figure, both as a member of the Emergency Committee in Aid of Displaced German Scholars (later renamed Emergency Committee in Aid of Displaced Foreign Scholars) since its foundation in 1933, and as an individual colleague sensitive to their plight. Veblen had been to Italy several times; he had corresponded with Vito Volterra and Tullio Levi-Civita since the late nineteenth century and had consulted them about the organization of mathematical life in Rome before shaping the Institute for Advanced Study. Almost all Italian would-be refugees turned to him: six mathematicians, two astronomers, two engineers, a full professor in Roman Law, a lecturer in embryology, many physicists, sometimes directly, sometimes through Levi-Civita.

Veblen always responded to their appeals, without giving illusions but also without cutting off hope. He collected information on openings all over the world, circulated the requests for help, carefully examined and ranked the applications, before submitting them to universities, research institutions, laboratories, archives, libraries or schools all over the world. Not infrequently, he also acted in mundane and precise matters, typing curricula written with illegible graphs, correcting English, and reviewing the files before proposing a candidate for a position. Often, he and his wife Elizabeth Mary Dixon Richardson hosted the Italian emigrants and helped them to fit into a country like America with a lifestyle and issues very different from Italy. The sons of Volterra, Castelnuovo, Fano and Fubini, who had known Veblen as children, ended up viewing him 'as a sort of father' (quotation from a letter of Gina Castelnuovo to Ugo Fano).

Thanks to Veblen, many persons mobilized in favour of Italians and teamed up with rescue agencies to resettle them in North and South America, Australia, etc. The engagement of these men represents a fundamental lesson in academic rescue and highlights the political role mathematicians can play through scientific diplomacy, even if their action did not always suffice. And even if, as happened on various occasions, Veblen's efforts provoked opposition within the American mathematical community.

Veblen also intervened publicly on at least two occasions: when he resigned from the Zentralblatt editorial board, in protest against Levi-Civita's dismissal and when he refused to participate in the Volta Conference of 1939, in public protest against the Royal Academy of Italy and the Italian Mathematical Union. For these gestures, as well as for his scientific contributions, Veblen would be appointed foreign member of the Lincei academy in 1947, nominated by Guido Castelnuovo.

Based on new archival materials, this paper presents an overview of the phenomenon of Italian mathematical emigration, placing an especial emphasis on Veblen's individual efforts. His correspondence with Italian refugees has offered

constructive suggestions for identifying at least three open questions which deserve attention.

- Did Veblen work merely on account of simple scientific realizations or did emotional involvement and humanitarian feeling play a role?
- How did Veblen's rescue action depend on his previous experiences of mentoring and fundraising?
- In aiding the refugees, did Veblen act as a stateman, as a diplomat, as a good person, or as a grand man?

Veblen's correspondence with Italian aspiring refugees and displaced scholars constitutes an intensely human iconography of personal and professional lives, of individual and institutional choices, of presences and absences (who succeeded in fleeing, who failed, who did not have the chance to leave), of scientific and ethical responsibilities in evaluating and recruiting colleagues. A portrait of a gentleman and of a gentle man emerges, of a man of science who combined a concern for the welfare of mathematics itself with a sympathetic concern for individuals.

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The Oslo International Congress of Mathematicians 1936

Christopher Hollings

The International Congresses of Mathematicians (ICMs) have been held at (reasonably) regular intervals since 1897, and — despite what many mathematicians have chosen to believe — have certainly not been isolated from the wider political circumstances within which they have taken place. This is particularly true of the 1936 ICM, held in Oslo against the backdrop of German rearmament, forced emigrations from Germany, the Italian invasion of Abyssinia, and the strengthening of ideological control in the USSR, to mention just a few points from the European politics of the mid-1930s. In this talk, I give a brief account of the congress, in both its mathematical and political aspects, as described in the book [2]. In line with the aims of the wider workshop, I try to bring out Veblen's contributions both to the ICMs (he was a plenary speaker in Oslo) and to the wider international mathematical community.

A study of the Oslo ICM reveals that there were five national groups in particular (though not all of them were present in Oslo) whose actions shaped the meeting:

- the Norwegian organisers;
- the politically selected German delegation;

- the boycotting Italians;
- the absent Soviets;
- the up-and-coming Americans.

To take the first of these, we see from the work of Henrik Kragh Sørensen [2, chapter 2] that the Norwegian organisers of the congress were self-consciously using the meeting as a forum not only to encourage the study of mathematics in Scandinavia, but also to promote Scandinavian mathematics on the world stage. Detailed surviving records give us a glimpse of the conversations that took place in the run up to the congress, particularly concerning the formation of the final programme of plenary speakers.

Similarly detailed records survive in connection with the official German delegation to the Oslo congress. By 1936, all German delegations to international conferences were selected and controlled by a central body, the Deutsche Kongreßzentrale (DKZ), linked to the German Propaganda Ministry. The DKZ issued guidelines as to how German scholars were to comport themselves at international meetings, and made its selections on political and racial bases. The leader (*Delegationsführer*) of the German delegation in Oslo was a mathematical educationalist named Walter Lietzmann, who subsequently supplied the DKZ with a detailed report on the congress, in which he commented critically on the lectures given by various other attendees, and reassured the DKZ that the behaviour of the German delegation had reflected well on the Fatherland [2, appendix D]. In particular, Lietzmann was keen to stress that the official German delegation had largely avoided any potentially embarrassing encounters with the several German emigrés who attended the congress from their new homes, often in the hopes of making contacts and finding a new position elsewhere in the world. More generally, in place of overt hostility, there was tacit competition between French and German delegates as to who could 'claim' Norway's mathematical greats, Niels Henrik Abel and Marius Sophus Lie, each of whom had spent time in both France and Germany during their careers. For instance, the German delegation laid a swastika'ed wreath at the Abel monument in Oslo, an event that was reported in the local newspapers.

The impact that Italian and Soviet mathematicians had on the Oslo congress was of a rather different character, since neither group was ultimately able to attend. In each case, several delegates were expected, including two Soviet plenary speakers, but when the congress opened, none of these were present, as they had been barred from attending by their respective governments. The League of Nations, of which Norway was a member, had imposed sanctions on Italy for its actions in Abyssinia, and so — despite a strong protest from the prominent mathematician Francesco Severi — the Italian government denied its scholars permission to travel to the congress. Mathematicians from the USSR, on the other hand, were prevented from travelling to Oslo by the start that same month of the infamous 'Luzin affair' [1]. This ideological attack on the Moscow function theorist N. N. Luzin, who was criticised in particular for his foreign contacts, sent the wider message that Soviet scientists should look inwards. As well as the

loss of plenary lectures on probability (to have been given by A. Ya. Khinchin) and Hilbert's seventh problem (A. O. Gelfond), the Italian and Soviet absences affected the mathematical profile of the congress in other ways: for example, in the loss from the programme of all algebraic geometry, a subject in which Italian mathematicians were world leaders.

One feature of the Oslo congress that was remarked upon at the time was the particularly prominent representation there of mathematicians from the United States, which in addition had benefited from the influx of academic refugees from Europe. In an interview to a Norwegian newspaper, the Danish mathematician Harald Bohr remarked that 'just as Göttingen was once the mathematical centre, this is now Princeton' [2, p. 86]. It was therefore very natural that the USA should be chosen as the host of the next ICM, planned for 1940. The organisation of an American meeting began almost immediately after the Oslo congress had concluded, but the plans were put on hold at the outbreak of war in Europe in September 1939. Nevertheless, preliminary steps had already been taken by Wilhelm Süss, chairman of the Deutsche Mathematiker Vereinigung, to prepare a German delegation for the 1940 ICM. The German authorities had also taken an interest in the racial profile of the American organising committee: in February 1939, the Ministry of Education sought clarification from Süss as to the background of W. C. Graustein of Harvard, chair of the ICM organisers. By July, the Ministry was able to assert that 'Graustein is German friendly [...]; Veblen, although no Jew, organizes the American fight against German mathematicians' [2, p. 132]. Precisely what Veblen had done to warrant such an assessment is not clear, though he was actively involved in bringing displaced German scholars to the USA, and had protested the dismissal of the Jewish Italian mathematician Tullio Levi-Civita from the editorial board of *Zentralblatt für Mathematik und ihre Grenzgebiete* the previous year.

