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From the Editor

Women in the History of Science

Mauro L. Condé[1]

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The importance of women's contribution to science and technology is far greater than what has traditionally been recorded in the history of science. These last few decades female participation in the production of scientific knowledge has increased, and as a consequence, the history of science has enhanced its focus on the role of women in science. Although these new approaches are only in the beginning, the narratives concerning women's history in science have highlighted not only their extraordinary participation in the production of scientific knowledge, but have also revealed much of what has been hidden by a patriarchal society that has dramatically hampered women's integration into scientific activity.

A historiographical reflection on the history of women in science, as a "transversal" reading, is something that aims to participate in this process of understanding the role and integration of women in science. Therefore, rather than addressing this history of women in science, it is necessary to have possibilities and reflect on such historical accounts. That is to say, rather than producing the narratives of female participation in science and technology – a crucial task in itself – we need to analyze them from this "transversal" perspective. By putting forward this special issue, this "transversal" perspective was the objective of our editors. The inspiration was to seek answers to questions such as: 1) does the historiography of women in science already adequately track the production of scientific and technological knowledge by women?; 2) are there differences of a historical narrative about women in the sciences produced by women themselves?; and 3) what is the role of men in this endeavor? Perhaps, it is only between the lines that this special issue is able to answer such complex questions as these, but certainly, these are open-ended questions about which, in a broader sense, we have just begun to perceive, feel, and understand. Special issues such as this can provide valuable aid in this process of study.

We need more clarity and discussions about the course we need to take to deepen this vital issue of women in science. Perhaps, I am much more guided by the idea that it is necessary to do something than accurately know what to do. I have been marked by this problem more by personal experience than by historical analysis. My daughter and son have chosen to pursue careers in technology (Engineering) and science (Physics). At the beginning of their undergraduate studies, I set out to provide them with some questions about women's participation in science and technology. At that time, they had no clear position as

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to whether or not there was a real difference in the treatment of girls and boys pursuing a scientific or technological career. Years later, at the end of their studies, they had informed opinions and a deeper awareness of the subject as well as identified some significant differences, if not stronger in the formation, indeed in the reception given by society to women scientists or engineers. Needless to say, my daughter's position on these disparities was far more compelling. Even when perceiving the effort made by the university to reduce such differences, it is clear that we live in a society that is deeply marked by its patriarchal roots that still affect women in many ways. This is notably when women exercise specific tasks and duties, including those in science and technology.

Although there have been many changes in Western culture, this restriction imposed on women still persists, which causes me a great deal of discomfort. I feel that, in order to change this picture definitively, among the many actions and changes in attitudes, it is also necessary to think of a pedagogy that helps us, men and boys, to enter into this new context with more clarification as to what our role is in society.

I hope that women and men in the near future, all over the world (even knowing that this future reaches different places at very different times) can coexist equally in social life, the world of work, and particularly when cooperating on the production of scientific and technological knowledge. I also hope that this segregation of women in the science will soon be a sad and distant memory, so that it can always serve as a warning to all on the path that guides us into the future.

I would like to express my sincere thanks to Andrea Reichenberger (Paderborn University) and Moema Vergara (Mast – Rio) for accepting to lead the organization on the dossier *Women in Sciences: Historiography of Science and History of Science – On the Work of Women in Sciences and Philosophy*. Without their expertise, competence, and zeal, this dossier would not have existed.

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Special Issue – Women in Sciences: Historiography of Science and History of Science – on the Work of Women in Sciences and Philosophy

Introduction

Andrea Reichenberger[1]
Moema Vergara[2]

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Women's participation in the advancement of science and the discussions of philosophical issues have a long history. In fact, their participation in the production of knowledge is as old as mankind itself, or in order to avoid the generic use of "man" and to use gender-neutral language, it would better to say that it is as old as humanity itself.

In 1690, Gilles Ménage published the first-ever history of women philosophers, *Historia mulierum philosopharum* (*History of women philosophers*), which provides an account of 65 female philosophers from the past 2,500 years. The Paris intellectual, Ménage, advocated for the appointment of women to the *Académie française*, arguing that their contribution had greatly enriched science and philosophy. Nearly 100 years later, in 1775, Christian August Wichmann wrote the German encyclopedia entitled *Geschichte berühmter Frauenzimmer* (*History of famous women*).

Despite such remarkable exceptions, women usually remained unnoticed in the historiography of philosophy and science. Nowadays, there is a growing awareness of the importance of academic studies concerning women's contributions in the humanities and sciences. This is demonstrated by the numerous research projects and emerging funding priorities in universities worldwide. The reason for this positive development is, in a few words, gender equality. Which is defined as a fundamental right, an internationally agreed upon sustainable development goal, and an essential feature of stable and transparent democracies. The historiography of science, which analyzes scientific knowledge production in its many social implications as well as its epistemological and educational presuppositions, plays an important role here and bears a significant responsibility. It is of utmost importance that we practice what we preach, i.e., that we include women's contributions to the problem-

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oriented and systematic discourse of the current historiography of science and science education.

Learning from history does not guarantee that we can solve contemporary problems and open questions, but this knowledge can contribute to a better understanding and approach to these problems and issues. "Only those who know the past can understand the present and shape the future". This sentence, attributed to the Social Democrat August Bebel, carries with it a special, modified meaning against the background of the promotion of women and gender equality: "Only those who are able to rethink the past can shape the future". We have learned that without a well-established science education, science has no future. We should learn and understand that without a well-established integration of women in the historiography of science, the promotion of women in science has no future. What we need are not only gender-sensitive studies and quantitative-statistical evaluations of women's under-representation in research and teaching practice, but also the approaches that have the potential to reform and diversify our picture and image of science.

In the second half of the twentieth century, the feminist movement was fundamental to the entry of feminist studies into the Academy. It opened a new field of study that was complex and interdisciplinary and which, among other things, made a revision of the Marxist historiography that saw the main motor of history as a class struggle and furthermore, made women invisible in the historical narrative.

Feminist criticism and its attack on patriarchalism have made society rethink concepts, such as Man, Truth and Science as rigid categories that are committed to progress and always focused on the common good. It was within the context of women's studies that gender studies emerged, especially around the 1970s, which in turn was strongly influenced by anthropology. Therefore, the main point was made by the critique of essentialism, to the extent that (insofar as) Simone de Beauvoir said, "one is not born, but rather becomes, a woman" (de Beauvoir 1952 [1949], 249).

The feminist movement became increasingly involved in the dynamics of theories, in the change of scientific categories and in the great intellectual revolutions. At the same time, Kuhn's 1962 seminal work, *The Structure of Scientific Revolutions*, has become a modern classic. For many people, this book became part of the scathing criticism of the status quo by placing the demand for a paradigm shift in the social and political agenda, whether in the role of women in society, economic development, technology, ideology or the writing of history. In retrospect, it might appear as an irony of history that this book, written by a man, and its central concept of a *paradigm shift* became legendary, while Margaret Masterman's criticism of Kuhn's vague and inconsistent use of the concept "paradigm" has been forgotten as much as the contributions of women to this discourse.

According to gender studies, male and female categories are socially produced and relational. In order to advance in social studies, it is important to understand women and men in other categories such as social class, race/ethnicity, and religion, among others. Since there is no universal man, there is no universal woman either. We have learned from feminist studies that gender identities are cultural and are manifested not only in our bodies, but in language, philosophy, and worldview. Nevertheless, we still live in a world marked by gender differences in terms of access to employment opportunities and wages. Discrimination in the political sphere has shifted from the struggle for the right to vote to greater political representation. Furthermore, the public still identifies scientific activity with men in white coats, so in this sense, the struggle is still going on and the envisaged inclusion of women into the historiography of science is only marginally achieved.

This special issue aims to contribute to a historiographical reflection on the history of women in science as a "transversal" reading. It consists of two contributions to individual female figures, namely to Helena Antipoff (by Regina Campos and Erika Lourenço) and Sofia Alexandrovna Yanovskaya (by Dimitris Kilakos). Moreover, we have two studies providing a general overview of the state of research regarding the impact of women in computer science history (by Karina Mochetti) and in the history of modern logic (by Karin Beiküfner and Andrea Reichenberger). Last but not least, Sandra Benítez Herrera and Patrícia Figueiró Spinelli offer a report on a school teaching project which demonstrates that the historiography of women in sciences is a valuable resource that can be used in all educational levels as well as museums. The contributed papers reaffirm that a lot of work still needs to be done. They are rather excerpts of a work in progress than a systematic overall presentation. We are grateful to Mauro Condé, who initiated this special issue and assisted and advised us with patience and precision.

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Special Issue – Women in Sciences: Historiography of Science and History of Science – on the Work of Women in Sciences and Philosophy

Women and Logic: What Can Women's Studies Contribute to the History of Formal Logic?[1]

Karin Beikúfner[2]
With a commentary by Andrea Reichenberger[3]

Abstract:

Beiküfner's report reflects on woman's place in the history of logic. These reflections date back to a larger research project entitled *Case Studies Towards the Establishment of a Social History of Logic* (1985–1989). The project was initiated under the direction of Professor Christian Thiel, University of Erlangen-Nuremberg, and funded by the German Research Foundation DFG. The main focus of the Erlangen research project was laid in the historical analysis of the emergence of modern logic in Great Britain and Germany during the 19th and early 20th century. This research prompted the discovery of a series of important female authors in the Anglophone and German speaking area. This led, firstly, to the question of what might be gained from the research results for the project's objectives and, secondly, to a closer examination of the methodological demands and problems of a feminist historiography of science.

Keywords: Female Logicians; History of Logic; Erlangen Logic Documentation; Feminist Historiography of Science

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In today's lecture, I do not want to present any new research results, but rather perform a stocktaking of my previous work. Particular research projects in the field of "Women and Logic", or "Women in the History of Logic", could be continued in various directions. Within

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[1]The following article is the English translation of a short report by Karin Beiküfner. The German original was published in 1989 as "gray literature" within the research project *Case Studies Towards the Establishment of a Social History of Logic* (1985–1989), funded by the German Research Foundation – DFG. Thus, with this English version republished in a journal directed towards a large and specialized audience, we hope to give Beiküfner's ideas the attention they deserve. Karin Beiküfner: "Frauen und Logik. Was kann Frauenforschung für die Geschichte der formalen Logik leisten?" *Arbeitsberichte aus dem DFG-Projekt Fallstudien zur Begründung einer Sozialgeschichte der Logik*, No. 25, [Erlangen] July 1989, pp. 22–26. We would like to thank the author Karin Beiküfner and the editors of the report series, Volker Peckhaus and Christian Thiel, for their permission to translate and publish the contribution.

[2] Karin Beiküfner is a former member of DFG project *Case Studies Towards the Establishment of a Social History of Logic* (1985–1989) which was initiated under the direction of Professor Christian Thiel, University of Erlangen-Nuremberg. As a graduate student, she has written 13 reports within the project. After completing her master's degree, she worked for private foundations dedicated to the promotion of interdisciplinary research.

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the framework of our research project, the current problem is, therefore, the weighting of the particular research directions and the integration of women's works in the context of the overall project.

Since the topic "Women in the History of Logic" was not initially part of our research project, I would like to briefly describe how this research came about. In the history of logic, several authors mention female logicians. However, hardly any details about these women are given. Therefore, we picked them out and investigated them in the same manner as the other authors. First, the most important biographical and bibliographical data were determined. In this context, it quickly became clear that these female logicians worked in completely different social and institutional environments. Further, the conditions under which they developed their contributions to formal logic were substantially different from those of their male colleagues.

The question as to how the unequal conditions of scientific work for men and women could be taken into account led to a closer examination of the methodological demands and problems of a feminist history of science. The subject of this still very young discipline is the question of how women can be methodologically recorded as subjects and objects of historiography. Initially, our project *Case Studies Towards the Establishment of a Social History of Logic* was not intended as a feminist project in which the discovery and research of women in the history of logic occupy a central position. This led to the question of what might be gained from the research results for the project's objectives and how the newly developed sub-project "Women in the History of Logic" can be integrated into the overall context of the project. We defined the following six areas of research:

Biographical Research

A major focus, especially at the beginning, was the compilation of the most important biographical data of those women who were mentioned in works on the history of logic and by logicians. Among others, *Christine Ladd-Franklin, Emily Elizabeth Constance Jones, Susanne K. Langer, Grace Chisholm Young, Janina Hosiasson, Lizzie Susan Stebbing*, and *Sophie Bryant* were recorded. In the near future, the biographical data regarding *Marie Deutschbein* and *Jane A. Winscom* will have to be supplemented, but this still requires further extensive historical research.

Bibliographical Research

Subsequent to the data collection and biographical overview, a compilation of the works published by the respective female logician is planned, which is currently only available from E. E. C. Jones.[4] Bibliographical material on the other female logicians is only fragmentarily available so far. The acquisition of the logical works also encounters some technical difficulties, since not all monographs or journals, in which the women have published their works, are accessible via the national library lending system. The purpose of the bibliographical research is to answer the question of what importance the logical works have concerning the female authors' oeuvre as a whole and how their contributions to formal logic are to be evaluated.

[4]Unfortunately, this bibliography of the works of E. E. C. Jones cannot claim to be complete. See Karin Beikúfner, "A New Law of Thought? Zur Biographie der Werke von Emily Elizabeth Constance Jones", *Arbeitsberichte aus dem DFG-Projekt Fallstudien zur Begründung einer Sozialgeschichte der formalen Logik* No. 21 (December 1988), 18–26.

Documentation and Evaluation of Logical Works

A substantive discussion of the works written by female logicians has so far only be done for Christine Ladd-Franklin.[5] The connection to other logicians and the reception of their works has to be examined.

Reception of the Works of Female Logicians

Starting from women's writings on logic, the question must be asked in which context these works were created, and which influences become visible, i.e., whether and in what way these works refer to other logicians. Conversely, it is necessary to examine by whom and in what way the logical works of women were received. In this context, particular attention is paid to the question whether the fact that these authors were female logicians influenced their reception.

The History of Institutions

The reconstruction of the conditions under which women worked in the field of formal logic includes, besides the investigation of the socio-cultural environment, a history of the institutions providing the possibility of scientific activity, i.e., the educational institutions accessible to women. For the period of our project, the problem of women's education and access to scientific institutions was at the center of the demands of the feminist movement. So far, the history of women's studies and the discussion on the admission of women to higher education have been outlined for the nations of Germany, Switzerland, England and the United States of America, which were relevant to the development of formal logic. In addition to the general scientific working conditions, the question of the possibilities of working in the field of logic and participating in the internal discussions in this field is to be answered in particular.