As American mathematicians prepared for their ICM during the late 1930s, plans were also afoot for a German bid to host a similar international meeting. The fluid dynamicist Ludwig Prandtl hoped to bring the International Congress for Applied Mechanics to Germany in 1942, but the bid was ultimately unsuccessful, as Prandtl was unable to guarantee that Jewish and non-Jewish delegates would be treated equally. By the start of the 1940s, a rift was therefore opening up in the international mathematical community. Unable and unwilling to collaborate with other nations in the way that those nations demanded, Nazi Germany sought instead to 'reorder' European science on its own terms. In the mathematical context, this led to the formation of a new research institute in the Black Forest, which was intended to be an attractive international meeting place for mathematicians. Indeed, this institute, now the Mathematisches Forschunginstut Oberwolfach, survived the German defeat and was instrumental in rebuilding German mathematics after the war [3].

To return to the Oslo ICM, we note the mismatch between the image that many of the assembled mathematicians wanted to project and the political realities of the time: the strongly internationalist rhetoric of the congress's opening speeches

belied what the great range of archival sources clearly indicates was going on in the background.

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Mathematics in the United States before Oswald Veblen

Deborah Kent

This talk presents an episodic overview of mathematics in the US before the Institute of Advanced Study. Included is a discussion of mid-nineteenth-century efforts to elevate mathematical education and to sustain specialised publication in the US, with general attention to Johns Hopkins University and *The American Journal of Mathematics*. There is also particular consideration of Harvard and Chicago during Veblen's years there, which includes discussion of the foundation of the *Transactions of the AMS* with E.H. Moore as editor.

On the value of mathematics in society: Observations via education in America during the 1920s

Laura E. Turner

This talk is a preliminary overview of several contexts in which the cultural value and status of mathematics in the United States during the 1920s are described, discussed, and measured.

The first context, on which the bulk of the talk focuses, is that of secondary mathematics education. The first two decades of the twentieth century saw many changes to mathematics education in the United States, including an increasing interest in reforming curricula in ways that were both child-centered and focused on social utility. No subject was safe from scrutiny; mathematics, too, became a subject of newfound reflection. In 1920, for example, Truman L. Kelley (1884–1961) at Teachers College of Columbia University sought to explore the broader values of high school algebra, including to girls, as proposed by "men and women of affairs" and mathematicians beyond his own institution, and how to measure them. Identified values ranged from "reasoning" and "preparation for advanced science and mathematics" to "neatness", "pleasure — recreation", and "respect for truth" (among many others) [2].

Another report from the same year was authored by the "Committee on the Problem of Mathematics in Secondary Education," established in 1911 under the

auspices of the National Education Association. This report divides secondary students into four categories: the "general readers;" those requiring limited but specific mathematical ideas for work in particular trades; those who would become engineers or students of certain sciences requiring considerable knowledge of mathematics; and those who would specialize in the study of mathematics either in connection with research or teaching, or out of mere satisfaction. "No item shall be retained for any specific group of pupils unless, in relation to other items and to time involved, its (probable) value can be shown," proclaimed the report [3]. In early-twentieth century America, where "business was King," education leaders embraced business management ideas within educational administration, such as standardization, efficiency, economy, cost accounting, and assessment [1]. The above principle in the report, properly applied, could serve as a "grim pruning hook to the dead limbs of tradition" [3].

Perhaps unsurprisingly, mathematicians were critical of this latter perspective. The Mathematical Association of America (MAA) reacted preemptively in 1916 by establishing the National Committee on Mathematical Requirements (of which Veblen was initially — albeit briefly — a member), tasked with making recommendations as to the restructuring of courses and improvement of teaching. Its own report, published in 1923, provides one point of departure for outlining the cultural status of mathematics at that point in time, and emphasizes the teaching of mathematics in high school and junior high school primarily as a means of developing "powers of understanding and analyzing relations of quantity and space which are necessary to a better appreciation of the progress of civilization and a better understanding of life and of the universe about us," and of developing "those habits of thinking which will make these powers effective in the life of the individual" [4].

The viewpoints expressed by MAA members in the pages of the *American Mathematical Monthly* provide others, as do the reports of the Committee on the Problem of Mathematics in Secondary Education and Kelley (the latter of which includes viewpoints from men and women "in sundry walks of life" [2]). The possible significance of exploring the values and cultural status of mathematics during this period within the contexts of undergraduate mathematics clubs and perspectives on the value of mathematical training in relation to the First World War was also noted. Many undergraduate mathematical clubs in America during the early twentieth century, for example, published summaries of their activities (both scholarly and social) in the *Monthly*, providing a point of departure for assessing the topics in which students and faculty were engaged and the connections forged with subjects outside of the classroom. Similarly, the *Monthly* contains a series of publications devoted to "Collegiate Mathematics for War Service" in which the preparation of college students in matters of navigation, statistics, and other wartime needs are outlined.

Already at this preliminary stage, it emerges that the questions of the cultural status and value of mathematics depended then — as now — on whom one asked, and to some, on who was learning and using it.

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Report of workshop summary talk

Benjamin Braun, Christopher Hollings

On the final afternoon of our workshop, we gave a talk summarizing what the workshop participants discussed and learned, and indicating future research directions. We outline the contents of that talk in this report.

Our key takeaway is that **this workshop has successfully generated a working group focused on developing a larger body of scholarly work focused on Veblen.**

1. Reflections on the structure of this workshop

This workshop was run in a different style than the typical Oberwolfach workshop, in that we generally had two talks per day, and an end-of-day reporting session. The rest of the time was spent working in research groups on projects that had been sketched out during the weeks preceding the workshop. In general, the participants viewed this workshop as a success. The talks were of the highest quality and were responsive to the discussions at the workshop, and there was a deep level of interdisciplinary interaction that led to the research projects that emerged throughout the week being rich and substantial. Some of the mechanisms that the organizers put in place that facilitated this success were the following.

1.1. **Pointing to archive materials.** The organizers procured scans of several boxes of the Veblen archives from the Library of Congress, and made these documents available to the participants. This was a critical tool for the research groups.

1.2. **Flexibility.** Each group was given flexibility to choose different ways of operating. The structure of the group sessions was not specified, but the groups were tasked with being prepared to report on their activities at the end of each day. Having flexibility allowed each group to choose the method of working that best aligned with their particular question/project topic.

1.3. **Developing research agendas from a preliminary topic list.** The organizers proposed a collection of research topics at the beginning of the workshop, which had been created based on preliminary input from participants prior to arriving at Oberwolfach. Participants then selected a group to join based on their particular interests, but the groups were not restricted to their original topic. Several groups went through multiple iterations of ideas for research projects before they landed on a solid project idea. However, every group did end up with a clear long-term research project.

1.4. **Conversations in multiple contexts.** We had conversations via discussions after informal talks, groups, meals, walks, evenings, etc. Because the modality of our interactions changed throughout the day, this allowed our conversations to remain fresh and vibrant. This was also critical for the success of our very interdisciplinary group, as we needed to have multiple opportunities to connect across disciplines.

1.5. **Dynamic scheduling of talks.** Several of the talks were given with very late notice (only one day notice). This was actually a positive aspect for the speakers, because it allowed them to frame their talks in direct response to the conversations and developments of the preceding workshop days. This also contributed to the vitality and energy of the workshop.

2. Approximate state of public Veblen scholarship

Veblen is present many places, but not as the primary focus except for a few articles and biographies. Thus, we feel that this workshop topic is both timely and ripe for new work. A number of sources dealing briefly with Veblen came up repeatedly during the workshop. One possible short-term goal for our working group would therefore be to create a more comprehensive reference list of Veblen-related articles/materials.

3. Known archives with Veblen materials/correspondence

In addition to the Library of Congress papers that were available to us, we became aware during the week of many other archival sources relating to Veblen. One short-term goal is to make more of these archival materials accessible to our working group.