Methodological Problems of the Integration of Female Logicians in the Overall Context of the Research Project

Finally, the different working conditions for women compared to those for men require a methodological reflection on the treatment of female logicians within the framework of a social history of formal logic. The question of how the different working conditions that were and are valid for women should be taken into account is not only an important part of fundamental considerations in writing the history of logic, but also in the historiography of other scientific disciplines. The criticism of traditional sciences studies from feminist perspectives as well as several feminist positions regarding the philosophy of science has already been discussed and will be published in the near future.

Open Questions

The research results on women in the history of logic raise a whole series of specific historical and methodological-theoretical questions that are currently still unanswered and probably cannot be answered satisfactorily within the time-frame of the project. The current interesting questions are as follows:

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[5] See Volker Peckhaus, "Brilliant young lady-mathematician – Ernst Schröders Urteil über Christine Ladd-Franklin", *Arbeitsberichte* No. 16 (March 1988), 38–54.

- How can women's studies be legitimized within a history of logic which is the subject of our project?

- Can the impression be verified that the percentage of women in the formal sciences – logic and mathematics – is significantly high? Is a comparison with other disciplines at all possible or meaningful?

- Is there a demonstrable connection between the activities of women in the scientific field and their involvement in the feminist movement?

- Can the social-historic approach to the history of logic be combined with the demands of a feminist history of science, or at least brought into accordance?

A well-founded answer to these questions presupposes, however, that the historical research on women in the history of logic is first continued.

Commentary by Andrea Reichenberger

The DFG project *Case Studies Towards the Establishment of a Social History of Logic* (1985–1989) was initiated under the direction of Professor Christian Thiel, University of Erlangen-Nuremberg. Christian Thiel has worked on topics related to the history of modern science, in particular on the logic of the 19th and 20th centuries and the work of Gottlob Frege (Thiel 1965, 1982, 1995, 2006). The members of the research group were (in alphabetical order): Karin Beikúfner, Thony Christie, Randolf Hümmer, Volker Peckhaus, and Michael Sperl. The members of the committee with whom there was an exchange of experiences and research results were: Irving H. Anellis, Ivor Grattan-Guinness, Gerhard Heinzmann, Dieter Hoffmann, Lothar Kreiser, Albert Lewis, and Jan Woleński. A total of 97 reports written by the members of the research group were published as "gray literature".

Volker Peckhaus has written two reports on the status of the project, one for the period from 1985 to 1987, the other for the period from 1987 to 1989 (Peckhaus 1989; see also Peckhaus 1986 and Peckhaus 1997). Both reports together give us a well-founded overview of the research organization and document the research process. They summarize the aims and scopes of the theoretical framework of a social history of logic by emphasizing the primacy of a problem-oriented reconstruction of ideas.

The methodology of the project, called "Contextual historiography of scientific disciplines" (see Peckhaus/Thiel 1999), was divided into two parts: a quantitative data collection and a qualitative analysis. At the end of the project, the databases consisted of 1025 persons. The qualitative analysis was divided into three topics: (i) case studies about logicians, (ii) case studies about logical textbooks, (iii) case studies about teaching classes. The focus was on the historical development of the algebraization of logic in Great Britain and Germany in the 19th century and the institutionalization of mathematical logic in the early 20th century. A Documentation Center for the History of Formal Logic was planned, but could never be realized. The Erlangen Logic Documentation is now at Paderborn University, in the archive at the professorial chair of Volker Peckhaus.

Research on female logicians within the DFG project was prompted by a series of important contributions to modern logic by female authors in the Anglo-American area, among them Christine Ladd-Franklin and Emily Elizabeth Constance Jones. In Peckhaus' reports, this research is subordinated under historical research on education and plays only a minor role.

At the end of the project's period, the "Erlangen Documentation" included 60 female logicians from twelve countries, 22 of whom are also mentioned in Alonzo Church's *Bibliography of Symbolic Logic* (Church 1936/1984). The period of coverage begins in 1725 with Johanna Charlotte (Unzer 1751). In total, the documentation recorded sixteen German-speaking women: Lilly Buchhorn, Marie Deutschbein, Olga Hahn, Elli Heesch, Grete Henry-Hermann, Lily Herzberg, Philippine Freiin v. Knigge, Edith Landmann, Hilda v. Mises, Martha Moers, Wilma Papst, Rosemarie Rheinwald, Amalie Rosenblüth, Karoline Schelling, Johanna Charlotte Unzer, Elisabeth Walther-Bense.

Pioneering work in this field has been carried out by Karin Beikúfner, supported by the Erlangen group members Michael Sperl, Christian Thiel, and Volker Peckhaus. Their reports were published as "Arbeitsberichte" within the Erlangen-DFG-project. Most of them were never published anywhere else. Karin Beikúfner has written 13 reports: "Christine Ladd-Franklin und die John Hopkins University", "Sophie Bryant (1850–1922)", "Emily Elizabeth Constance Jones (1848–1922)", "Christine Ladd-Franklin (1847–1930)", "A New Law of Thought? Zur Bibliographie der Werke von Emily Elizabeth Constance Jones", "Zum Frauenstudium in den USA. Christine Ladd-Franklin und die Johns Hopkins University", "Zum Frauenstudium in Deutschland: Sonja von Kowalevsky in Heidelberg", "Die Entwicklung des Frauenstudiums in Deutschland zwischen 1850 und 1910", "Berichte ausländischer Studentinnen über ihr Studium an deutschen Universitäten Ende des 19. Jahrhunderts", "Der Beginn des Frauenstudiums in Großbritannien", "Frauen in der Wissenschaftsgeschichte. Überlegungen zu einem frauenspezifischen Zugang", "Schreiben Frauen eine andere Wissenschaftsgeschichte? Zur feministischen Diskussion der Wissenschaftsforschung", "Frauen und Logik: Was kann Frauenforschung für die Geschichte der formalen Logik leisten?".

Michael Sperl has contributed to Janina Hosiasson-Lindenbaum, Susanne Katharina Langer, and Lizzie Susan Stebbing and Volker Peckhaus to Christine Ladd-Franklin and Olga Hahn. Christian Thiel has reported on "Davies' (Psycho-)Logical Ladies", and "Zur Mitarbeit von R. Adamson, C. Ladd-Franklin und C. S. Peirce an Baldwins Dictionary of Philosophy and Psychology." Thiel has also published an article about "Philippine Knigges Versuch einer Logic für Frauenzimmer", in: *Adolph Freiherr Knigge in Kassel*, ed. Birgit Nübel (Weber & Weidemeyer: 1996, 98–06).

The Erlangen work on women in logic was later continued by Adelheid Hamacher-Hermes in the RWTH-funded project *Women in Logic at the Beginning of the 20th Century in Germany* at the University of Aachen (1994–1996). Her final report (Hamacher-Hermes 1996) includes short biographical and bibliographical information as well as documentation and evaluations regarding the following women: Buchhorn, Lilly; Deutschbein, Marie Anna; Haack, Hildegard; Hahn, Olga; Heesch, Elli Johanna Anna; Herzberg, Lily, *née* Wagner; Kahl-Furthmann, Gertrud, *née* Furthmann; Krenz, Editha; Landmann, Edith , *née* Kalischer; Mises, Hilda v., *née* Geiringer; Matzun, Uta; Moers, Martha Franziska Constanze; Papst, Wilma; Rand, Rose; Rosenblüth, Amalie; Schmitz, Thekla. Hamacher's comprehensive report never officially appeared. She published two articles, one about Rose Rand (Hamacher-Hermes 2003), another about Elli Heesch (Hamacher-Hermes 2008).

Both Hamacher and Beikúfner's research intended to make the contributions of women visible and to evaluate their works for the developments in logic under their particular conditions of origin. Against this background, Beikúfner and Hamacher-Hermes have investigated the educational situation of women at the beginning of the 20th century in Germany, after the universities were opened to women. The demonstrably good performance of women in the formal sciences, especially in mathematics, has encouraged discussions about women and logical thinking worldwide (or, at least, in the Western world). In 1893, Christine Ladd-Franklin, well-known for her contributions to symbolic logic and the theory of color vision, intervened in the discussion. In her article "Intuition and Reason" in *The Monist*, Ladd-Franklin remarked:

> It is not true that men's minds and women's minds have a different way of working; [...] It is not true that the Creator has made two separate kinds of mind for men and for women; but it is true that society, as at present constituted, offers two somewhat separate fields of interest for men and for women, and that the nature of their conduct is of necessity determined by the character of the action which is demanded of them. (Ladd-Franklin 1893, 211f.)

Christine Ladd-Franklin's strong passion for promoting and advancing women in academia is one of many examples for the impact of the feminist movement on science and on the education system in the late 19th century. During this period, a number of articles and monographs appeared on this topic. Noteworthy is Alphonse Rebière's book *Les femmes dans la science*, published in 1894 (Rebière 1894). It followed the encyclopedia format, listing the women alphabetically, giving their names, dates of birth, the social conditions under which they had lived, their contributions and publications. Also in Germany, renowned mathematicians were committed to the advancement of women, among them Wilhelm Lorey, Felix Klein, and David Hilbert. In Germany, the controversy over the admission of women to universities culminated at the end of the 19th century. In November 1895, Berlin newspapers announced that Heinrich Treitschke and Eric Schmidt had expelled several women from their classes. In the following year, the theologian Arthur Kirchhoff invited 103 leading university professors and intellectuals (all males) to discuss the prospects of admitting women to German universities (Kirchhoff 1897). In Kirchhoff's volume, several famous scientists advocated better educational opportunities for women, among them Felix Klein, who highlighted foreign female mathematicians as outstanding examples. However, some of them also expressed deep prejudices about women's academic work, among them Max Planck.

The undeniable gender differences in academic careers are well and widely explored. In comparison, there are hardly any studies about female logicians in German-speaking countries until today. Beiküfner and Hamacher-Hermes' studies are one of the few exceptions. A problem-oriented integration of women's contribution within the framework of a social history of logic and its reconstruction of ideas is missing until today. The focus of the Erlangen research project, namely the historical development of modern logic in Great Britain and Germany, would have been perfectly appropriate for this purpose. At this point, we want to give an outlook for highly relevant possible research in the near future.

According to widespread opinion, "the great epoch in the history of logic did open in 1879, when Gottlob Frege's *Begriffsschrift* was published" (van Heijenoort 1967, vi). This work "presented to the world, in full-fledged form, the propositional calculus and quantification theory" (ibid.). Frege rested his logic not on the distinction between propositions and terms or between subject and predicate but instead on the distinction between function and argument. Therefore Frege is often called the founder of modern logic. Historians of logic have criticized that the claim of a "Fregean" revolution neglects the complexity of the historical development and reduces the algebraic logic of Augustus De Morgan, George Boole, Charles Sanders Peirce, and Ernst Schröder as belonging to the Aristotelian tradition. Today, there is a broad agreement that when Frege published his quantification theory, an equivalent one was (being) developed at the same time in the school of Charles S. Peirce, later taken over by Schröder, and extensively discussed in the second volume of the *Vorlesungen über die Algebra of Logik* (Schröder 1891). Later, the theory of quantification became known as classical first-order logic. The early part of the 20th century witnessed the discovery of many of its deepest properties through the development of metalogic and proof theory, especially in the form of model theory and recursion theory. That is all well-known, thoroughly documented and widely discussed.

It is an astonishing fact that women's contribution to that development are excluded from standard textbooks and introductions until today, although many of their works have been known for a long time and are the subject of well-funded historiographical studies. The new view of algebra as the study of operations captured by rules for the symbolic manipulation of formulae suggested the possibility of applying this approach to domains other than numbers, or mathematics in general. It was Ada Lovelace who hinted at this in her brief proposal of a machine to compose music (see Priestley 2011, 68; Hollings et al. 2017). The first application of these ideas to a domain outside mathematics was then made by George Boole, whose overall goal was to mathematize logic.

Among others, Volker Peckhaus has shown that the British tradition of the algebra of logic was recognized in Germany with a delay of 30 years (Peckhaus 2012, 2005). In this context, the German mathematician Ernst Schröder played a key role. Schröder was not only heavily influenced by Peirce, but also by Christine Ladd-Franklin and her study of William Stanley Jevons and Hugh MacColl. Ladd-Franklin, in turn, was well acquainted with both Schröder's and Peirce's work. She reviewed Schröder's logic in *The Mind* (Ladd-Franklin 1892). In turn, it was Schröder who drew her attention to Frege's *Begriffsschrift* (Frege 1879). Ladd-Franklin, on the other hand, drew Peirce's attention to Schröder's review of Frege in the 1880 *Zeitschrift für Mathematik und Physik* (Anellis 2018). As many logicians of that time, both Ladd-Franklin and Schröder underestimated the importance and innovative aspect of Frege's ideas.

Frege became known to a wider circle of (anglophone) readers after the appearance of Bertrand Russel's *Principles of Mathematics* (Russell 1903). Emily E. Constance Jones discussed Russell's *objections* to Frege's theory in the form of an elaborated critique (Jones 1910). In her *Modern Introduction to Logic* (Stebbing 1933), Lizzie Susan Stebbing referred to both Ladd-Franklin and Jones, although she did not discuss them. But let us come back to the German-speaking female logicians.

According to Irving H. Anellis, "the conception of a Fregean revolution was further disseminated and enhanced in the mid-1920s thanks to Paul Ferdinand Linke" (Anellis 2011, 134), who came to Jena in 1907, where he taught until the end of his days. In 1946, Linke published an article entitled "Gottlob Frege als Philosoph" (Linke 1946). Linke did not present an introduction to Frege's philosophy, but interpreted Frege through the glasses of the Brentano-school. A much more challenging and worth reading introduction was offered 13 years earlier by Wilma Papst. Her book has the same title: *Frege als Philosoph* (Papst 1933).

Papst not only presents an overview of Frege's philosophy, but discusses its ontological premises and epistemological implications in detail and contextualizes the results within the historical background, by comparing Frege with Husserl, Bolzano, and Russell, just to give a few examples. In an original way, she combines her interpretation with Hermann Weyl's reflections on the relationship between formal symbolism and the construction of the real world and tries to build a bridge between logicism and formalism via Gestalt theory. Linke did not refer to her contribution, but he was probably familiar with her work, at least since 1954. In this year, Günter Mortan, who was an assistant of Linke in Jena, finished his dissertation *Gottlob Freges philosophische Bedeutung* (Mortan 1954), in which he made several references to Papst. Linke was the first referee and supervisor of Mortan's doctoral thesis. The second referee was the Neo-Kantian Hermann Johannsen, who became one of the most important representatives of modern logic in the DDR after the Second World War.

One of Johannsen's early students was Editha Krenz, who received her doctoral degree in 1942 with a work on Frege's concept of number at the University of Vienna (Krenz 1942). In her curriculum vitae, she mentions Johannsen as the one who advised her to work on Frege, when she was studying in Jena. Krenz's work was an important contribution to Frege's philosophy of arithmetic. Influenced by Friedrich Waismann's *Introduction to Mathematical Thinking: The Formation of Concepts in Modern Mathematics* (Waismann 1936), she also reflected on foundational issues in the light of Gödel, Gentzen and Skolem after and beyond Frege.

Particularly worth mentioning are the contributions of female logicians within the Vienna Circle (Hilda Geiringer v. Mises, Olga Hahn (Neurath), Rose Rand, Amalia Rosenblüth et al.) and the Lwów–Warsaw school (Eugenia Blaustein, Daniela Gromska, Janina Hosiasson-Lindenbaum, Maria Kokoszyńska-Lutmanowa, Janina Kotarbińska et al.), which cannot be explicitly addressed here. It remains to be desired that logic experts recognize the relevance of the task to investigate, evaluate and interpret the works of female logicians. At the very least, I hope that my short commentary has demonstrated that women have highly contributed to the history of modern logic.

Much harder to answer is the question of how a problem-orientated historiography of logic can be combined with the demands of a feminist history and philosophy of science. Karin Beikúfner has given a remarkable approach that should be pursued and expanded.

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Special Issue – Women in Sciences: Historiography of Science and History of Science on the Work of Women in Sciences and Philosophy

Helena Antipoff: Science as a Passport for a Woman's Career between Europe and Latin America

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Abstract

Helena Antipoff was one of the pioneers in the constitution of the fields of knowledge of educational psychology and special education in Brazil. Born in Russia, Antipoff received her education in Paris and Geneva. Researches in the history of education and of psychology have revealed the innovative character of Antipoff's work as a researcher, as a professor and as a founder of different educational institutions in Brazil, with a focus on educational and psychological care for children with disabilities or at social risk. Her career is characterized by a sound scientific approach combined with a deep commitment to the right of children and youth to education and care. These directions can be associated with her scientific training in the sciences of education in a time of social turbulence and school reform, when many women became professionals in the field of education, trying to combine family, work and militant activity.

Keywords: Helena Antipoff; History of Psychology; Educational Psychology; Psychology of the Exceptional; Special Education; Women in Science; Women in the Sciences of Education

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Introduction

Helena Antipoff (1892-1974), a Russian psychologist and educator, settled in Brazil from 1929, played a role of great relevance in the establishment of areas of study and research in psychology and education in the country. She was educated in Saint Petersburg,[3] Paris, and

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[3] The name of the city of Saint Petersburg, in Western Russia, changed to Petrograd (1914-1924) and later to Leningrad (1924-1991). With the end of the Communist regime, it reverted to the old name (*Le*

Geneva, and worked in institutions for the shelter and education of abandoned children, in a social-risk situation, in revolutionary Russia between 1917 and 1924. Subsequently, she was an assistant professor at the University of Geneva (1927-1929), and in 1929, because of this work, she was invited to direct one of the first laboratories of pedagogical psychology established in Brazil, linked to the Teachers' College in Belo Horizonte, capital of the State of Minas Gerais. In this position, in the following years, she participated actively in the movement to renovate the public school system of Minas Gerais and in the formation of educators and psychologists. She acted as professor, researcher and creator of educational institutions such as the Pestalozzi Societies of Minas Gerais and Brazil, the educational complex of the Rosário Farm, in Ibirité, Minas Gerais, and several other initiatives for the education of children with disabilities, and in the preparation of professors and specialists for special education, rural education and public education in general.

In the Psychology Laboratory of the Teachers' College, the research carried out by Antipoff and her students had the objective of describing the psychological and psychosocial characteristics of Belo Horizonte schoolchildren. The focus of the investigation were children's ideals and interests, their cognitive and socio-affective development, and their life in the family and at school. The idea was that the knowledge of the child and the adolescent was necessary to best orientate educators in the educational process. This was inspired by the ideas of educational renovation defended by the doctor and psychologist Édouard Claparède (1879-1940), and his colleagues, the founders of the Jean-Jacques Rousseau Institute, a college of preparation in educational sciences founded in Geneva, in 1912. The institutions whose creation was initiated and orientated by the Russian educator in the years 1930-1940 – the Pestalozzi Society of Minas Gerais, and the Pestalozzi Society of Brazil – , had the objective of caring for children and adolescents with deficiencies, particularly of those that presented deficiencies or problems of mental health, utilizing innovative methodologies, in harmony with the most advanced scientific discoveries of the time. In 1939, Antipoff inaugurated the chair of psychology in the recently established Faculty of Philosophy, Sciences and Letters of the University of Minas Gerais, initiating her work of preparing educators at university level (Alvim, 1954; Haddad, 1988). In this position, she contributed to the university education of some of the members of the first generation of Brazilian psychologists and helped to initiate the movement for the legal regulation of the profession in Brazil.[4] She also continued to expand the applications of psychology to education, as a psychologist herself and also through her students, who came to learn with her from diverse Brazilian states, and also from other countries in Latin America. New methods were taught in the education of children with disabilities or in the preparation of teachers for the public schools, both in rural and urban areas. In 1972, she became an emeritus professor at the Faculty of Education of the Federal University of Minas Gerais for her outstanding contribution to the theory and practice of psychology and education and to the preparation of new generations.

Her work was characterised by a solid theoretical foundation, obtained in the studies in educational sciences that she did in Europe, and by a concern in applying the knowledge in the resolution of the practical problems encountered in the process of institutionalisation of the public health and educational systems in Brazil. Her sensitivity to local culture helped her transcend frontiers and promote the development of institutions focused on the realization of the fundamental human rights of needy populations in a situation of social-risk,

Petit Larousse Illustré 2002, 1655). In this article, we shall use the original and current denomination of Saint Petersburg.

[4] The movement for the legal regulation of the profession of psychologist and the establishment of university courses for the training of psychologists in Brazil was initiated by educators, psychiatrists and other professional in the beginning of the 1950s and was successful with the approval of Law 4119 in August 27, 1962. (Brasil, 1962)

contributing to make her an outstanding leader in popular education, in special education, and in rural education in Brazil (Campos, 2010, 2012; Lourenço, 2000)

In this text, we shall accompany her professional trajectory using her own reports and those of the people who were closest to her, such as her son, the psychologist Daniel Antipoff (1919-2005), her husband, the Russian writer Viktor Iretsky (1882-1936), and her friend and master from Geneva, Édouard Claparède. We shall try to comprehend her courageous decisions in this web of personal and professional relationships where she made her way. We utilize as sources for the narrative the correspondence and writings published by the personalities in this fascinating story, affected by the extraordinary political events of the 20th century. Among them, we single out the biography written by her son, the correspondence conducted with Édouard Claparède between 1915 and 1940, carefully organized and edited by Martine Ruchat of the University of Geneva, and the correspondence between her and her husband Viktor Irestky during the years 1920-1930, recently found in Moscow.[5] (Antipoff, D. 1975; Ruchat 2010; Iretsky to Antipoff, H. unpublished manuscripts). Also important are studies about the Antipoff's life and works in France, Russia and Switzerland during the difficult years of war and revolution in the early 20th century. (Campos, 2010; Ruchat, 2012; Masolikova & Sorokina, 2018)

Helena Antipoff`s biography reveals important aspects in the experience of women who, like her, sought to combine family tasks with professional obligations throughout the 20th century, and who were also militants in the movements for educational reform, trying to make education more humanized and concerned with the rights of the children. The social and cultural transformations provoked by the accelerated industrialization and urbanization that occurred during the 19th and 20th centuries led many women to participate increasingly in the productive processes and to assume progressively the tasks of caring for and educating children and young people in the large mass education systems that were set up in several countries. Institutions destined for the education of the very young, and primary and secondary education sprang up in the large cities and industrial areas, promoting the development of new methods and educational processes. In the middle of the population movements, the wars and revolutions, the progressive construction of the area of sciences in education and of a new education movement were also being organized (Éducation Nouvelle, in the francophone tradition, New Education, in the Anglo-Saxon, Reformpädagogik in the Germanic countries). This multifaceted movement was born out of these new educational experiences that were being disseminated, transforming the ways of educating and promoting cultural standardization, as well as the listening and institutional care of children and young people. In recent years, much research has been done on the ideas that circulated worldwide from these educational innovations, and on the participation of women in their preparation (Hameline, Helmchen and Oelkers 1992; Haengelli-Jenni 2012, 2015; Droux and Hoffstetter 2015; Gutierrez, Besse and Prost 2012). Studying the participation of women in the New Education Fellowship, founded in Calais in 1921 by a group of educators and scientists of education interested in promoting educational renovation and peace through education, Haengelli-Jenni observed that belonging to the feminist movements and political networks and movements for the protection of childhood was a constant among them. It was through these networks and movements that the new pedagogical ideas were disseminated at the national and international levels (Haengelli-Jenni, 2015).

In Antipoff's trajectory, we can see the tensions and the effects of these movements and transformations in the life and intellectual production of a woman who participated actively in building the new educational movement and the educational sciences, in Europe

[5] The authors wish to thank the historian Marina Sorokina and the psychologist Natasha Masolikova, of the Solzenitcyn Institute for Studies on the Russian Diaspora, in Moscow, for the precious information on the life of Helena Antipoff and Viktor Iretsky in Russia and Berlin, as well as for access to the correspondence between them during the years 1920-1930.

and Brazil, and who contributed to its dissemination and consolidation. In this article, we intend to provide evidence of the impact of this participation on her personal and professional life, and how her professional career was being moulded by these movements.

As Haengelli-Jenni observed concerning the participants of the New Education Fellowship in the interwar period, Helena Antipoff also combined scientific activity with political militancy for educational reform in her work and by the attention to the rights of children and young people. They stress especially in Antipoff's case the adhesion to science as a means of adapting to diverse environments and cultures, utilising scientific language as a *lingua franca* in the different countries in which she acted professionally, making of the sciences of education a passport for the building of a productive and successful career.

Education in Europe

Helena Antipoff was born in Grodno, in Russia, in 1892. Her father was a general in the Russian army, and her mother was from a military family. They lived in Saint Petersburg until 1909. In this city, an important cultural and intellectual centre of the Tsarist Empire, Helena was educated at an elite college, learning to play the piano and to speak French, German and English. While she attended the Teacher's College, she was a witness to the value then attributed to scientific activity by the Russian elites. In 1904, the scientist Ivan Pavlov received the Nobel Prize for physiology for his work on conditioned reflexes; the Saint Petersburg Psychoneurological Institute was founded in 1907. The intense cultural life of the city awakened an interest in science, music and literature. At the same time, the young woman was witness to the social conflicts and political struggles that swept Russia at the start of the 20th century – struggles against the absolute power of the Tsar, and in favour of installing a constitutional monarchy in the country, with a division of powers between the Tsar and parliament (Antipoff, D. 1975).

The atmosphere of political and social insecurity and the signals that a revolutionary movement was about to break out in Russia led the Antipoff family to move to Paris, in 1909. The general stayed in Saint Petersburg, and Sofia Antipova, the mother, took the three daughters to France. While Sofia gave private classes in the Russian language, in her own apartment in the Paris Montparnasse District, Helena decided to continue her studies at the University of Paris, the famous Sorbonne. After a period of some months in England working as a young lady's governess, and afterward in an institution for children with neurological difficulties and emotional problems, she commenced her studies in medicine at the University of Paris soon becoming attracted to psychology, while attending the seminars of the Collège de France.[6]

Antipoff has recognized the influence of the seminars in her background, especially those of Henri Bergson (1859-1941), because of their phenomenological approach to human consciousness, and Pierre Janet (1859-1947) because of their functional approach in psychology. Other strong influences on Antipoff's education in France came from her participation in the research undertaken by Alfred Binet (1857-1911) and Théodore Simon (1873-1961) with the intelligence tests, invented at the time in the Sorbonne Psychological Laboratory itself, which was directed by Binet. These were fully tested in the laboratory on school-age children of an elementary school located in the Rue Grange-aux-Belles, in Paris, the first pedagogical and psychological laboratory established in France. By means of the tests, Binet and Simon went deeper into the study of the causes of school failure in primary schools in Paris to recommend forms of treatment and education for children considered

[6] The *Collège de France*, founded by François I in 1530, is a teaching and research institution where the courses are public, with no examinations or the granting of diplomas. These courses, ministered by specialists and researchers of advanced level, are considered as complements to the higher education ministered in the faculties (*Le Petit Larousse Illustré* 2002, 1252).

retarded, complying with a request from the French Ministry of Education. It was to evaluate the cognitive capacity of children that the two built the first scale for the measurement of intelligence, in 1905. The scale consisted of a set of questions, graded by age, so that for each age there corresponded a set of typical replies. The tests were reviewed in 1908 and 1911 when the concept of mental age was included for the first time (Binet 1920; Nicolas 2013).

Antipoff was an intern in the laboratory of the Rue Grange-aux-Belles in 1912, under the direction of Simon (Binet having died a few months previously) and participated in the standardization of the scales for the Parisian school population. During the apprenticeship, she became familiar with the techniques for the validation of tests of mental level, with the statistical analysis of the different items of the scale, and with the study of the relationship between verbal development and motor skills.