4. If there were a book about Veblen...

If we wrote a book about Veblen based only on our discussions from this workshop, it might deal with Veblen under the following headings:

- Veblen as social cultivator, engaged in formal diplomacy and also the creation of physical spaces for the pursuit of mathematics;
- Veblen as mathematical advocate, involved in fundraising, and as an advocate both within and outside of the mathematical community;
- Veblen as researcher, with four primary areas of contribution: foundations, *analysis situs*, differential geometry, and mathematical physics.

What would be missing from this book are (at least) the following topics, which are all of tremendous import.

4.1. **Broader social contexts.** Veblen lived during complicated times, and it would be of interest to know more about his thoughts, roles, the impact of his actions, etc., regarding the following aspects of his time: women's suffrage; active destabilization of race relations in the US; increasing educational access in the US; wild variation in economic periods, e.g., roaring twenties vs depression thirties vs wartime forties; intellectual movements destabilizing "traditional" narratives, e.g., literature (Gertrude Stein, James Joyce, J. L. Borges), art (Henri Matisse, Pablo Picasso), science (Werner Heisenberg), mathematics (Kurt Goedel), etc.

4.2. **Veblen's failures.** Many of the topics we discussed in this workshop were focused on Veblen's successes. However, there must have been plenty of times in Veblen's career when his skills failed him, and he was unable to achieve various goals. Some of these are clear, for example, he was unable to place every refugee mathematician and scientist who contacted him for help. However, it would be interesting to find out more about other ways in which Veblen failed at specific efforts or initiatives.

4.3. **Competing interests and needs in the mathematical community.** In the 1910s and 1920s, there was significant tension in the mathematical community regarding how to balance and address various needs, especially related to research and teaching. The MAA was formed at this time, and through the 1920s there were discussions of how best to support mathematicians working with different areas of focus. It would be of interest to know more about Veblen's opinions and/or thoughts on these matters, as he was active in the AMS but also was of service to the MAA.

4.4. **Veblen as human.** Much is discussed about Veblen's work in mathematics and the mathematical community, but it is less clear what Veblen's interests and activities were outside of mathematics. What were his non-mathematical interests (if any)? Did he have hobbies? Or was his life primarily devoted to mathematics? What was his relationship with his wife and his extended family? How, if at all, did Veblen curate his own narrative by selecting what to leave to his archives? Did Veblen curate a narrative of heroification of his story?

4.5. **Veblen's support structure.** Veblen did not work alone in his efforts. Who were the people assisting with his work? How much did he rely on others to do administrative tasks? Did he function with significant support from staff, or was he more independent in this regard?

5. Deliverables

We discussed what types of deliverables we hope will come from this workshop. These include: a possible book; talks; articles; a special issue of a journal; future conferences; "popular" expositions about Veblen (where "popular" might have several meanings).

Oswald Veblen's years at Princeton and his role in making Princeton the mathematical centre of the world. Research in progress report.

Caroline Ehrhardt, Laura Turner, Helena Durnová

Oswald Veblen came to Princeton University in 1905. He spent most of his career in Princeton, but in our research, we concentrate on the first quarter century, from 1905 until the founding of the Princeton IAS in the early 1930s. During this time, Princeton mathematical community developed into the centre of mathematical research, and we would like to find out what Veblen's role in this development was. It seems his travels to Europe as well as his excellent social skills were of crucial importance. In writing the story of Oswald Veblen in Princeton in the two and a half decades before the Institute for Advanced Study was founded, we will draw on the work of other historians of mathematics as well as general historians from both sides of the Atlantic, including work that focuses on mathematical community in Europe itself. Accepting the view presented recently by Batterson in [4], namely that of American mathematics trying to catch up with Europeans, we should take into account the developments of European mathematics. For the US side of the story, the works by William Aspray [1, 2] and Karen Hunger Parshall [11] are particularly relevant. In our project, we would like to focus on exploring what kind of mathematics was considered relevant by Veblen and his colleagues and to which European mathematical centers and communities they were looking for inspiration, both in terms of research matter and research culture.

1. Basic timeline of Veblen's years in Princeton, 1905 to 1933

In 1905 Oswald Veblen joined the newly established rank of preceptors in Princeton on the invitation of Woodrow Wilson (1856–1924), then the president of Princeton University. Luther Pfahler Eisenhart (1987–1965), who was later Veblen's close colleague in differential geometry, had been in Princeton since 1900, becoming a preceptor in 1905 [6]. A key personality behind these early improvements to the mathematical section in Princeton was Henry B. Fine (1958–1928).[1] Veblen's close colleague in the early years was John Wesley Young (1870–1932), with whom he worked on projective geometry [7]. In 1909, two promising mathematicians, G. D. Birkhoff (1884–1944) and the Scotsman J. H. M. Wedderburn, joined the Princeton mathematical community [3].

Veblen became full professor in Princeton in 1910 [9]. In the following decade, he, L. P. Eisenhart, and Tracy Y. Thomas developed an approch in differential geometry, called the *Geometry of Paths* [14]. Towards the end of the 1920s, Veblen became interested in local differential geometry and topology.

In 1913, Veblen visited mathematical centers in Europe, including Oslo, Berlin, and Göttingen. There, he came to the conclusion that American mathematics was competitive even by European standards. Batterson [3] noted that Veblen saw a major difference in the teaching loads of the German and American mathematical

[1]Basic information abou Henry B. Fine may be found in [15].

faculty, realising how their lighter teaching loads allowed German mathematicians pay more attention to their own research.

Betwenn 1917 and 1919, Veblen left Princeton for a service for his own country due to the WWI. He spent much of the time at Aberdeen Proving Grounds, where he joined the team of experimental ballistics. He showed his organisational skills and brought several other mathematicians into the team [7]. In 1923–1924, he served his term as the president of the AMS. It was at Veblen's suggestion that the National Research Council extended the postdoctoral fellowships to mathematics students in 1924 [9].

Veblen was Henry Burchard Fine Professor from 1926, when Fine professorship was established in Princeton, until 1932, when he moved to the IAS [7]. During the 1920s, Veblen actively sought financial support for research in mathematics with the Rockefeller foundations [5], possibly leading to the idea of founding the Institute of Advanced Study in Princeton. There are indications about tensions between the mathematics department of Princeton University and the Institute of Advanced Study. These seem to have to an end around the beginning of the year 1933, when Abraham Flexner suggested an agreement to L. P. Eisenhart.[2]

2. Primary sources to be studied

Resources in the Princeton University archives, especially course offerings, will help us understand better how math studies were developed, what courses were taught, and what measures Princeton faculty employed to boost mathematics studies. Was it through attempting to shape the students' and professors' personalities, or through strengthening foreign links and using them to get more promising mathematicians come to Princeton? Was Veblen's WWI involvement with the military in any way instrumental for his subsequent performance at the university?

Among Oswald Veblen papers at the Library of Congress, there is a correspondence with H. B. Fine, starting in 1905, which is of particular interest. Further insights may also be gained from correspondence of Veblen's colleagues, also in third parties' correspondence (L. P. Eisenhart, J. W. Alexander, T. Y. Thomas, and others).

We will also rely on the oral history project conducted in the 1980s [10] and now available online.[3] Although the interviews focus on the 1930s, some interviewees (e.g. the physicist Banesh Hoffman and Churchill Eisenhart, the son of L.. P. Eisenhart) touch also on earlier periods.

Last, but not least, we will make extensive use of Princeton University periodicals, published on the campus. These include *The Daily Princetonian*, founded in 1876, and the *Princeton University Weekly Bulletin*, published since 1911.[4] The lectures in the Princeton Mathematical Clubs were announced in these periodicals, and thus we know, for example, that Veblen gave a talk devoted to foundations

[2]Oswald Veblen papers, Library of Congress, Box 5, Folder "General correspondence", Abraham Flexner to L. P. Eisenhart, January 9, 1933.

[3]https://www.math.princeton.edu/about/oral-history

[4]Both available online at https://theprince.princeton.edu/princetonperiodicals/.

of geometry at the Mathematical Club on 8 November 1921. The periodicals also give us an insight into the life on campus as well as about connections between Princeton and other universities in the US.