At this time, this Laboratory attracted researchers from various parts of the world, interested in studies on intelligence. There Antipoff was introduced to the Swiss doctor and psychiatrist Édouard Claparède, professor at the University of Geneva, where he founded the Jean-Jacques Rousseau Institute, for "introducing students to the use of scientific methods necessary for the advance of child psychology and instruction techniques", collaborating in the development of educational sciences (Claparède 1931, 267). Claparède went to Paris to recruit students for studies at the Rousseau Institute and Antipoff was invited to be part of the Swiss group. Her son, Daniel, describes the meeting of the then student of medicine in Paris with the professor who she was later to call "mon patron", my master, throughout her life:

> One afternoon, a neurologist, professor at the University of Geneva, came to visit the laboratory. He was trying to organize an institute of the "Educational Sciences" in that city. He had already visited Belgium and other countries, to recruit professors and students. Seeing the work of those "emeritus interns", who did not receive[7] any remuneration, after months of activity, invites two of them: Aline Giroud and Helena Antipoff herself. (...) It is thanks to this casual meeting that Simon's intern got to know the eminent Swiss psychologist Édouard Claparède. (Antipoff, D. 1975, 40)

The contact with Claparède was crucial for the development of Antipoff's scientific and humanistic view of the relationship between intelligence and education. Accepting the invitation, she left for Geneva and decided to make herself an educator, having received her diploma from the Rousseau Institute. She embraced the principles of functional education recommended by Claparède, who affirmed that the educational process should take the interests of the children as the basis for their activities in school. In this approach, the purpose of education would be the development of intelligence and creativity. It was supposed that intelligence would be developed as the students had the opportunity to manipulate the environment and to seek active solutions for the problems raised by them over the educational process. From this perspective, denominated currently constructivist, education, instead of depending on mental skills already existing in children, would become the process itself of building the skills. The methods of functional education and of the Genevan "active school" were developed at the *Maison des Petits,* an experimental school linked to the Rousseau Institute, where Antipoff acted as one of the first professors under the supervision of Claparède (Hameline 1996; Ruchat 2010).

The political situation on the European continent, at this time, however, was very complicated. The First World War, which had started in 1914, continued to provoke conflict and immense losses. The war had affected Russia, where in addition to the struggle against Germany, was also suffering from internal movements of the struggle against the tsarist regime. In receiving the news that her father, the General Vladimir Antipoff, had been gravely

[7] In this case "perceive" means to receive payment.

wounded in her native country, in 1916, the educator decided to absent herself from Geneva and, after briefly passing through Paris, said goodbye to her mother and sisters and returned to Russia to see her father. After finding him and taking care of his recovery, she sent him to Sinferopol, in the Crimea, a small town with a pleasant climate on the Black Sea, where he continued to convalesce in the house of relatives.[8]

Helena then returned to Saint Petersburg, where she started work in an institution for orphaned or abandoned children who had lost their families in the disorganization in the country following the war and the internal conflicts, and were living on the city streets. To shelter them, the government organized hostels and educational centres (Antipoff, H. 1924, 1931). In the Medical-Pedagogical Post of Petersburg the task of the psychologist consisted in identifying and examining the children sheltering in the orphanage, and planning their re-education. In these exams the Binet-Simon tests were used, with which she was already familiar, and also the Lazurski technique for studying children's personalities, called "natural experimentation" because it included the observation of children in their natural environment, to avoid the artificial situation of the laboratory or the tests. It was due to these studies that Antipoff started the preparation of the concept of "civilized intelligence" to describe the intelligence measured by the tests, a concept that she was to develop later on in her work in Brazil. The fact is that, although the performance of the abandoned children in the intelligence tests, or those in a street situation, was lower than that of children in normal conditions of life, it was possible to observe, in practice, their "incredible capacity to deal with the concrete problems of life", as she stated several years later, in relation to the research carried out in Brazil. Thus, the limited results obtained in the tests could be better explained, according to the educator, by problems deriving from the instability of their conditions of life, by the lack of a family life and troubles in schooling, that is, by questions of a social and cultural origin (Antipoff, H. 1931). Thus, the educator started to operate a synthesis between the psychology learned in Paris and Geneva and the socio-cultural perspective then being developed in Soviet Russia.

The time she spent in her native land, however, was very troubled. In 1917 the Communist Revolution occurred producing great social and political upheaval. Daniel Antipoff describes the situation thus:

> October 1917 is the date of the insurrection of the masses and the Russian revolution. It is the end of the tsarist regime that for centuries had dominated Russia. It is also the date of great violence and horror on the part of the wronged and starving plebeians. Russia will still take many months to raise itself from the chaos and complete disorganization; years will be needed before the old regime can accept the impositions of the communists; long periods will be needed for the supporters of the new regime to make themselves respected in their new goals. (Antipoff, D. 1975, 70)

Moreover, it was precisely at this time that Helena Antipoff became a mother, thus assuming responsibility for a child in this uncertain and turbulent condition in the country. In 1918 she had joined the writer and journalist Viktor Iretsky, whom she had met in Petersburg, when he had visited the institution where she worked. From this union, in March 1919, their only son, Daniel, was born.

The first years of the boy's life seem to have been difficult, food was scarce, he suffered greatly from rickets and was sick. A peasant woman, Tatiana Vassilevna, who had lost an also sick son, ended up saving Daniel, suckling him at his mother's request. When the wet nurse no longer had any milk, Viktor and Helena decided to live with the son and a helper, Olga, in

[8] Her son Daniel Antipoff divulged this version of Antipoff's return to Russia. Up to the present the version has not been entirely corroborated by Russian sources, according to information received by the author from the historian Marina Sorokina.

an abandoned house in the country, in the neighbourhood of Petersburg, obtaining food with fishers and smallholders in the region. Helena continued her work for some time at the Medical-Pedagogical Post in Petersburg.

Viktor Iretsky was quite a well-known journalist, one of the founders of the Writers' House in Petersburg, founded in 1918 as a syndicate of writers and intellectuals to represent them in their relationships with the revolutionary power. At the end of the Civil War that followed the Communist Revolution, in 1921, and with the Bolshevik victory, the House started to be seen as an ideological opposition to the government. The authorities decided that all opponents of the new regime should exile themselves and, to oblige them to leave the country, a group of intellectuals (including Iretsky) was arrested on 4 September 1922, and sent into exile in Berlin, in Germany. Antipoff even protested against the exile of her husband, in a letter to the head of the secret police in Petersburg, but this manifestation only resulted in putting off Iretsky's journey for a month, and he left Russia in fact on 15 December 1922.[9]

With the exile of her husband, Helena had accepted an invitation to work in another medical-pedagogical institution located in the city of Viatka, in Russia. At the end of 1924, however, the husband sent some money to pay for the journey of the wife and son Daniel to Germany. She then definitively left Russia, with an authorization signed by Netchaiev, professor of pedagogical psychology at the University of Petersburg, on the pretext of visiting centres of education for abandoned children in Germany.

Antipoff never returned to Russia. However, during the years of the Revolution, she had aggregated this extraordinary experience of applying the knowledge of psychology in institutions of social education to her intellectual makeup that would profoundly mark her work in the future, especially her work in Brazil, as we shall see.

From Exile in Geneva to the Invitation to Lecture in Brazil (1925-1929)

In Berlin, Antipoff tried to resume the contact with Claparède, by correspondence, sending news of her experience in the Soviet Union, of the situation of psychology and education in the country, after the Revolution, and asking him about the possibility of returning to Geneva to complete her studies, under the orientation of the master. She explains her work in Russia to her former professor thus:

> the two years I worked under your direction allowed me later, returning to my native country, to join several Russian establishments, for the psychological study of children. In spite of the revolution, the hunger and the general disorder that have characterized recent years in Russia, the institutions of pedagogical research are functioning satisfactorily and have garnered rich empirical material. For my part, I was able to study, in different laboratories in Saint Petersburg and Viatka, during the last five years, more than a thousand children, mainly orphans, that the government has put in homes for normal and abnormal children. The children were submitted to different psychological examinations and treated by various methods of pedagogical investigation. (Antipoff, H. to Claparède 18.10.1924; cited by Ruchat 2010, 4)

In the letters sent to the Genevan psychologist, Antipoff adopts a position of neutrality in relation to the Bolsheviks. She observes that her work in the Soviet Union possessed a humanitarian as well as a scientific character, and sends news on the work of psychological observation of children and adolescents utilizing the method of "natural experimentation"

[9] Information supplied to the author by the historian Marina Sorokina.

elaborated by the Russian psychologist Alexandre Lazursky, celebrated in Russia for his research of individual and characterological psychology. About the method, Antipoff explains:

> This method, situated between pure observation and the psychological experimentation of the laboratory, possesses the advantages of one and the other without the defects, which are the imprecision and the part played by chance, on the one hand, and the artificial milieu as well as the artificial problems, on the other. This method, far from disappearing with the death of its author, currently encounters wide application in Russian laboratories of individual and child psychology. In addition, the researches of Lazursky have been very useful for school programmes, as almost all the teaching material has been analysed from the point of view of the psychological functions that each of them exercises in the child. (Antipoff, H. to Claparède 18.10.1924; cited by Ruchat 2010, 5)

After the description of the experience in Russia and the situation of an exiled person with no work in Germany, Helena proposes to Claparède the publication of articles of her authorship on Soviet psychology and education. Claparède replies positively to the proposals of his former pupil, and she is elated with the news received from Geneva:

> I cannot tell you how happy I was to receive your news in such a beautiful letter. Reading it in the post office I couldn't stop myself giving little jumps of joy besides my five-year-old son. My son, seeing me do this, started to do the same. The people (present there) I believe must have been asking themselves if we had not gone mad. I thank you from the bottom of my heart for the help you have offered me. (Antipoff, H. to Claparède 8.11.1924; cited by Ruchat 2010, 7)

Effectively the professor had invited Helena to return to Geneva as his assistant, commenting on how she had always demonstrated great enthusiasm for university activities. The student accepts the invitation, and comments about her situation in Berlin and her professional plans:

> in Berlin, I did not put down very deep roots. I collaborate in the direction of a Russian *kindergarten*, and put a lot of energy into this, the school is good, but the pedagogical work itself interests me much less than what you are proposing for me – because it is happiness itself to be able to be in the Institute again and work near you, under your direction. (Antipoff, H. to Claparède 19.9.1925; cited by Ruchat 2010, 15)

About her husband and son, she states:

> my husband will separate from us with much regret, but, in the end, will give me his blessing. Life in Berlin is becoming daily more difficult and expensive. Regarding my little Daniel, he will come with me to Switzerland, naturally. At the moment, he is six and a half. I shall ask you, my dear sir, should my journey become reality, that you recommend a new school not far from Geneva where he could be accepted as a boarder (should my means permit it). So that, free from all domestic concerns I shall be able to concentrate my whole time and effort on one thing only – my work at the Institute! (Antipoff, H. to Claparède 19.9.1925; cited by Ruchat 2010, 16)

One sees, therefore, that Antipoff accepts with satisfaction the invitation to become the pedagogical assistant of Claparède. She calculates that the work in Geneva will allow her to grow professionally more than in Berlin, as well as to give Daniel a more advanced education, from the pedagogical point of view. This school that she wishes for her son should follow the "new school" orientation. Thus, soon after she manages to exchange her Russian passport for a Nansen[10] passport, granted by the League of Nations. But the difficulties are great for obtaining an entry visa into Switzerland, where the authorities fear the entry of foreigners who would end up by settling there permanently. Only on 21 November 1925 does Claparède receive a communication from the Swiss police department charged with foreigners conceding the visa for his future assistant, the concession being conditioned to the immediate presentation of the return visa to Germany and the guarantee deposit of 2,000 Swiss francs. On receiving the news, Antipoff is disappointed and almost gives up the idea of the journey, advising Claparède in the following terms:

> unfortunately, the Bolsheviks took everything we had and neither I nor my husband will be capable of depositing the gigantic amount that is required of us. I asked a staff member (of the Embassy) if he thought it was possible to reduce the guarantee or even suppress it altogether. He replied very seriously that the Berne resolutions were incontestable. (Antipoff, H. to Claparède 26.11.1925; cited by Ruchat 2010, 22)

The professor also tried to convince the Swiss authorities to remove the requirement of the guarantee, without success. He then wrote to the police department in charge of foreigners, making himself responsible for the payment. In a long letter, he guaranteed the honour of his former pupil and explained the difficulty of finding Swiss candidates for the post of assistant to the Psychology Laboratory offered to Antipoff, because of the low salary. And he concluded saying that the invitation to a foreigner was justified because, in those circumstances, her qualifications recommended her to the University of Geneva. Thus, Antipoff finally succeeds in transferring to Geneva in January 1926, remaining there until 1929. Claparède helped her to find a person who could put her up and take care of her son while she was working in the Laboratory, a Russian woman living in Geneva, Madame Baranoff. The idea of Daniel boarding in a "new" school, outside the city, was put off for later.

During this new stay in Geneva, Antipoff lectured psychology and collaborated in the laboratory, carrying out research on the development of intelligence, the relationship between the higher mental processes and motor skills and the development of moral judgment in children. At the time, her articles, published in the *Archives de Psychologie*, (a scientific journal published by Claparède), and the **Intermédiaire des Éducateurs,** (a journal published by the Rousseau Institute, aimed at educators), were characterized by a concern with the study of children in their natural environment. An attempt was made to know their forms of interaction with the environment, physical as well as socio-cultural, and on the development of motor skills. The emphasis on the relation between psychomotricity and intellectual development seems to be part of the inheritance of the Soviet period, because Russian thinking at this time accorded considerable value to the association between manual and intellectual work. Later, in Brazil, Antipoff was to comment that the human being "thinks with his hands", showing the need to educate children and adolescents by supplying them with opportunities to exercise their motor skills in the pedagogical workshops of the Pestalozzi Society (Campos 2010; Borges 2015).

At the end of the 1920s, the Jean Jacques Rousseau Institute was already known worldwide. Claparède's book called *The psychology of the child and experimental pedagogy* (Claparède, 1926) had been translated into several languages and Geneva was already a centre known for its studies on child psychology and its active methods in education (Hofstetter, 2010). So that when the government of the state of Minas Gerais, in Brazil, decided to create a Teachers' College for the preparation of specialists and educational

[10] The Nansen passport was an international document conceded to stateless persons, allowing them to travel between countries (Ruchat 2010, 15).

managers in Belo Horizonte, the state capital, a mission was sent to Geneva, at the end of 1928. Its purpose was to invite specialists in psychology and education to lecture Brazilian educators in the new institution.

Helena Antipoff decided to accept the offer of a two-year contract in Belo Horizonte, starting in August 1929. The decision, however, was not easy. Claparède did not agree readily to the journey and offered her the possibility of collaborating in setting up a branch of the Rousseau Institute in Cairo, Egypt. Antipoff was thrown off balance by this. Egypt would allow her to take her son, where he could continue his studies in a French school, but the commitment had already been assumed with the government of Minas Gerais. She was not thinking of taking her son to Brazil, and therefore sent the boy to an experimental school that had been started by a colleague in the Rousseau Institute, Marguerite Soubeyran, in Dieulefit, in the south of France – the school came to be called Beauvallon. The project of having Daniel boarding in a "new" school was starting to be realized (Delpal, 2016). On the other hand, the Brazilian salary would allow her, in addition to helping with the payments of Soubeyran's school, to also send help to her mother and sister in Paris. All this was explained to the "patron", by letter, as Claparède was in Cairo, setting up the new Institute.

Another motive that seems to have influenced the decision to accept the invitation of the Minas Gerais government and undertake a journey to a far-off and unknown country was the plan to acquire a new homeland for the family. Her husband, still exiled in Berlin, wrote to her suggesting that she try to take out Brazilian citizenship quickly. According to Viktor, the threat of another war was already taking shape in Europe and he would not like his son Daniel to become a French citizen, as he would run the risk of being called up to the front (Iretsky to Antipoff, H. 14.6.1929 (?), 15.01.1930).[11] Antipoff herself commented, in a letter to her husband, soon after her arrival in Brazil, that she was thinking of buying a small farm in which he would be occupied. Unfortunately, this plan did not materialise, probably due to Viktor's health problems, and he died in 1936.

Thus, after some days on holiday with her family, Helena Antipoff undertook alone the long journey to Brazil, arriving there on 6 August 1929. In the port of Santos she was received by the psychologist, also of Russian origin, Leon Walther,[12] and by Professor Manuel Bergström Lourenço Filho, and his assistant Noemi Rudolfer. After visiting the Psychology Laboratory directed by Lourenço Filho in the São Paulo Model Teachers' College and other educational institutions in the Brazilian metropolis, she resumed her journey to Belo Horizonte. There she was received by one of the parties responsible for the teaching reform that was then being undertaken, Professor Mário Casassanta, General Inspector of Public Education, and by the director of the Teachers' College, Amélia de Castro Monteiro. She then took up her activities at the front of the Psychology Laboratory of the Teachers' College of Belo Horizonte, the installation of which had started with the arrival of other foreign specialists, such as Théodore Simon, in 1928, and Léon Walther, in 1929. After several renewals of the contract, throughout the 1930s, and a brief passage through the Ministry of Health, in Rio de Janeiro, as director of the National Department of the Child, in the 1940s, Antipoff decided to stay definitively in Brazil, and in 1952 took out Brazilian citizenship (Antipoff, D. 1975).

[11] The authors would like to thank Marina Sorokina and Natália Masolikova for sending the letters of Iretsky to Antipoff and Antipoff to Iretsky. They were found in a file in Moscow's national archives by these researchers. In the first, the date is not clear. However, as the text requests Antipoff to send a telegram from Rio, and she arrived in Rio on 6 August 1929, it can be deduced that the letter was written in 1929.

[12] Léon Walther (1890-1963), Russian, licentiate in letters from the University of Saint Petersburg and in Law from the University of Geneva, specialized in work psychology and professional orientation, and, through the indication of Antipoff, rendered services to the government of Minas Gerais for three months, during the first semester of 1929.

Her Work as a Psychologist and Educator in Brazil (1929-1974)

In the first letter she sent to Claparède after arriving in Brazil, Antipoff recounts her first impressions of the country and of the city: the beauty of the city, appropriately called "Belo Horizonte" (meaning 'beautiful skyline', because of the mountains that surround it), inhabited by people who were a little suspicious on the first contact, the expectation of political problems that were looming – the Revolution of 1930. About this, she commented to the master:

> The state of Minas Gerais is particularly agitated because its President[13] is the head of a liberal alliance; together with another two states, they are against 19 others in Brazil. There is therefore little chance that the liberal alliance will be the winner. The new government can turn the politics of the country on its head, compared to what it is today, and then it will be goodbye to all foreign missions and perhaps goodbye also to the contracts signed by the former government. (Antipoff, H. to Claparède 15.9.1929; cited by Ruchat 2010, 52)

Insecure about the future of Brazil and far from her son, she describes in the following section, the students of the Teachers' College where she was to lecture:

> 150 women and young people from Minas were taken from their homes and the schools where they taught by government Decree, and made to come to Belo Horizonte to attend the Teacher's College. Mothers were not spared and were separated from their children. The course lasts two years with only one month of holidays, when they can return to their homes, in the interior of the country. In the school they receive teaching in psychology, the methodology of their mother tongue, arithmetic, natural sciences, drawing, modelling and physical education. (Antipoff, H. to Claparède 15.9.1929; cited by Ruchat 2010, 52)

However, Antipoff appears to be charmed with the young women, whom later she was to call her "bees". It was they who would gather the data (as the bees gather the pollen to produce honey) to be worked on in the Psychology Laboratory, with the objective of understanding the child in Minas Gerais better and thus being able to orientate schools regarding their education:

> Our students are, in their majority, charming and extremely beautiful. I think that it is in Brazil that one finds the most beautiful women in the world. Beautiful and gracious, but also intelligent, with a quick understanding. They are good mothers, faithful wives and very good educators, in the family, or the schools. In the primary schools only the women teach; the men, at least in Minas, do not. (Antipoff, H. to Claparède 15.9.1929; cited by Ruchat 2010, 52)

The Teacher's College had been set up by the government of Minas Gerais in 1928, as part of a wide-ranging reform of education undertaken in the state to facilitate access to it, improve the preparation of the teachers of elementary level and rationalize the academic and administrative processes. This reform was associated with other educational reforms promoted in several Brazilian states during the 1920s, with similar objectives. The contribution of psychologists for setting up the new policies was highly valued. Using the information obtained in the literature circulated about the New Education movements in

[13] The governor of the state, at the time, was called 'President'.

Europe and of progressive education, in America, the leaders of the New School movement, in Brazil, recommended the use of tests for measuring intelligence – the famous intellectual quotient (IQ) tests. This had the purpose of organizing the "homogeneous" classes at the primary level and improving the selection of students for secondary and higher level by basing it on their intellectual capacities. In addition, the changes realized in the educational system reinforced the importance of having a new well-prepared generation, in terms of academic and civic skills, to fill positions of leadership in a society undergoing a process of modernization and urbanization (O'Neill 1975; Wirth 1977).

In Minas Gerais, the educational reform of 1927, among other initiatives, proposed the significant expansion of the number of Teachers' Schools for the preparation of educators and the establishment of the Teachers College for the preparation of personnel qualified for planning and managing the educational system. The discipline "educational psychology" was instituted as part of the regular curriculum of Teachers Schools, and, in the Teachers' College, the laboratory of psychology was established. Helena Antipoff was contracted to lecture psychology and pedagogy, and to direct the laboratory, where the research would be carried out on the psychological and psychosocial characteristics of local children, helping the schools in the organization of the homogeneous classes, through the research and standardisation of IQ tests (Peixoto, 1981; Cirino and Miranda, 2015).

In taking over the classes at the Teacher's College, and the direction of the laboratory, the educator soon commenced a programme of research on the ideals and interests of the local children. She had the idea of organizing a museum of the child, with data on the physical and psychosocial development of the smaller inhabitants of the city, relevant for parents and educators. About these first activities, she expressed herself thus to Claparède:

> My 'pet scheme' – the Museum of the Child – seems to have interested the public and the powers that be, and I believe that it is going to become a reality. We have just carried out an inquiry about the ideals and interests with nearly a thousand children of Belo Horizonte. This is truly a psychological and social tool, revealing at a glance the mentality of the people. These inquiries carried out systematically every 20 years will demonstrate well the march of culture. This march will not always be progressive; there will be more or less durable halts and retreats, I believe (Antipoff, H. to Claparède 9.12.1929; cited by Ruchat 2010, 63)

Effectively, the first report of the inquiry into the ideals and interests of students of the fourth primary grade was quickly published (Antipoff, H. 1930). In this survey, both the influence of the Genevan "active school" and the historical-cultural Soviet approach can be seen. Antipoff was concerned in investigating the thoughts of the children that the schools in Minas Gerais should adapt themselves to. The small questionnaire replied to by the students of the local public schools focused on the preferred tasks at home and school, preferred toys and books, adult models and plans for the future. The results were compared with those obtained in other countries and reveal the influence of the social and cultural environment on the children's formation.

Antipoff observed that the ideas and interests of the Brazilian children seemed less diversified than those of their foreign counterparts. The author interpreted these results considering that the students who replied to the questionnaire came, in large part, from a modest social *milieu*, in which family life was the predominant experience in their lives. She also observed the influence of schooling on these results: Brazilian children had fewer daily hours of classes than European and North American children. How could the school enrich and diversify the students' experiences? In her opinion, the intimate tendencies of the children could only develop in a sufficiently diversified environment, in which "various types of children will encounter the destiny adequate for their nature" (Antipoff, H. 1930, 42).

These basic premises were to guide her subsequent work in Brazil: on the one hand, the concern with the impact of the social environment on the modelling of the cognitive and psychosocial characteristics of the children; on the other, the idea that the schools could promote the development of the intellectual, physical and socio-affective capacities of the children.

Continuing with the laboratory research, she studied the curve of the mental development of the local children and adolescents through the application of instruments such as the Binet-Simon scale, the Goodenough Draw-A-Person Test, and others. The objectives of these studies were: 1) to investigate the mental development of school-age children, by age group; 2) to compare the mental development of Brazilian school-age children with the results obtained in other countries; 3) to investigate how the mental development can vary because of the influence of the socio-cultural environment. In these investigations, the impact of society and culture on the development of cognitive skills was examined more deeply, a theme that increasingly was to influence her work in Brazil. Based on the definitions of intelligence proposed by Binet and especially by Claparède, as "the capacity to resolve new problems by thinking" (Claparède 1933, 3), Antipoff observed that the intelligence tests dealt only imperfectly with the skills of comprehension and invention implicit in such a definition. In her opinion, the results of the mental tests should be considered, more modestly, has an evaluation of the general level of mental development of a given population. This could include the skills of concentrated attention, observation, logical reasoning, and a certain "fluidity of thought". But this was only part of the problem. The other important question was to know if this intelligence could be considered natural, that is, dependent only on the innate dispositions and age for its development. For Antipoff, intelligence was a combination of innate dispositions, intellectual as well as of character, and of the environment in which the subject was educated, thus including the conditions of life and culture, and the experience itself of the child in school.

According to this reasoning, Antipoff worked out her definition for the capacities measured by intelligence tests: for her, they would be the mental skills polished by the action of society and culture, which she denominated "civilized intelligence". In this definition, she recalled her experience with abandoned children in Russia, as well as the observation of street children in Brazil. She had observed that these children, although presenting lower scores when submitted to intelligence measuring scales, could not be considered less endowed. Of course, they lacked a certain capacity for concentrating their voluntary attention, on the one hand, and on the other, to achieve a state of abstraction that made possible conceptual thinking. However, in the particular domain, stimulated by an immediate interest, and by spontaneous attention, they were successful in working out complex strategies of survival in adverse conditions.

The investigation of the mental development of the school-age children in Belo Horizonte allowed an empirical check of the precision of the Antipoff concept of "civilized intelligence". Results of tests applied to the school children in Belo Horizonte demonstrated that, on average, the performance of the local children was inferior to European or North American subjects of the same age group. They also suggested quite a strong association between the socio-economic conditions and performance in the tests. To confirm this correlation, the average IQ scores were compared for each school, which led to the conclusion that the "classification of each school corresponded approximately to the level of economic and social wellbeing of the district in which the school was located" (Antipoff, H. 1931, 191). As a conclusion, Antipoff observed that the IQ tests should be utilized with care in the evaluation of the general level of children's mental development, but they could be considered a reasonable instrument for evaluating the level of the social and economic wellbeing of a determined population.

In addition to the studies of mental development, the educator proposed a series of studies that she denominated "*escolológicos*".[14] She commented that, among the educational sciences, one dedicated to the study of the school as an educational institution was lacking, in all its complexity: building, organization of the work, management, teaching methods, characteristics of teachers and students, the flow of activities, results of the teaching. She explained this new initiative to Claparède in the following way:

> With the second year students, we are undertaking a magistral pedagogical study in the schools. Each pair of students has under its responsibility a complete study of a school class. The monograph of a class (...) should comprehend the global and detailed study of the whole life within this class, conceived as a society whose conduct is determined by all the physical and psychical conditions possible: this study, comprehends the study of the school building, the furniture, all the hygienic and material conditions; all the influences that emanate from the master, from the regime and the school method; the interactions between the children, the survey of the types of children – what is done from the individual study of each one (physical, social, psychological study) (Antipoff, H. to Claparède 21.2.1930; cited by Ruchat 2010, 71)

In that year 35 monographs of classes were prepared, each one with 40 children. Regarding the expected results of the initiative, Antipoff commented:

> A study such as this will provide them (the students) with real pedagogical competence, and counter the frightening dilettantism, the lack of consciousness, the unserious work which prevail in the school. (...) several problems can be studied for the final work of our students. They will only have to extract, from the immense material collected, the documents relevant to the study of the particular problems. It will be a small tribute to science, because I hope that the efforts of our 70 intelligent and diligent students will know how to extract a tiny amount of scientific synthesis. Could I be mistaken? (Antipoff, H. to Claparède 21.2.1930; cited by Ruchat 2010, 71)

Still a little sceptical regarding the results to be obtained from all the work she was planning, Antipoff was optimistic. however with the possibilities opened up for her. She observed, in a letter to her husband written at the time:

> (...) Minas – one of the most beautiful Brazilian states, picturesque and rich. The beauty of the landscape, the mountains, the vegetation or steppe and distant horizons – incredible – and for me, personally, it can compensate for the nostalgia of the separation from my son, and the lack of the cultural life of Europe. (Antipoff, H. to Iretsky 3.11.1929)

She also comments on the work that she is doing, with a particular interest in the study of cultural differences in thinking and in the psychological development of the children:

> Now, exploring the mental development of the local children, to obtain interesting data, (I'm thinking) of comparing them with what we know about Europeans and North Americans (children). After all, out tests, do not (inform) so much about the natural mental talent as about the degree of civilization in which the child is developing and maturing. Naturally, in the case of super-endowed children or those with birth defects, it is conceivable that it does not depend so much on the environment. But the average person is a mirror of the environment. (...) To know the conditions of

[14] Translator's Note. An invented word, roughly "scholological".