3. Veblen actively building the perfect space for research mathematics

Through elaborating what it actually meant when a European mathematician referred to "Princeton," and how the significance of the name changed over the years before and immediately after the IAS was founded, we would like to deepen our understanding of mathematical culture in Princeton and Veblen's role therein. Over the quarter of a century, the role and status of the mathematics department within Princeton University may have changed. Within the greater story of competition between Chicago, Harvard and Princeton as to which university would become the greatest place for studying mathematics, we propose to investigate Veblen's role in and contribution to the creation of an American institution mathematicians from Europe would never want to miss on their trip.

Given the trajectory of Veblen's career, it is probable that he was actively trying to establish a research center for mathematics on the North American continent. Two questions are relevant here: What was the intention? What was to happen at such a center, to what was it planned to contribute? To elucidate that, we propose to look at the developments of the institution from Veblen's arrival at Princeton to the time when Princeton became a prestigious place in the academic world. Since Veblen arrived in Princeton shortly after it was transformed from liberal arts college into a university, he could well have played a major, if not crucial, role to play in the process.

A number of mathematicians passed through Princeton as preceptors, graduate students, professors, etc. The American group included Henry Burchard Fine (1858-1928), Gilbert Ames Bliss (1876–1951), Luther Pfahler Eisenhart (1876–1965), Einar Hille (1894–1980), George David Birkhoff (1884–1944), and Tracy Yerkes Thomas (1899–1983). They were joined by their European colleagues, and the list here is far from exhaustive. Their stays ranged from short visits to permanent positions, as was the case of John von Neumann (1903–1957), hired in 1929. Already in 1913–1915, a student of Mittag-Leffler, T. H. Gronwall, was teaching in Princeton. In the academic year 1928-1929, G. H. Hardy came to Princeton through an exchange with Veblen. Jan Arnoldus Schouten (1883–1971) came for an extended stay in 1930.[5]

Some European mathematicians were also present through their textbooks. For example, Émile Picard's (1856–1941) book was used by Henry B. Fine in the two-semester graduate course on Modern Analysis. Others came to give a lecture at the Mathematics Club, like Karl Runge (1856–1927) in 1909, Émile Borel (1871–1956) and Vito Volterra (1860–1940) in 1912, Hermann Weyl (1885–1955) in 1926 and 1929, Dirk Jan Struik (1894–2000) in 1927, H.S.M. Coxeter (1907–2003) in 1932, Tullio Levi-Civita (1873–1941) and George Pólya (1887–1985) in 1933, and

[5] *Daily Princetonian* **55**, no. 116, 24 October 1930.

Emmy Noether (1882–1935) in 1934. Still others were on the wish list, but mostly for personal and organisational reasons, they never came to Princeton. These included Erik Ivar Fredholm (1866-1927) and Erhardt Schmidt (1876-1959).

The image of Princeton mathematical culture typically includes, but is not limited to, the afternoon tea as an informal gathering and Fine Hall as a meeting place. It seems only natural for Veblen, who was an Anglophile, to introduce or promote some features of the English institutions he visited. For example, in 1928/29, he swapped places with G. H. Hardy and spent an extended time in Oxford. Through his involvement with the actual construction of new buildings on Princeton campus, Veblen may be seen also as an architect, especially in the sense of noticing, if not understanding, the possibilities spatial disposition offers to the growth of a cultural institution. Paradoxically, Fine Hall as the materialization of the efforts to build a math community in Princeton, may have generated tensions, as William Duren described in an interview:[6]

> "When I came, the math department of the university was divided into two practically armed camps: the people who were in local differential geometry (this group was headed by Luther Eisenhart, Veblen, Tracy Thomas, and Morris Knebelman) and the people who were in topology (this group was headed by Alexander and Lefschetz.)"

A significant role in cultivating mathematics in Princeton was also played by the local Mathematics Club. Unlike mathematical clubs elsewhere, the one in Princeton soon aimed at graduate rather than undergraduate students. Veblen's connection to the club is not clear to us, but it may have played a role in developing taste for research mathematics among Princeton University academics. Similarly, Veblen's temperament also influenced his role at the university as well as his relationship with other people, e.g. his close mathematical colleague Luther Pfahler Eisenhart. It was Eisenhart with whom Veblen is known to have discussed possible invitations to Princeton. Thus, in 1912, they corresponded about inviting French mathematicians, especially from the research community around Borel. It is also probable that they consulted the eminent French mathematician Jacques Hadamard.

Looking at the quarter of a century of Veblen's involvement with Princeton University Mathematics Department seems to confirm that he was the right man who found himself at the right place at the right time. He seems to have had suitable upbringing and talents, boosted also by his experience. In our proposal to write a social and cultural history of mathematics in Princeton, we would like to show what skills, positions, and situations helped Veblen achieve his goal, eventually most probably materialising in founding the Institute of Advanced Study in Princeton.

[6]Interview (PCM 8) with William L. Duren, Nathan Jacobson, and Edward J. McShane, conducted by Karen Hunger Parshall on 10 April 1984 [10].

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Report of working group on Veblen and the American Mathematical Society

Benjamin Braun, Samson Duran, Sloan Despeaux

Oswald Veblen served as President of the American Mathematical Society (AMS) from 1923 to 1924. As AMS president, Veblen presided over a significant increase in fundraising activities, capitalizing on the recent incorporation of the society. Veblen was also active in AMS committees and meetings, and played a significant role as a leader, both formal and informal, in the AMS during the 1920s. Veblen's involvement in the AMS during this period is covered in depth in the second chapter of Karen Parshall's 2022 publication *A New Era in American Mathematics, 1920-1950* [4].

In the process of investigating Veblen's work during this time, we discovered the pivotal role in the AMS played by Dr. Caroline Eustis Seely (1887-1961), who

features prominently in Veblen's correspondence during this time. Seely earned her PhD in Mathematics at Columbia University in 1914. As a graduate student, she worked with D.E. Smith at Columbia as a mathematical assistant. She would continue to work with Smith on several projects, including the compilation of the Union List of Mathematical Periodicals (Bureau of Education, 1917). In 1913 she began what would become a twenty-two-year employment at the AMS, serving as the first mathematician with a full-time employment by the society. Throughout the 1920's, Seely continued to make original contributions to mathematical research, publishing several articles in the *Annals of Mathematics*. Her role at the AMS steadily grew, and she was officially recognized as associate editor of the *Bulletin of the AMS* from 1925 to 1934 and the cooperating editor of the *Transactions of the AMS* from 1924 to 1936.

During our week at MFO, our working group began investigating Seely's official and unofficial roles at the AMS and the support she provided to AMS leadership, in particular Veblen. Our belief is that Seely will provide an enlightening case study into the broader question of the role of highly qualified support staff to impactful mathematical statesmen such as Veblen. In particular, at the AMS, Caroline Seely provided AMS officers with a deep and broad institutional memory. AMS presidential terms in the 1920s were limited to two years. Thus, as presidents came and went, "Ms. Seely" was a constant. Further, our initial review of correspondence from the Veblen archives indicates that Dr. Seely was included in many high-level discussions of critical issues during this time. It is of interest to determine more precisely the role that Dr. Seely played in AMS leadership and decision-making processes, and how her contributions might or might not have influenced AMS leadership, with a focus on Veblen. Our ongoing work will investigate these questions in detail.

A connected topic of interest to this investigation is the role of women in American mathematics in the early twentieth century. Recent scholarship has focused on gender, masculinities, and "self-made" American philosophies in mathematical culture [1, 2, 3]. This project will contribute to further scholarship in this area.

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"An individualist of the old-fashioned American type": The informal scientific diplomacy of Oswald Veblen

David Aubin, Christopher Hollings, Stephen Kennedy, Deborah Kent, Erika Luciano

It is easy to think of Oswald Veblen as the consummate institutionalist. He, along with Luther Eisenhart and Henry Fine, built a world-class department at Princeton. As President of the AMS he led an incorporation movement and ambitious corporate fund-raising effort. He was Abraham Flexner's main collaborator in designing the programs and recruiting the faculty for the Institute for Advanced Study. He was elected, unanimously, President of the 1950 International Congress of Mathematicians. And yet, in a statement written on May 25, 1953, Veblen writes of himself [1]:

> The fact is that I am the opposite of a communist, namely, an individualist of the old-fashioned American type that grew up in the 19th century. My life has been devoted to my science (mathematics), to my students and to my institutions of learning. This career has been interrupted by the following episodes:
>
> (1) Voluntary service, after I was 37 years old, in the American Army in the First World War.
> (2) Much activity, against the opposition of American anti-Semites, in finding academic positions for refugees from Nazi Germany and Fascist Italy.
> (3) Service as a civilian, after the age of 61, with the Armed Forces of the United States in the Second World War.
> (4) Efforts to find academic posts for refugees from China and from behind the Iron Curtain in Europe.