> civilization in Brazil, Belo Horizonte or even Paris (helps) you to have the correct data for determining what is necessary for the children (...) All this is, of course, obvious, but the task of science is to situate a banal piece of knowledge within some simple laws, whose combination allows one to forecast a series of more complex phenomena with considerable precision. (Antipoff, H. to Iretsky 15.1.1931)

She does, however, feel the lack of her son's presence very much, and decides to bring him on holiday to Brazil. She expresses herself about this plan to her husband:

> Being separated from Dônia[15] is seriously affecting me. Not figuratively, but my heart really aches (...). If I can't see him at the end of this first year of separation, I'm going to throw the contract (away) and return to Europe. The following would be more reasonable: Dônia would come here during his summer holidays. In the school, I have two weeks of holiday – when I will be able to see him and we could be together, and then, for him not to be sad with me in Belo Horizonte, I could take him to the Stavrovietski[16] place in Caeté (where, by the way, he could study Russian). The schedule of talks would leave me free on Saturday. I would have to go to Caeté on the Friday night and return on Monday morning – its 2 hours by car from Belo Horizonte. Two and a half days a week, we will be together. He could stay here in July, August, September and the start of October, and when the classes start up again, he would return to Europe to complete his primary education. These three months in the most agreeable climate, dry and cold in Brazil, he would not find that strange. If there are no friends to accompany him on the ship – he can be put in Villefranche, in the care of the ship's captain, the same "Julio César".[17] In Rio, I should be there to meet him after his 11-day voyage. I am writing to you about my plan now to know your opinion. (Antipoff, H. to Iretsky 21 February 1930)

The boy really did come to Brazil in 1931, and thus his mother could continue her work in the Teachers' College. Daniel reports what happened in the following years, after the return to France:

> For eight more years mother and son were separated by the ocean, each one expressing him/herself in a different language, French for the son and Portuguese for the mother. During these eight years, Helena was to return to Europe on two occasions, until the only son settled definitively in Brazil in 1938, on the eve of the Second World War (Antipoff, D. 1975, 126).

In 1938 Daniel left Paris because of the coming war (World War II, 1939-1945) and joined her mother in Belo Horizonte, at the age of 19 years old. He got his university diplomas in Agronomy at the University of Viçosa (in the city of Viçosa, near Belo Horizonte) and in Philosophy at the University of Minas Gerais. He worked in education and psychology, and became one of the first educators to be recognized as a psychologist in Brazil, after the profession's regulation in 1962. After a successful career as a clinical and educational psychologist, he passed away in 2005 (Campos, 2001, 50-53).

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[15] Dônia is the son, Daniel's nickname.

[16] The couple Anatole and Nina Stravovietski, Russian immigrants who lived on a rural property in the region of Caeté, MG, were friends of Helena Antipoff.

[17] Júlio César was the name of the ship in which she herself had sailed to Brazil.

Exceptional Children

Starting in 1932, Antipoff involved herself in initiatives destined to help and resolve the problems of children who were intellectually retarded or not adapted, which she proposed to call "exceptional" to avoid the negative associations of the word "abnormal". Together with a group of clerics, intellectuals, professors and philanthropists, she founded the Pestalozzi Society of Belo Horizonte, the name of the organization inspired by the celebrated Swiss educator, to collaborate in the education of "exceptional" and socially disadvantaged children. In 1933, the Pestalozzi Society established medical-pedagogical consultancy offices for the examination and orientation of these children. Starting in 1935, the offices were expanded and, with the support of the state government, became the Pestalozzi Institute, receiving children with disability or mental/psycho-social problems (Sociedade Pestalozzi 1934, 129; Lourenço, 2000; Borges, 2015).

The treatment of the children's problems was carried out in special classes established in the Institute, the children were grouped according to their IQ. The definition of the concept of exceptionalness, adopted by Antipoff, included, in addition to organic problems, also the abnormality socially produced by a school system whose requirements were beyond the possibilities of many children. Above all, Antipoff did not consider abnormality a definitive and irreparable defect. For her, the majority of children who presented some mental abnormality were educable and could be successful.

In addition, for Antipoff, the concept of mental abnormality included other disorders in addition to limited intelligence, for example, disorders of personality due to problems in the primary socialization of children. The psychologist was conscious that families with economic difficulties were far from offering ideal conditions for the development of their children. Research undertaken at the time showed high rates of alcoholism and violence in the interior of families. So that the low results presented in the IQ tests could be considered a symptom of a complex of social and family problems experienced by the "exceptional" children. The proposals of the team from the Pestalozzi Society had the objective of supporting these children and adolescents in their trajectory through school and life.

At the end of the 1930s decade, and have decided to stay in Brazil, Antipoff promoted the creation, by the Pestalozzi Society, of a model rural school for retarded and abandoned children on land near the small town of Ibirité, near Belo Horizonte. In her opinion, this school would be the place for the demonstration of practical forms of dealing with "exceptional" children. According to the guidelines issued by the International Bureau of New Schools, from 1919, the Rosário farm-school was inspired by the methods of the "Active School" for the education of exceptional children in a rural environment (Antipoff, H. 1946, 1952, 1956, 1966).

The Farm-School can be considered Antipoff's most important work. In the Rosário, she attempted to proportion the ideal environment for the education of all the children and adolescents, exceptional or normal. The school became a living experiment, during the years 1950 and 1960, including in its activities those related to the preparation of teachers for the rural schools. As a majority of Brazilians lived in the interior, (where a large part of the "exceptional" children came from who failed in the urban primary schools), the educator thought that more advanced cultural standards should be introduced into the rural areas. This would allow people to take advantage of the benefits of civilization and at the same time live off the produce of the land and contribute to ameliorating the extreme poverty of the rural workers. For these reasons, Antipoff saw education as a source of democratization. Citing the Geneva Declaration of the Rights of Children issued by the League of Nations in 1924, she thought that a school should not proportion to its students a limited consciousness of their rights of citizenship. On the contrary, citizenship was seen as one of the important consequences resulting from better development of intellectual and psycho-social capacities of children and adolescents (Antipoff, H. and Rezende 1934).

Dissatisfied with her experience of wars and revolutions in Europe, Antipoff struggled for social harmony, which would be achieved if each one was given the opportunity to develop his/her vocation. In this development, education would have a central role. Believing in education as a process with a scientific basis, Antipoff followed her master Claparède: the sciences of education should accumulate knowledge, little by little, to help in the development of children in a harmonious, free and cooperative environment. All through her life, Antipoff maintained this faith in science, as well as the vision that individuals become useful for society to the degree to which it is allowed them to develop their vocations. In this sense, a school system would be democratic to the extent that the students were supported and encouraged to develop their capacities. Mental tests could be useful instruments in the deeper knowledge of the possibilities of each individual. However, they were only a start, the first step for the planning of development. The success of children in education was, therefore, the responsibility of the schools, and not of isolated individuals. A variety of instruction methods, originating in the proposals of the "Active School", should be put into practice for schools to be able to fulfil their civilizing role.

Conclusions

Helena Antipoff is considered a pioneer in the psychology of development and education in Brazil for her work as a researcher, university professor and creator of institutions. As a researcher, she established one of the first laboratories of psychology in the country, leading a consistent programme of investigations on Brazilian children and adolescents, an experience almost unique in Brazil at the time. In this laboratory, a contribution was made to the scientific preparation of a whole generation of professors and specialists in education with a lasting influence on Brazilian education in general, and of special education in particular. As a professor, she initiated the preparation of psychologists of university level in the state of Minas Gerais and contributed to the movement that led to the regulation of the profession in Brazil, in 1962. As a creator of institutions, she contributed to setting up a model for the wide-ranging system of institutions dedicated to the education of people with special needs, today represented by the various Pestalozzi Societies and Associations of Parents and Friends of Exceptional Children spread all over the country, with a methodology based on tolerance and respect for differences.

Her main legacy was and is in the hands and minds of her many students and disciples who spread through the institutions of higher learning and special education in Brazil. As a modest and unpretentious person, she received the many honours bestowed on her for her work with detachment, attempting to transfer the prestige to her followers and collaborators.

As a psychologist, Helena Antipoff combined the two attitudes considered by many to be irreconcilable: the scientific rigor of the researcher, and the richness and sensitivity of a clinical approach. This mixture led her to value science as a guide to well-informed action, aimed at benefiting humanity. Having left her native land, Russia, and learned respect for human rights during her education in Geneva, she adopted many Brazilian students, children and adolescents, as part of her family, devoting to them her competence, energy, dynamism and professional knowledge. Her commitment to the ideas of democracy was expressed in the belief that education should be a right of every human being, and that helping others was a form of obtaining human understanding and happiness.

In her educational work with exceptional children, she made the following recommendation to the educators:

> Extol the truly democratic attitudes, where personal responsibility is joined to a consciousness of collective responsibility making the whole work appear a product of each one and of everyone at the same time. (...) Prove that every human creature has value and all men can contribute, each with his own talent, to the progress of humanity. Show also that the human value is not limited only to intellectual aspects, but that other factors, like moral gifts, effort, humility, altruistic feelings, which we so often find in so-called exceptional children, constitute an appreciable social treasure in times (...) where egoism, greed for gain and the exploitation of the weak by the strong prevail. The Pestalozzi work thus appears as a work of justice and compensation for the ills that increasingly filter into social life. (Centro de Documentação e Pesquisa Helena Antipoff 1992, 307)

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Special Issue – Women in Sciences: Historiography of Science and History of Science – on the Work of Women in Sciences and Philosophy

Girls of Today and Women from the Past: When the History of Female Scientists is Used to Engage Girls with Science

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Patrícia Figueiró Spinelli[2]

Abstract:

"Girls in the Museum" is a project aimed at school students to encourage them to explore scientific careers and engage with science. To achieve its goals, the project uses a variety of methodologies during the training sessions, always emphasizing the contributions of women to science and society throughout history. In one activity, the participants had to select 14 scientists and philosophers and compile their contributions in a talk that they presented in various Museum events. 1,5 years after the first presentation, we have interviewed and analysed the impressions and memories of the girls on this activity. The results show that the participants could still remember the history of the selected scientists and understand their scientific work because they felt represented. We argue that the historiography of women in sciences is a valuable resource that can be used in all educational levels as well as museums.

Keywords:

Women in STEM; Science Education; Science Communication; History Education; Science Museums

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Introduction

In the past 50 years, the access of women to education and their participation in the production of knowledge has increased substantially compared with previous epochs.

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However, what it might seem like a definite triumph of the feminist struggles since the XIX century, has unfolded three simultaneous side effects.

In the first place, the realization that equal education does not lead to equal status, authority and even recognition in working environments. Secondly, the prejudice against women's intellectual abilities has not disappeared as a consequence of their more significant presence, on the contrary, women standing out in any field of knowledge must continously show their credentials to be accepted and valued within that field. Thirdly, even women who achieve success and have their work recognized at a particular time, do not enter into the common imaginary and symbolic capital (Marini 1993). In general, they continue to be associated with the subjective and the feminine, and not the universal, represented by the masculine (Beauvoir 2016, 12). Therefore, most of their production is forgotten and does not linger for the next generations.

Indeed, the historical contribution and impact of women in areas such as science, philosophy, politics, literature and arts, is usually explored in specific courses named as "Women studies" or "Women in (any area)". While the historical significance of men is called "History" and it is learned by us all since the early stages of primary education (Maggs 2017, 10).

We observe this very clearly in the textbooks used in formal education systems worldwide. The references to women in didactic books account for only 13% and this number even drops to 7% when considering science textbooks (Lopez-Navajas 2012).

Other non-school spaces of education, culture and memory, such as museums and cultural centers, may also materialize through their choices of expography, reproductions and perpetuation of a specific history of women, associated with traditional roles, that quenches the contribution of women as thinkers and leaders. Museums, as institutions of memory, may impose "representations on the past through the selection of what should be preserved as part of the past" (Gevher 2017, 12).

The Awakening of the Hidden Figures

In the last years, there seems to be a rising interest by society in the figures of female scientists and intellectuals who had been ignored or hidden in the trunk of memories for a long time. The foundations of this interest may rest on the many resources that have now addressed the obliteration of women and are oriented to various audiences. For instance, several films, books, media channels have brought the attention to the scandalous absence of women in the history of science, philosophy, literature or art, despite of having being responsible for crucial contributions (e.g. Ignotofsky 2016; Evans 2017). Thanks to these resources some sectors of society have become aware of the invisibility process women philosophers, scientists, writers and artists have been subjected to, at the same time that demand the proper credit for them.

Preceding this movement that now pervades the non-academic audiences, the debate of gender in the sciences have emerged in formal (schools, universities) and informal education spaces (museums, science and cultural centres), often motivated and pressured by public policies. In this regard, the Millenium Goal number three of United Nations that targeted the elimination of "gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015",[3] had played an important role to

[3] Millennium Goals were signed in the year of 2000, as a commitment among world leaders to defeat poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women: http://www.un.org/millenniumgoals/gender.shtml. In 2015, United Nations member states adopted the 2030 agenda, which replaced the 8 Millennium Goals for the 17 Sustainable Development Goals.

promote the inclusion of more girls in science careers and more welcoming and equitable workplaces in universities.

In December 2015, the United Nations General Assembly established an annual International Day, 11 of February, to acknowledge and celebrate the contribution of female scientists to progress and society. Implemented by UNESCO and the United Nations – Women, the celebration has the goal to promote full and equal access to and participation in science for women and girls.

With these spurs, universities, research institutions and scientific societies slowly started to revise their habits related to the visibility and recognition given to former and current female researchers.

In 2013, the National Council for Scientific and Technological Development (CNPq, in the Portuguese acronym) in Brazil, launched the program Pioneers in Science dedicated to present the work of 19 Brazilian female scientists who have contributed to the establishment of various fields of research in the country. The content of the program also gave birth to a travelling exhibition. Since then, every year, CNPq posts a new series of scientists in the program webpage.

Another example was the last edition of the *Paralajes* scientific magazine produced by the Institute of Astrophysics of the Canary Island (IAC) in Spain.[4] The issue was dedicated to honoring the figures and discoveries of great female figures in the history of Astronomy, such as, Henrietta Leavitt, Williamina Fleming and Cecilia Payne, as well as to make visible their current female employees, highlighting their scientific contributions.

The History of Women in the Sciences: An Available Resource

Gender studies show that from the earliest years of schooling, girls are little encouraged to like science disciplines, which eventually causes the lower concentration of women in scientific careers (Olinto 2011; Vasconcellos and Brisolla 2009; Bian, Leslie and Cimpian 2017). Stereotypes, particularly stronger in science fields, reinforce the idea that women have no equal intellectual capacity as men, logic reasoning, nor talent for scientific work. The scarcity of models to be emulated by girls in these fields stands out as another fundamental problem in perpetuating this segregation (Viegas 2013).

These ideas accompany girls throughout elementary and middle school and, in the crucial phase of career decision-making, many ends up choosing courses traditionally associated with a socially constructed feminine vocation, like nursing or teaching (Sainz & Upadyaya 2016). Which, simultaneously, produces a systematic devaluation of these highly "feminine" professions in the labor market (Olinto 2011).

The influence of the closest environment on female teenagers also impacts their career choices. For a girl to choose to pursue a career in sciences and engineering, it is crucial that both parents have a tertiary educational level and especially, that the mother has been to university (Vasconcellos & Brisolla 2009). This highlights the importance of role models for girls to inspire them to become future scientists.

The lack of references of female scientists and philosophers in textbooks, the difficulty for girls to meet actual scientists and mentors that they can identify with, the absence of women as important characters to society in memory spaces like museums, and the long-standing biases and gender stereotypes socially constructed that surface the science careers steers girls away from professions that will have to deal with logical reasoning.

[4] http://www.iac.es/adjuntos/prensa/Paralajes_Mujeres_en_Astro.pdf

In this paper, we discuss how we used the historiography of women in sciences and philosophy as a thematic topic in a project aimed at female teenagers ran by the Museum of Astronomy and Related Sciences (MAST, in the Portuguese acronym) in Rio de Janeiro, Brazil. The project had the goal of encouraging girls to explore scientific career paths and engage with science. It was coordinated and supervised by three scientists of MAST Education Department.

The project conception was based on a broad theoretical framework in the areas of science education and gender in sciences, as well as education and communication in museums. In particular, we ascribe to the vision that science museums are institutions that have as a mission to expand society's access to scientific knowledge and encourage the excitement of discovery. They cannot be places that legitimate the obliteration of the important contributions women have done to the science. In this context, models become important, not just models of current female scientists, but historical figures who have contributed to the construction of a particular field. In the case of MAST, this is very important since the institutions is a science and a history of science museum.

To assess whether the project's goals have been met, an evaluation study was conducted during the 18 months that the project was run. Various activities were evaluated, in particular, the one in which the participant girls conducted studies on the history of various female intellectuals and scientists in different periods of world's history. In this article, we present the analysis of the discourse of the participant girls on the thematic and discuss the importance of such resources for educational activities in museums.

Women at the Forefront: Discoveries by the Youth

"Girls in the Museum" is a science education program that seeks to motivate female high school students into liking science and train them as science museum mediators.[5] The project uses Astronomy as a tool and a gateway to other science subjects like physics, chemistry, mathematics, geology and computing sciences to motivate and involve the participant students in scientific practices. Ultimately, it aims at presenting different possibilities available to the students, who will soon have to decide about their future.

The project, to achieve its goals, uses a variety of methodologies during the training meetings, from theoretical classes with renowned scientists and educators, to hands-on science activities, a museum dedicated tours and movie screenings. Besides, the contributions of women to science and society throughout history has always been an active part of the sessions.

Concurrently with the meetings, a study was conducted to evaluate the project and verify possible changes in the students' viewpoints and the perceptions towards science. Interviews and focal groups were carried out in specific training sessions to document the relevant experiences lived and survey the attitudes of the participants. After the conclusion of the project, interviews have also been conducted to follow-up the participants.

"Girls in the Museum" group consisted of seven female high school students from the city of Rio de Janeiro, with ages between 15-18 years. Four of them were selected by a collaborating teacher, attending a state (public) high school, located in the central area of

[5] Mediators are the professionals responsible for welcoming the public and carrying out activities in museums, such as guided tours or practical activities. They allow the visitors to deepen their understanding on the themes presented and make their experience more significant. Other names can be found in the literature for these professionals such as educators, monitors, presenters, guides, explainers.

Rio de Janeiro. Two participants studied at the Technical College of the federal rural University, in the western part of the city. One of them knew about the project after participating in a Museum event dedicated to girls. The other student had already been a summer intern at the Museum, six months before the project was launched. One student went to a private school, not very uncommon in Brazil. The school was located in southern Rio, the wealthier part of the city. She has learned about the project while visiting the Museum with her family. The latter three students had a manifest interest in science, and in particular in Astronomy, before the beginning of the project.

The first edition of "Girls in the Museum" took place between July 2016 and December 2017. During that period, the participant students engaged in a series of talks and practical workshops not only about science, but on the social aspects of science. Scientists and educators of various institutions were put in contact with the participating girls who attended the activities twice a month.

Along the process, the students had to design and develop their own educational activities and experiments, always supervised by senior female scientists, and present at science communication events offered to the general public by MAST. They also acted as Museum mediators once a month and in special events coordinated by the Museum Education department.

One of the activities the participants were actively engaged was the talk presentation entitled "Incredible Unknown Female Scientists", that highlighted the contributions of fourteen female scientists and philosophers from various periods in world history. The talk was fully elaborated by the participant girls and the idea for the theme came after a meeting where students became aware of the very few names of female scientists they, and their colleagues back at school, actually knew of.

To help the participants to realise the activity, the supervisors of the project provided them various texts on female scientists who have worked or are currently working on different fields. Choosing this reference material has proven rather challenging, provided that the historiography of many women in the sciences are restricted to academic journals. Different education material compatible with the education level of the participant girls tended to highlight the same scientists. For instance, Madame Marie Curie has her presence assured on all texts about female scientists. Finally, the girls were advised to use the following references (all in Portuguese):

- De Melo, H. P. & Rodrigues, L.M.C.S. *Pioneiras da Ciência no Brasil*. [*Pioneers of Science in Brazil*]. Sociedade Brasileira para o Progresso da Ciência. 2006.

- Do Nascimento, J. B. *Algumas Mulheres Da História da Matemática*. [*Some Women From The History Of Mathematics*]. ICEN/UFPa. 2016.

- Tosi, L. *Mulher e Ciência: a revolução científica, a caça às bruxas e a ciência moderna.* [*Woman and Science: the scientific revolution, the witch-hunt and the modern science*]. Cadernos Pagu, vol 10, p. 369-397. 1998.

- Sousa, L. P., Sombrio, M. M. O & Lopes, M.M. *Para ler Bertha Lutz*. [*To read Berta Lutz*]. Cadernos Pagu, vol 24, p. 315-325. 2005.

- Article from Scientific American Brazil "A história das 'estrelas além do tempo' reais da NASA" ["The hitory of the real 'Hidden Figures' of NASA"].
- Movie about Nise da Silveira: "Nise: The Heart of Madness" 2015.

Participants also looked for additional information on the internet, selecting the scientists they found life and work more interesting. Later, they prepared one slide per scientist highlighting the work, professional trajectory and main accomplishments. They also included in the presentation the difficulties those women had throughout their scientific careers, having to face severe discrimination, humiliation, retaliation and sometimes even death.

The selected scientists by the participants were:

- Hypatia (Greek mathematician, astronomer and philosopher, 5th century),
- Hildegard von Bingen (German abbess, writer, philosopher and anatomist, 12th century),
- Marie Meurdrac (French chemist, 17th century),
- Laura Maria Caterina Bassi (Italian physicist, 18th century),
- Mary Anning (British palaeontologist, 19th century),
- Rosalind Elsie Franklin (British biophysicist, 20th century),
- Cecilia Helena Payne-Gaposchkin (British-born American astrophysicist, 20th century),
- Katherine Coleman Goble Johnson (American mathematician, 20th century),
- Vera Florence Cooper Rubin (American astrophysicist, 20th century),
- Wendy Laurel Freedman (Canadian-American astrophysicist, 20th century)
- Joana D'arc Félix de Souza (Brazilian chemist, 20th century),
- Nise da Silveira (Brazilian psychiatrist, 20th century),
- Graziela Maciel Barroso (Brazilian botanist, 20th century),
- Bertha Maria Júlia Lutz (Brazilian zoologist, politician and diplomat, 20th century).

The participants of the project selected the scientists based on their historiography. They have organised and compiled the relevant information, designed the talk and chosen the title. The "Incredible Unknown Female Scientist" talk was first presented at the "III Girls Day" organised by MAST and, afterwards, was replicated during the Brazilian National Science Week in several venues, as well as at schools. It was presented to various audiences throughout the year of 2017. Figure 1 shows the first presentation of the talk.

Fig. 1

Fig. 2

Fig. 3

Figs. 1, 2 and 3:
III Girls' Day event organized by MAST. Four "Girls in the Museum" presents their favorite scientist to a broad audience. Credits: MAST.

Incredible Unknown Female Scientists: The Discourse Analysis

As part of the study conducted to evaluate "Girls in the Museum", six months after the project ended (nearly 1,5 years after the first presentation of the talk), we interviewed the participants. Questions were addressed to understand how they liked the activity "Incredible Unknown Female Scientists", how they felt about having to present to a broad audience the life and, specially, the scientific work of the selected scientists, and which of them they could still remember.

The answers of the participants were transcribed and analysed based on the Discourse of the Collective Subject methodology (Lefèvre 2003). The technique uses the individual answers of each participant, grouping sentences that belong to the same idea. Sentences from all participants that match the same idea are used to create a unique discourse/speech, as if it was given by the social group the participants represent (in our case, teenagers from Rio de Janeiro). This unique discourse/speech incorporates the beliefs and opinions on a specific topic of that particular social group.

In brief, this is done by classifying the sentences of each individual answer (aka. *key expressions*) into conceptual categories (aka. *central ideas*) and quantifying the number of times that specific category appears in the discourses (aka. *intensity*). The answer of a participant may contain more than one central idea, for example, when there is a contradiction in the answer. The researcher is responsible for building a unique discourse to each central ideas, or the so-called, discourse of the collective subject (DSC). To finalize, the researcher may introduce a few adjustments (for instance, by inserting connectors or missing words) so to bring the DSC to fruition. The DSC is written in first-person.

The Discourse of the Collective Subject has been widely used in social sciences in an attempt to unveil the ideologies underlying the perceptions of different social groups composing our society and complement the qualitative analysis of the discourse with a way of quantifying the intrinsic ideas found in them.

Results

In this section, we present the discourses obtained from the interviews about the "Incredible Unknown Female Scientists" activity, conducted six months after the end of the "Girls in the Museum" project. Six of the seven female students responded to questions, as did the only male participant of the project. We have decided to include his opinions because they reflect how the historiography of women in science can inspire both girls and boys into liking science.

In the following, we show the conceptual categories found for every question and their associated intensity. This number indicates the frequency with which that particular idea appeared in the answers given by the students. The discourses are then transcribed separately for each of these central ideas.

The first question was: *What did you think about the activity "Incredible Unknown Female Scientists" that we organized for the III Girl's day at MAST and also used at other events?*

In Table 1 we list the five different central ideas found in the replies to this question. We observe that, in general, the activity was well-liked as well as it inspired the students, expanding their vision and even exposing their own prejudices. Particular emphasis was given to the topic of the activity itself. All the participants agreed that the subject was very interesting and important to be addressed. Specifically, four of the students stated the relevance of presenting these female scientists to a broad audience and to make visible the participation of women in science (in the past and the present).

Table 1: Central ideas obtained for the first question

Central Idea	Intensity
1.1 I liked it	5
1.2 It inspired me	3
1.3 Interesting and important topic	8
1.4 Importance to convey to others	4
1.5 I was afraid of speaking in public	2

Central Idea 1.1 "I liked it" (Intensity = 5)

> [I thought it was incredible, I really liked it. I found the talk (we have created and presented) was great, wonderful and I loved preparing the slides. Best lecture ever.]

Central Idea 1.2 "It inspired met" (Intensity = 3)

> [I felt very motivated and excited studying about several incredible women and discovering that their lives were not easy, but that they did not give up their career. This activity opened my eyes, helped me greatly to expand my vision (since), like many, I used to believe that the great discoveries came only from men, that they were responsible for everything.]

Central Idea 1.3 "Interesting and important topic" (Intensity = 8)

> [The two (times we have given the) talks were amazing and interesting in different ways. I found it very interesting using the opportunity to discuss such an important content, because it is a topic that is not usually addressed.]

Central Idea 1.4 "Importance to convey to others" (Intensity = 4)

> [I found the presentation very appropriate for the public. We managed to show women over a historical perspective, from ancient times to the present day. Aside from studying them, we were able to tell other people about them, which I think is great. Being able to present (them) at other events allowed me to believe that our first performance was worth it. I hope (it opened) the eyes of several other people to the fact that women's participation in science was not and is not small.]

Central Idea 1.5 "I was afraid of speaking in public" (Intensity = 2)

> [(It was) a somewhat challenging experience, because I had to overcome my shyness and my speaking too fast. I still had a fear of saying something out of context (but) I loved being part of some of the presentations.]

Two students referred to personal difficulty when speaking in front of a large audience. A fear that also appeared in the discourses derived from the second question when was asked: *How was the process of preparing and studying the talk?*

In Table 2, we can read the central ideas found for this question. Four students explicitly said they struggled to remain calm before the talk, though at the end they managed to get through it and were able to present in front of the public.

Most of the students found the process of preparation and studying satisfactory and easy, expressing that they really enjoyed learning about female scientists. As in the first discourses, the topic again was an incentive for this phase. We observe that they actually "got attached" to the female scientists they chose to present and were genuinely interested in their lives and scientific work. This highlights the importance of having access to role models the students can identify with.