Expressions of political positions from Veblen are rare, we are left trying to understand his core beliefs by observing his actions. This statement is the most explicit statement of his political philosophy of which we are aware. It is worthwhile to examine the, not yet completely understood, circumstances that elicited this statement. The document from which this quotation is extracted contains references to various circumstances when Veblen was drawn into political activities. He mentions his declining the Honorary National Co-Chairmanship of the American Committee for Protection of Foreign Born in 1948, acknowledging his support of an initiative sponsored by the Committee to petition President Truman with respect to the rights of citizens born abroad. He also refers to limited exchanges he had in the early 1940s with the American Council of Soviet Relations and the American Association of Scientific Workers. This provides evidence of Veblen's support being actively sought after for various political causes and of his relatively sympathetic ear to such requests, but also of his careful reluctance at being formally involved in these political organizations.

The documents we had access to are insufficient to assess fully the circumstances that led to the expression of this statement. In the files we were able to consult,

the only direct evidence of Veblen's political loyalty being personally questioned comes from a letter addressed to him by Alfred Kohlberg, a textile importer close to Senator Joseph McCarthy. We may note that Kohlberg was the funder of the anti-Communist newsletter Counterattack, copies of which are to be found in the archives. In this letter, dated October 23, 1952, Kohlberg pointed out that Veblen was among the signatories of a letter addressed to members of Congress requesting the repeal of the McCarran Act. Although professing not to know Veblen's connection with the Communist movement, Kohlberg underscored that a majority of the signatories were Communists or fellow travelers, ending his letter by asking "whether you consider that your motivations at this time, when American are dying in a shooting war with Communism, is none of the public's business."

Among other documents we were able to consult, we find evidence of Veblen's involvement in the defense of Dirk Struik (accused of having plotted to blow up the White House) in 1951 [2]. After a letter exchange with Hadamard related to the Rosenbergs' trial in 1952, Veblen wrote to President Truman (on January 12, 1953) asking to commute the death sentence to life imprisonment. Stating that he has "no sympathy of the ballyhoo of the Communists," Veblen stated that he thought that "the death sentence is extreme and inadvisable" [1].

Several boxes of documents, as well as Veblen's personal diaries, kept in the Library of Congress might help shed further light on the circumstances that led him to make this statement.

The opening Veblen quote above cites his two instances of war service as breaks in his mathematical career. Existing literature on Veblen nonetheless focuses on his institution-building and war work. When the United States mobilized to participate in the first World War, Veblen took charge of the office of experimental ballistics at Aberdeen Proving Ground in January 1918. The work of modelling the flight of a projectile and computing range tables was quite a departure from the algebraic topology that previously had been the focus of his research and impacted his approach to organizing research work, especially with regards to assembling teams working on related problems. A four-month tour of British, French and English ballistics laboratories increased Veblen's international connections. The experience in WWI brought Veblen and Moulton and Dickson together post-war to discuss questions of preparedness in peacetimes and moved Veblen towards a position of national leadership. The experience also involved him in national-level curriculum discussion of the relative importance of pure versus applied mathematics in education. Veblen, in World War II, served on the Applied Mathematics Panel for OSRD. More research will need to be done to discover his role on that body.

Far better understood is Veblen's WWII work in aiding displaced European mathematicians. See, e.g. [4] and [3]. For displaced mathematicians fleeing from Central and Eastern Europe, Veblen was a reference figure, both as a member of the Emergency Committee in Aid of Displaced Foreign Scholars since its foundation and as an individual colleague sensitive to their plight. In placing the refugees

Veblen had a large role. However, it was the Depression. Young American mathematicians were finding it hard to get appointments, and the question of whether to bring in foreign mathematicians to occupy positions which would then not be available to American mathematicians was debated. Veblen, while continuing to do everything he could, wrote to an Italian colleague, "we have absorbed so many of the scholars who were displaced from Germany that we are dangerously near the saturation point." Throughout the crisis Veblen remained a gentleman and a gentle man who actuated two considerations: a concern for the welfare of mathematics and a humane concern for mathematicians. More research is needed to understand Veblen's prioritization schemes to rank mathematicians who needed placement and to understand the opposition to his efforts mounted by American anti-Semites.

After the Second World War Veblen continued to provide the sort of individualized aid to mathematicians seeking political refuge that, in the 1930s and 1940s, he provided to refugees from Nazism and Fascism. There appears to be evidence that Veblen played for Romanians seeking to flee Communism a central role similar to that he played for Italians a decade before. He claims to have aided mathematicians fleeing Communist China in the excerpt above. As noted above, he involved himself in a variety of left-leaning activities during the postwar decade, enough so that he drew the unwelcome attention of the hunters of Communists. He was, from 1933 onwards through and beyond the war, the nexus of a web of personal connections providing aid to distressed mathematicians. Curiously, he primarily provided this aid from no official position, instead he simply exploited his knowledge of the community and his extensive personal relationships. This institution-man was, paradoxically, a hyper-individualistic giver of succor.

The informal networks that Veblen mobilized for the support of refugees fleeing Europe appear to have emerged quite naturally from the normal scientific contacts of an internationally-minded mathematician. We can get a flavor of Veblen's wider intellectual context by taking the examples of his surviving correspondence with G. H. Hardy, Bertrand Russell, and Hermann Weyl.

From as early as 1905, Veblen was engaging in friendly academic correspondence with Russell. While no detailed mathematics appears within the surviving letters, they are nevertheless about mathematics: Veblen relates, for example, the extent to which Peano's ideas are penetrating into the United States. Indeed, the foundations of mathematics, an interest of both men at this time, are the main feature of the early letters. Reference is also made to publications exchanged, and to the possibilities of visits in both directions.

Veblen's correspondence with Hardy takes a similar form, although here we begin to see features that are evident in his correspondence more generally: the gradual appearance, over the course of the 1930s, of references to aid for refugee mathematicians fleeing Europe, and a more general commentary on the European situation. For example, in a pair of letters that, based on their dates, must have crossed in November 1938, Hardy and Veblen both express the same view, and

propose the same course of action (i.e., resignation), regarding Levi-Civita's recent dismissal as an editor of Zentralblatt.

The shift from mathematical discussions and exchange of publications is even more evident in the much more comprehensive surviving correspondence between Veblen and Weyl. At the end of the 1920s, Veblen assisted Weyl in his arrangements for a visit to the United States, and their correspondence of the time touches briefly upon geometry in relation to problems in mathematical physics – most notably, general relativity. But then, in the early 1930s, the problems encountered by mathematicians seeking to leave Germany are raised by Weyl, at first for others, and then for himself and his family. The correspondence continues throughout the decade, leading up to Weyl's move to Princeton, and becomes still warmer in the process: by 1940, they were addressing each other 'Dear Oswald' and 'Dear Hermann,' in contrast to the relative formality of their earlier correspondence.

In each of these three cases, the correspondence shifts away from scientific exchanges of a more standard type, as Veblen's network was co-opted for his efforts to aid refugees, and indeed also to help non-endangered individuals such as Russell, who sought a position in the United States. But, in line with our wider view of Veblen's scientific diplomacy, the network remained an informal one – Veblen continued to interact with his correspondents on an individual-to-individual basis, without involving any formal structures or organizations.

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Veblen's lecture notebooks on foundations of geometry

Emmylou Haffner, Jemma Lorenat, Nicolas Michel, Deniz Sarikaya

The starting point of our group is the study of Oswald Veblen's notebook on E. H. Moore's lectures on the foundations of geometry given in the Autumn of 1901 at the University of Chicago[1], where Veblen was a graduate student. This notebook, which as far as we know has never been studied, is 45 pages long, and contains both notes from the lecture and additional notes showing how Veblen reappropriated the texts of the authors studied. The observation that some of Veblen's notes are directly related to results stated in his dissertation prompted us to a close analysis of the contents. We propose a critical transcription of this notebook, along with an in-depth commentary, linked with original sources and with Veblen's, E. H. Moore's, N. J. Lennes', and other participants' later works.

[1] O. Veblen, MSS 44016, Library of Congress.

Below, we describe four main themes that emerged through our group's work and which we believe will be fruitful to explore further.

1. Rewriting and digesting mathematics, an overview

E. H. Moore's seminar relied largely on reading five contemporary works: Hilbert's 1899 *Grundlagen der Geometrie* [13], Pasch's 1882 *Vorlesungen über neuere Geometrie* [17], Peano's 1894 paper *Sui fondamenti della Geometria* [15], Ingrami's 1899 *Elementi di Geometria per le scuole secondarie superiori* [18], and Schur's 1901 paper *Ueber die Grundlagen der Geometrie* [16].[2]

Veblen wrote most of his lecture notes on the right-hand side of the notebook, keeping the left-hand side for later annotations. The amount of notes varies largely from one page to another. This organisation is consistent enough that the few exceptions should require special attention — and indeed seem to be additional reflections by Veblen.

We observed that the notes constitute a first assimilation of the sources studied, likely mediated by Moore. Many of these notes are translations of the original sources, which were easy to trace. However, some of the translations are slightly inaccurate, sometimes leading to annotations by Veblen showing his confusion. For example, the translation of Hilbert's Axiom IV_1 is:

> If A, B are 2 pts on a line a and further A' is a pt on the same or /an/other[3] line a', /then/ on a a given side* of the pt A' on the line a', there is always one and only one pt B' so that the segment AB (or BA) is congruent to the segment $A'B'$, in not[atio]n
>
> $$AB \equiv A'B'.$$
>
> Each segment is congruent to itself i.e.
>
> $$AB \equiv AB.$$
>
> (p. 14)

The * added after the word "side" is written in pencil and refers to a note added on the left-hand side page, which simply reads "side?". In fact, Hilbert's original German is:

> *Wenn A, B zwei Punkte auf einer Geraden a und ferner A' ein Punkt auf derselben oder einer anderen Geraden a' ist, so* ***kann man auf einer gegebenen Seite der Geraden*** *a'* ***von*** *A'* ***stets einen und nur einen Punkt*** *B'* ***finden****, so dass die Strecke AB (oder BA) der Strecke $A'B'$ congruent ist.* [13, 10]

The bold part of that axiom, which caused Veblen's confusion, states that from a given side of the line a' of A', that is, the side of a' that A' lies in, one can always

[2] Veblen wrote as a reference for Peano the first volume of his 1889 *I Principii Di Geometria Logicamente Esposti* [14] but our analysis of the notes showed that this reference does not correspond to the notes in question, which are mostly literal translations of the axioms in [15].

[3] Words written /like this/ were added later by Veblen.

find one and only one point B', which certainly makes the idea of a "side" much more understandable.

Other similar examples can be found. An exhaustive comparison of the original sources with the notes is thus needed. In addition, notational and conceptual changes are noticeable in a number of cases, suggesting a deeper examination of the sources, which should be investigated further. The first goal of our commentary will be to map the influences and references exhaustively — including Moore's 1902 paper *On the Projective Axioms of Geometry* in which he refers to this seminar (see Section [4] of this report). We will also consider other archival sources in Veblen's and in Moore's archives if we find any relevant ones.[4]

On the other hand, the notebook also exhibits many notes showing Veblen's original reflection and digesting of the sources, some of which can be traced to his 1904 dissertation and to later works (see the commentary on "Thm 5" in the section below). Our second goal will be to correlate the contents of the notebook to Veblen's dissertation, as well as to his later works in the foundations of geometry and topology and to his pedagogical reflections. We will propose a general overview, which will map the contents of his notebook into the contents of his dissertation, so as to better understand its conceptual and textual genesis. We are, here again, hoping to find additional sources in his archive at the Library of Congress, in particular relating to the writing of his dissertation.

2. From sources to lecture notes to publications

To illustrate the dynamic evolution between Veblen's sources, lecture notes, and publications, we here present two complementary representative cases. These capture what could be further examined on the basis of the notebook — how Veblen selected and rewrote results from published sources and how he continued to reorder, reduce, and refine them.

First, how did Veblen import material from mathematical sources and lectures into his notebook? The case of one theorem, simply referred to by Veblen as "Thm 5," is particularly illuminating. This theorem is included twice in the notebook, both on the left-hand side, indicating a later addition. The first iteration in pencil on a small piece of paper folded and glued into the notebook asserts that "Any 2 inside pts can be joined by a st line not intersecting Δ [this is Veblen's notation for triangle in his notebooks] for if [...] not we should have $BABC$ and B would be out."

Thm 5 is more formally presented (now as "Theorem 5") a few pages earlier in the text. This time, however, it is in ink with the annotation that it is now "stated in language sug. by Prof. Moores [sic] remarks," which leads us to conclude that this is a later version. The page includes a diagram representing the line a and a "broken line" $A'AB$ such that AB intersects a. The numeration and the diagram are slight modifications of Hilbert's *Satz 5* (pp. 7–8) in his *Folgerungen aus den Axiomen der Verknüpfung und der Anordnung.* Notably, Hilbert does not include

[4]Moore, Eliakim Hastings. Papers, Hanna Holborn Gray Special Collections Research Center, University of Chicago Library.

a proof for the theorems in this section with the claim that they follow *ohne Mühe* [without difficulty] from the axioms. Hilbert's figure (Fig. 5) is nearly identical to Veblen's except that, in the latter, regions above and below a are respectively labelled $+\alpha$ and the region below with $-\alpha$.

In Veblen's dissertation [9], this result becomes Theorem 26: "Any line decomposes a plane in which it lies into two regions." The figure is gone, the proof is formalized to align with earlier definitions and axioms. Still, the proof invokes "observation" — a surprising choice in a paper on axiomatic foundations.

Veblen builds from this result in his work on analysis situs, beginning with "Theory on Plane Curves in non-Metrical Analysis Situs" in which he references it as a "special case of a simple polygon" for the Jordan Curve Theorem [1]. The result is also cited in the dissertation of his classmate N. J. Lennes, who was also in Moore's 1901 seminar [8]. Both publications refer explicitly to Moore's seminar. These iterations of "the same" theorem prompt further investigations of figures, definitions, and symbols as they circulated from Hilbert's publications to classrooms in Chicago.

The second case concerns Veblen's "Projective Axioms of Dec 14. 1901" that appear toward the end of the notebook. Their physical and temporal proximity directly links these course notes to what would become Veblen's 1904 dissertation. On the right-hand side of the page are nine axioms labeled 1 through 9. On the left-hand page, Veblen writes "Rearrange" and then uses Roman numerals to reorder and reduce this list. Below are further notes, dated April 9th (probably 1902), where Veblen further modifies the language.

A detailed cross-text comparison of these axioms demonstrates Veblen's keen attention to language, experimentation with reducing or expanding axioms (both within each axiom but also as a system), and sensitivity to audience expectations. The almost trivial proofs immediately derived from these axioms that appear in his notebooks are condensed in his dissertation but then expanded in his pedagogical writings, for instance [10]. Components of Veblen's formulation are first cited in [3]. This study complements that of "Thm 5" as here we have an instance of Veblen's original mathematics that cemented his reputation in axiomatic foundations of geometries.

3. Veblen's foundational views in global and interdisciplinary context

Around the time of Oswald Veblen's first forays into mathematics, new questions and approaches pertaining to the foundations of geometry were increasingly gaining traction, especially in Germany, Italy, and the United States. Veblen's notebook demonstrates close attention to many of the iconic texts of turn-of-the-century foundations. On a subtler level, Veblen's position at the University of Chicago requires a consideration of the intersection of logic and geometry in the local context — E. H. Moore as well as John Dewey (cf. [6]). We shall determine to what extent Veblen adopted or modified the philosophical interpretations of his

own mathematical work Hilbert proposed, as well as the role played by Moore in mediating these ideas (comparing f.i. [13] with [9] and with the work of Moore).

In the first pages of the notebook (cf. O. Veblen, MSS 44016, Library of Congress, 6 RHS), Veblen remarks that "[t]he idea of the proof of the existence of a science is probably due to Hilbert, (Paris congress)" and raises the question of studying "whether the axioms are independent what is the simplest set of axioms." Those themes are picked up in later publications, like in the published version of his thesis [9]. Similarly, [12] stresses that we need "to distinguish between geometry as a branch of mathematics and geometry as a branch of physics".[5]

Moreover, Veblen displayed an active interest in theoretical physics, especially in relativity theory, to which he himself contributed via his *geometry of paths program* developed during his time at Princeton (cf. [7]). These activities further deepened his aforementioned understanding of geometry as both an axiomatic science and a branch of physics (cf. [11]). How do these views relate the *Laboratory Method* advanced by Moore [4]? Veblen was in particular interested to foster exchanges between mathematicians and physicists. Those efforts were in part unsuccessful due to disinterest within the scientific community of American physicists and in part due to the failure of Veblen's efforts to attract funding from the Rockefeller foundation.

4. Collaborative dynamics and the making of Veblen's geometry

Perhaps more than for his own scientific achievements, Veblen is oft remembered for his active leadership within the American mathematical community [19, pp. 63-101]. This leadership, as other groups in this workshop have demonstrated, involved the creation, strengthening, and administration of spaces and institutions specifically designed to grow this community. But Veblen's mathematical production also consists to a rather unusual degree (for the times) in co-authored articles and textbooks. In this section, we wish to focus on other kinds of collaborative and mentoring activities, namely the hands-on tutoring and fostering of promising students, whether it be as a supervisor of master's and doctoral theses or as the organizer of graduate seminars.

These latter activities were ones which Veblen himself had directly experienced under E. H. Moore. The notebook under study, as well as its traces in later published articles, all bear witness to how formative these experiences were. In Veblen's famous 1905 paper on Jordan's closed curve theorem, for instance, Moore's seminar on the foundations of geometry is explicitly credited for providing the impetus and scientific environment in which novel ideas and approaches flourished – not only Veblen's own, but also those of Lennes, another student of Moore at the University of Chicago between 1898 and 1907:

[5]This idea is further elaborated: "When you try to make a point you really make a spot, and when you try to draw a line you really make a strip. But the more accurately you succeed in indicating the points and drawing the lines, the more beautifully will the result of the experiment be in accord with the theorem stated." (p. 211)

> This case was under discussion at the University of Chicago in 1901-02 in connection with Professor Moore's seminar on Foundations of Geometry. Mr. N. J. Lennes gave a proof in his master's thesis (1903), ... Another proof appears as theorem 28 in the writer's dissertation ... The present paper owes much to the discussions of the subject that have taken place under the leadership of Professor Moore.[6]

Conversely, while staying in Chicago after his graduation until 1905, Veblen followed in Moore's footsteps by organizing his own seminars and taking a proactive stance toward the mentoring of other graduate students, who sometimes were barely younger than him. This practice finds echo for instance in the first scientific publication of fellow Chicago graduate R. L. Moore, wherein Veblen is credited not only for orienting Moore towards certain topics but for having "given [him] much help in the way of actual contributions."[7] And it is in one such seminar, the site of constant interaction with other graduate students such as Lennes but also William Henry Bussey (a student of Leonard Dickson), that Veblen first worked out the content of his axiomatic theory of finite projective geometry.[8]

Thus, seminar teaching and research were so interwoven as to be inseparable in Veblen's mathematical life. This part of the project seeks to examine the modalities of such collaborative dynamics and how they contributed to shape Veblen's geometry, culminating with his 1910 textbook on projective geometry. It will do so using the Moore notebook and other lecture notes preserved at the University of Chicago, as well as a comparative analysis of the scientific publications on geometry written by the members of the Chicago seminars between 1900 and 1905.

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Veblen at the Institute for Advanced Study: Building for excellence

Juan Carvajalino, Della Dumbaugh

This collaborative project explores mathematician Oswald Veblen and his early work at the Institute for Advanced Study (IAS).

1. The Institute for Advanced Study

In early 1929, Louis Bamberger and his sister, Caroline Bamberger Fuld, sold their department stores, Bamberger & Co., to R. H. Macy Company and began to focus on how to invest their sizable fortune. Initially, they hoped to found a medical school for Jewish students. They enlisted the help of their longtime accountant, Samuel Leidesdorf, and attorney, Herbert Maass, to help determine the feasibility of transforming this idea into reality. When Leidesdorf and Maass began to explore this possibility, they were referred to Abraham Flexner, an educator who had completed a review of Medical Schools in North America and published his findings in 1910 in his *Medical Education in the United States and Canada* [1], otherwise known as "The Flexner Report."

Rather than endorse Bamberger and Fuld's idea for a new medical school, Flexner proposed an educational initiative with an entirely different focus. This series of events led Flexner to meet with Bamberger and Fuld in early 1930. This timing could not have been more propitious for Flexner. He had just completed a comprehensive study of universities that he published as *Universities: American, English, German*. Consequently, instead of outlining a medical school for Bamberger and Fuld, Flexner drew inspiration from the ideas of Daniel Coit Gilman and laid out a research institute as a potential investment for Bamberger and Fuld.

The philanthropic interests of Bamberger and Fuld and Flexner's dream of a research institute came together in May, 1930, when the New Jersey State Board of Education issued a certificate of incorporation in the name of "Institute for

Advanced Study: Louis Bamberger and Mrs. Felix Fuld Foundation." Flexner was hired as Director of this still unformed Institute that same month.

By September, 1931, Flexner announced that the Institute would initially focus on the subject of mathematics. The following year, Oswald Veblen joined the faculty and played an instrumental role in shaping both the intellectual and physical structures of what would become the Institute for Advanced Study (IAS).

2. WWI as Catalyst for Collaborative Experiences

By the time Veblen joined the faculty at the IAS, he had, among other achievements and accomplishments, earned his PhD at the University of Chicago under the direction of E. H. Moore, secured a position at Princeton University, put his mathematical skills to good use in World War I, and served as President of the American Mathematical Society. For the purposes of this study, we begin with Veblen's experience during the First World War when he served as an officer for the Army at the Aberdeen Proving Ground, where he organized and led a group of mathematicians that conducted research and experiments on ballistics. This war work seems to have underscored the relevance and value of collaboration for Veblen, an experience he had enjoyed as a student at the department of mathematics of Chicago University in the early 1900s.[1] This time, however, the collaboration not only included working with others but also connected mathematics with other academic fields and with urgent practical matters. WWI acted as catalyst for Veblen's understanding of collaborative experiences and "convinced him that the old ways of individual researchers were now outmoded; real advances were to be expected only through teamwork and the full mobilization of talents." [3, p. 151]

This idea of bringing people together to do mathematics and to use mathematics in other disciplines remained with Veblen when he assumed a critical role in the early years of the IAS. In particular, this study focuses on the tension that emerges in the correspondence between Abraham Flexner, the Director of the institute during the 1930s, and Veblen, regarding building a faculty (colleagues) and building a space (a physical structure) for faculty to do mathematics.

Using archival materials from the Oswald Veblen Papers at the Library of Congress and various collections at the Shelby White and Leon Levy Archives Center at the Institute for Advanced Study, as well as other primary source material, we highlight the tension between these aspects that, on the one hand, formed a unifying role in terms of building a viable Institute for Advanced Study and, on the other hand, stood in opposition to one another in terms of allocating resources.

3. Flexner's "free society of scholars"

We explore Flexner's ideas, ideals, and organizational plans for what he defined as a modern university, a place that he described in rather very abstract terms as a "free society of scholars." Having left his work as a philanthropic official at

[1]See, for example, Veblen's "Theory on Plane Curves in Non-Metrical Analysis Situs" where he documents the collaborative discussions in E. H. Moore's Foundations of Geometry seminar (p. 83).

FIGURE 1. Oswald Veblen in uniform. Library of Congress, Oswald Veblen Papers, Washington, DC.

the Rockefeller Foundation in 1928, he wrote *Universities: American, English, German* [2], a book where Flexner drafted ideas that would guide him for the years to come as the director of the institute to-be. In his words:

> Progress might be greatly assisted by the outright creation of a school or institute of higher learning, a university in the post-graduate sense of the word. It should be a "free society of scholars"–free, because mature persons, animated by intellectual purposes, must be left to pursue their own ends in their own way... It should furnish simple surroundings–books, laboratories, and above all, tranquility–absence of distraction either by worldly concerns... Provision should be made for the amenities of life in the institution and in the private life of the staff (1930b, 217–18 italics added).

As Flexner outlined, this "free society of scholars" hinged on the pursuit of "intellectual purposes" in "simple surroundings." Relative to the former, in his *Universities*, Flexner often criticized American universities for having, during the last decades, favored expanding undergraduate education while restricting the development of advanced research. In terms of the latter, Flexner advised caution when allocating funds for physical structures. "Large sums," he wrote, "have been wasted in useless or extravagant building schemes, 'side-shows,' as President Wilson called them" [2, p. 201]. This, he thought, did not contribute to

FIGURE 2. Repository: Front View of Fuld Hall (circa 1950), Institute for Advanced Study photographs. From the Shelby White and Leon Levy Archives Center, Institute for Advanced Study, Princeton (N.J.).

the development of higher education and research, for, in his terms, "we are precisely where we started, not enriched by an idea but impoverished by a building and funds" [2, p. 117]. The founding of the IAS highlights this conflict between Flexner's ideals about infrastructure and actual research as he aimed to manage and advance higher education in his new role.

4. Veblen's School of Mathematics in Flexner's Institute

When the School of Mathematics was established in 1933, Veblen served as its first Director. In this role, he worked alongside Flexner to shape this "educational Utopia." In our work, we contrast Flexner's ideals with those of Veblen's and, in particular, the tensions that arose between them.

In 1933, the roster of faculty members in the School of Mathematics read like a veritable "who's who" in mathematics. In particular, it included renowned national and international figures such as Veblen himself, the senior and highly

regarded German physicist Albert Einstein, and the German mathematician Herman Weyl, as well as two young scholars, the American mathematician James Alexander and Hungarian mathematician and mathematical physicist John von Neumann. The American mathematician Marston Morse would join the group in 1935.

Veblen played a pivotal role in bringing these individuals to the Institute for Advanced Study. As Flexner acknowledged to Veblen [4], "you are the real founder of the School of Mathematics.. You have chosen your associates.. You have chosen your own methods of working. My part in making the School of Mathematics what it is has been almost negligible." It can thus be fairly argued that while Flexner's role consisted of convincing the Trustees to make the appointments, it was Veblen who selected the scholars best suited for the institute project in mathematics. Even more, in most cases, Veblen also convinced these scholars to accept relocating to Princeton, a very small, traditional, and conservative town in the middle of the New Jersey.

In contrast with Flexner, however, Veblen advocated for a physical structure to make the "existence" of the IAS "as an independent entity physically visible." Specifically, Veblen argued that "the Institute should have, if possible, a large plot of land" and "a residential center analogous to an Oxford college without the monastic background." Veblen's commitment to collaboration and a sharing of talents was everywhere present in his outline of a physical space to "provide a recognized social nucleus for the Institute" [5].

This work highlights the tensions that animated the Veblen-Flexner relationship that were rooted in their contrasting approaches towards buildings and "seats of learning."

5. Building the Institute: von Neumann as a Case Study

The relationship between Veblen and von Neumann provides an insightful case study revealing Veblen's practices as Director of the School of Mathematics. For this aspect of our work, we rely extensively on their correspondence. Almost every year during the 1930s from May to September, von Neumann traveled to Europe for research purposes as well as to visit his family in Budapest. He also traveled across America. Von Neumann's letters to Veblen offer reports on his personal and family life, his mathematical activities, and his updates on "social, scientific and the other events"[6]. In particular, von Neumann outlined the progress of his research in mathematics and mathematical physics, often asking Veblen for advice and help on technical questions. Thus the Veblen-von Neumann relationship reveals that these two mathematicians, who are often presented as emblematic figures of pure mathematics, aspired to advance theoretical physics and other applications of mathematics during the 1930s.

In brief, the Veblen-von Neumann correspondence highlights the personal, social, political, and scientific aspects of the activities that linked their otherwise personal and professional lives. Taken together, they show that the uniting of these seemingly different spheres played a key role in creating the community of

mathematicians at the Institute, both in its very early stages and when the growing number of scholars at the Institute came to inhabit the same working space in 1939 in Fuld Hall.

6. Concluding Thoughts

Although this project initially began as a consideration of Veblen and his early contributions to the IAS, it quickly expanded to include Flexner and the associated tension that came with their shared and different perspectives. Our goal is to use tension as a lens to explore how the IAS took shape and, in particular, how Veblen contributed to this process. From there, we hope to extend our insights to highlight the favorable role of tension in contemporary questions in higher education.

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Reporter: Stephen Kennedy

Participants

Prof. Dr. David Aubin
Institut de Mathématiques de Jussieu
Histoire des Sciences Mathématiques
Case Postale 247
4, place Jussieu
75252 Paris Cedex 05
FRANCE

Prof. Dr. Benjamin Braun
Department of Mathematics
University of Kentucky
715 Patterson Office Tower
Lexington, KY 40506-0027
UNITED STATES

Dr. Juan Carvajalino
Université Paris 8
Laboratoire d'Economie Dionysien
2 rue de la Liberté
93200 Saint-Denis
FRANCE

Prof. Dr. Sloan Despeaux
Western Carolina University
Department of Mathematics and
Computer Science
426 Stillwell Building
Cullowhee NC 28723
UNITED STATES

Prof. Dr. Della Dumbaugh
221 Richmond Way
Dept. of Mathematics
University of Richmond
212 Jepson Hall
Richmond VA 23173
UNITED STATES

Dr. Samson Duran
EST-GHDSO,
UNIVERSITÉ PARIS SACLAY,
Bâtiment 407,
Rue du Doyen Georges Poitou,
91405 Orsay Cedex
FRANCE

Dr. Helena Durnova
Department of Mathematics
Faculty of Education
Masaryk University
Porici 31
603 00 Brno
CZECH REPUBLIC

Prof. Dr. Caroline Ehrhardt
Département de Mathématiques et
Histoire de Sciences
Université de Paris 8
2 rue de la liberté
93526 Saint-Denis Cedex
FRANCE

Dr. Emmylou Haffner
ITEM (CNRS/ENS)
45, rue d'Ulm
75005 Paris
FRANCE

Dr. Christopher Hollings
Mathematical Institute
University of Oxford
Andrew Wiles Building
Woodstock Road
Oxford OX2 6GG
UNITED KINGDOM

Prof. Dr. Stephen Kennedy
MAA/AMS Publications
1000 Greenleaf Ct
Northfield MN 55057
UNITED STATES

Dr. Deborah A. Kent
The Mathematical Institute
University of St Andrews
North Haugh
St. Andrews Fife KY16 9SS
UNITED KINGDOM

Prof. Dr. Jemma Lorenat
Pitzer College
1050 North Mills Avenue
Claremont, CA 91711
UNITED STATES

Prof. Dr. Erika Luciano
Dipartimento di Matematica
Universita degli Studi di Torino
Via Carlo Alberto, 10
10123 Torino
ITALY

Dr. Nicolas Michel
Bergische Universität Wuppertal
Fakultät 04 Mathematik und
Naturwissenschaften
Raum F.12.02
Gaußstr. 20
42119 Wuppertal
GERMANY

Dr. Deniz Sarikaya
Vrije Universiteit Brussel
Centre for Logic and Philosophy of
Science
Pleinlaan 2
1050 Brussels
BELGIUM

Dr. Laura Turner
Department of Mathematics
Monmouth University
400 Cedar Avenue
West Long Branch 07764
UNITED STATES