Table 2: Central ideas obtained for the second question

Central Idea	Intensity
2.1 I was afraid of speaking in public	4
2.2 Satisfactory	5
2.3 Easy	3
2.4 The topic helped	4
2.5 Difficult	2
2.6 Preparation method	1

Central Idea 2.1 "I was afraid of speaking in public" (Intensity = 4)

> [The difficult part was that the presentation itself, I had to deal with my nerves. The minutes before the performances were intense, the shyness spoke louder. I was really nervous. One cannot avoid feeling the jitters and the adrenaline when talking about something, especially something that few people know about.]

Central Idea 2.2 "Satisfactory" (Intensity = 5)

> [The overall preparation process was pretty cool and the study part was great. (It was a) good learning experience because I did not know much about the

> female scientists. After presenting the talk, I was very pleased to have been able to show this to some people. And everything went very well and that's what matters.]

Central Idea 2.3 "Easy" (Intensity = 3)

> [It was easy. Studying to present (the lecture) was more enjoyable than laborious.]

Central Idea 2.4 "The topic helped" (Intensity = 4)

> [There was a real interest in knowing the lives of those female scientists. I got attached to them, something that helped me to know more and feel better prepared for the presentation. I got quite excited while making the slides and learned a lot by looking up about each scientist. They all did incredible findings and discoveries so I wanted to know and speak a little about them all. The theme of the talk was wonderful, (I had) the feeling of "I have to show these women to the world".]

Central Idea 2.5 "Difficult" (Intensity = 2)

> [The process for me was a bit difficult, as I have a slight tendency of losing focus, but the harder part was to choose which scientists to talk about.]

Central Idea 2.6 "Preparation method" (Intensity = 1)

> [I read the texts they (the advisors) sent me and tried to find more information on the internet. (Also) I rehearsed and explained my part to my mother.]

Two participants found some difficulty in the preparation phase, but overcame it without further problems.

We also notice that one participant declared that she rehearsed her part of the presentation together with her mother, which again refers to the significance of closeby models for teen girls (especially the mother).

Finally, the students were asked if they remembered any of the scientists they had presented six months ago as well as if they could give names and reasons for recalling those scientists.

Table 3 summarizes the central ideas associated with this question. All students could remember at least one of the female scientists and three of them could remember up to three different scientists. The ones that were most cited by students were Hypatia and Nise da Silveira, both of them being mentioned three times. Joana D'arc Félix de Souza was cited twice and Graziela Maciel Barroso, Rosalind Franklin, Cecilia Payne, Mary Anning and Laura Bassi were quoted one time in the interviews.

Among the reasons given for remembering a particular researcher, the most recurrent concerned the experiences these women lived throughout their lives and specially the struggles to pursue their dream of a scientific career and the prejudices they encountered. Clearly, the tragic final of Hypatia had an emotional impact on the students, since it appeared repeatedly in the answers.

Furthermore, two students mentioned the personal gain in their education from having learned about these scientists. Also, two students pointed out the historical relevance of these figures who deserved both credit and recognition. One mentioned that the historical epoch was of great appealing to her.

Table 3: Central ideas obtained for the third question

Central Idea	Intensity
3.1 Yes, I do	7
3.2 Because of their lived experience	6
3.3 Because they contributed to my personal learning/background/education	2
3.4 Because they were Brazilians	2
3.5 Because they were great women	2
3.6 Because of the historical epoch	1

Central Idea 3.2 "Because of their lived experience" (Intensity = 6)

> [The ones that impressed me the most were because of the history that each one lived or for having suffered a lot of prejudice at the time. The story (of Joana D'arc Félix de Souza) was one of those that moved me, the most for so many things that she endured throughout her life. (Hypatia was) a woman ahead of her time who, due to the fear of the society of an independent and strong woman like her, was murdered in a terrible way. (Rosalind Franklin) had her research stolen (by a colleague), and the guy still won a Nobel for her work.]

Central Idea 3.3 "Because they contributed to my personal learning/background/education" (Intensity = 2)

> [They were great scientists and contributed a great deal to my education and my way of seeing the world and the people. They all helped to model the person I am today: the person who sees the greatness of women who have been killed, humiliated, and forgotten throughout history to defend what they loved.]

Central Idea 3.4 "Because they were Brazilians" (Intensity = 2)

> [They were Brazilian and part of the history of our country.]

We identify that three out of four of the Brazilian scientists were remembered by the students. Also, two students declared that the reason for remembering some of the scientists was because they were Brazilians. This shows the importance of also providing *local* reference models from the participants' country in order to challenge the myth that important scientific discoveries have only been made in western countries.

Central Idea 3.5 "Because they were great women" (Intensity = 2)

> [They made history, not just the ones I quoted or talked about in the talks. All of them contributed to science in general. All deserve recognition and respect. (For example, Nise da Silveira) was a great woman not only in her research but also in life.]

Central Idea 3.6 "Because of the historical epoch" (Intensity = 1)

> [(She was) from a historical epoch that I appreciate very much.]

It is also worth to mention that after the presentation at the different venues where the students participated, several teachers approached the coordinators of the project and expressed their interest about the activity and their willingness to reproduce it with their own students. Also many youngsters who attended the "Incredible Unknown Female Scientists" presentation asked more about these scientists and were very interested in the subject.

Conclusions

The absence of women's memory and cultural heritage in human History is being gradually addressed and reversed, though we still face a considerable lack of female figures in almost every field of knowledge, particularly in scientific areas. This exclusion perpetuates the inequalities that exist in modern society and is especially negative for young generations, who are being educated without learning about women's legacy and crucial contributions to philosophy, art, science and literature.

In this paper, we presented an education project aimed at female teenagers ran by the MAST in Rio de Janeiro, Brazil. While the project had a broader scope of encouraging girls to engage with science, a central part of it related to the historiography of women in sciences and philosophy.

The activity "Incredible Unknown Female Scientists" consisted on a one-hour talk on the life and work of 14 female scientists from different epochs of history. The slides were prepared by the students, who were also responsible for choosing the female figures, researching about them and presenting them to the general public attending several outreach events at MAST and other venues.

The project as a whole was evaluated by conducting interviews and focal groups during the full period it runs at MAST (18 months). Specifically, the impact of the "Incredible Unknown Female Scientists" activity was assessed via a short interview six months after the end of the project. The answers were analysed using the Discourse of the Collective Subject methodology, that allows to extract the main ideas from the replies, create a single discourse for each of those ideas and quantify their recurrence by means of the parameter intensity. The created discourses represent the social group's beliefs and opinions about a particular topic or central idea.

Our results point to a major trend: the students felt encouraged to study these scientists and understand their scientific work, because they felt represented. They repeatedly mentioned that it was very interesting learning about women doing this kind of job in the past and now, and that they felt proud to be able to present them to the public and, in their own words, "to restore" their role in science. The participants revealed that they felt represented, especially because they have analysed the historiography of Brazilian and Afro-American female scientists. Moreover, they not only felt inspired by the history and experience of those female scientists, but they also looked up to them as models they could identify with. The impact these women had in the students' lives can be expressed in the student's own words: "they helped to model the person I am today".

An immense potential lays in the history of women in science to encourage new generations of students to approach and be motivated by science. We argue that the historiography of women in sciences is a valuable resource that can be used in all educational levels in schools, universities, science museums and even professional conferences.

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Special Issue – Women in Sciences: Historiography of Science and History of Science on the Work of Women in Sciences and Philosophy

Sofia A. Yanovskaya: The Marxist Pioneer of Mathematical Logic in the Soviet Union

Dimitris Kilakos[1]

Abstract

K. Marx's 200th jubilee coincides with the celebration of the 85 years from the first publication of his "Mathematical Manuscripts" in 1933. Its editor, Sofia Alexandrovna Yanovskaya (1896–1966), was a renowned Soviet mathematician, whose significant studies on the foundations of mathematics and mathematical logic, as well as on the history and philosophy of mathematics are unduly neglected nowadays. Yanovskaya, as a militant Marxist, was actively engaged in the ideological confrontation with idealism and its influence on modern mathematics and their interpretation. Concomitantly, she was one of the pioneers of mathematical logic in the Soviet Union, in an era of fierce disputes on its compatibility with Marxist philosophy. Yanovskaya managed to embrace in an originally Marxist spirit the contemporary level of logico-philosophical research of her time. Due to her highly esteemed status within Soviet academia, she became one of the most significant pillars for the culmination of modern mathematics in the Soviet Union. In this paper, I attempt to trace the influence of the complex socio-cultural context of the first decades of the Soviet Union on Yanovskaya's work. Among the several issues I discuss, her encounter with L. Wittgenstein is striking.

Keywords: Sofia A. Yanovskaya; History of Logic; Women in Sciences

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Introduction

Sofia Alexandrovna Yanovskaya is a prominent figure for the history of mathematics in the Soviet Union. Unfortunately, though, her contribution remains relatively unknown, especially beyond the former Soviet Union. Yanovskaya is chiefly known as the editor of the first publication of K. Marx's "Mathematical Manuscripts" in 1933. Undoubtedly, this was a significant milestone in her successful career within Soviet academia. However, I maintain

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that Yanovskaya's life and work deserve more scholar interest for several more reasons. In this paper, I trace the influence of the complex socio-cultural context of the first decades of the Soviet Union on her fascinating life and career.

S. A. Yanovskaya was born in 1896 into a Jewish family, in Pruzhany, a small village then in Russian Poland (now in Belarus)[2]. Her birth name was Neimark and her father, Aleksander, was an accountant. When she was almost two years old, her family moved to Odessa; there, in 1905, the 9-year old Sofia witnessed the worker's uprising.

After graduating from the gymnasium in 1914 with a gold medal, Sofia Neimark entered the Higher School for Women in Odessa, which was part of the Novorossiisk University. There she studied mathematics, being tutored by Ivan Jure'vich Timchenko (a noted historian of mathematics) and Samuil Osipovich Shatunovsky (a well-known then mathematician in Russia). During her studies in Odessa, she developed her mathematical skills in a variety of topics, as well as her interest in the history of mathematics.

In those turbulent revolutionary years, Sofia was politically active. While studying in the Gymnasium, she assisted political prisoners as a member of an underground organization. She actively took part in the social uprising burst out throughout Russia with the Great October Revolution, giving up her studies in the university. In November 1918, she joined the Bolshevik wing of the Russian Communist Party. During the civil war, which broke up since counterrevolutionary forces from inside and outside Russia resisted to the victorious Revolution, she defended the Revolution. In 1919, she served the Red Army as a political commissar.[3]

Amidst the turmoil, S. A. Yanovskaya married her comrade Isaac Ilyich Yanovsky in 1918. As her friend M.G. Shestopal describes, Isaac was "her mentor and friend, a man of bright individuality, a pure soul and a deep, clear mind. Along with him, Sofia conducted political activities in the ranks of the Bolshevik Party, shared with him the military life in the civil war, repeatedly being exposed to mortal danger" (Shestopal 1982, 116).[4]

When the Red Army defeated the counterrevolutionary forces, communists had to deal with the even more laborious task of building the new society. Among other duties, of primary importance was the enlightenment of the masses. In that fashion, Sofia became an editor for the "Kommunist" newspaper in Odessa. From 1920 to 1923 she worked for the Odessa Regional Committee of the Bolsheviks.

Throughout these years, mathematics was not a priority for Yanovskaya. However, being an earnest and driven communist, soon after she responded to the call for a new intelligentsia to serve new society's needs. Thus, in 1923 Yanovskaya moved to Moscow and returned to her studies, attending seminars at Moscow State University. In 1924, she

2 For a concise, well-informed and accessible to English-speaking readers biography, one may look at the relevant article on MacTutor History of Mathematics archive, written by J. J. O' Connor and E.F. Robertson
(URL: http://www-groups.dcs.st-and.ac.uk/~history/Biographies/Janovskaja.html - Accessed on October 11, 2018). Several interesting biographical details are also offered in Bashmakova et al. (1966), Gorskii (1970), Bochenski (1973), Anellis (1987a), Anellis (1987b), Bashmakova et al. (1996), Kushner (1996), Trakhtenbrot (1997) and Bazhanov (2001). Levin (2012) is a comprehensive overview of Yanovskaya's life and work. A short and rather modest autobiography is (Yanovskaya 1982).

[3] Kilberg describes the following episode from that time: "During the retreat from Odessa, the Whites captured several Red Army soldiers. They shot the prisoners on the bridge, and they fell into the river. Among them [...] was Sofia Alexandrovna. A bullet shot through the high hat's hat. Sofia Alexandrovna fell into the river, managed to swim out and then spent the whole night sitting in the water in the reeds" (Kilberg 1982, 105).

[4] Sofia and Isaac had a son, who unfortunately was mentally ill and committed suicide shortly after his mother's death. (Kushner 1991, 71; Bashmakova et al. 1996, 360).

entered the Institute of Red Professors, where she became a student of V.F. Kagan (a significant geometer and historian of mathematics and a specialist on Lobachevsky)[5].

One may not exaggerate in suggesting that those heroic times deeply affected her character. As one of her closest friends writes,

> S. A. Yanovskaya lived a life imbued with kindness to people. Her whole existence was determined by a sense of duty, selflessness, and unselfish service to the cause. A modest and open-minded person, Sofia Aleksandrovna was exceptionally benevolent towards others. A very lively, cheerful and sociable person, she constantly felt the need to communicate with people [...] The name of Sofia Alexandrovna is surrounded by an atmosphere of moral purity. For everyone she met, she evoked a feeling of sympathy. [...] Being an extremely kind person, unusually delicate, she was always ready to respond to someone else's misfortune, to help a good cause. It was done quietly, with inherent tact. (Kilberg 1982, 104-107)

The Quest for "Red Scientists"

Before the Great October Revolution, admission to higher education was not an option for the vast majority of young people (especially workers and peasants). Besides the declared vision to raise class-barriers, the situation mentioned above has been troublesome for Soviet authorities: the number of scientifically educated personnel in pre-revolutionary Russia was insufficient for the implementation of the vast program for the reorganization and modernization of the economy and society in general. The pre-revolutionary intelligentsia neither sufficed for nor was in its totality eager to pursue this goal.

As long as mathematicians are concerned, it seems that efforts to draw them to Marxism had considerably less success than among other scientists (Joravsky 2009, 158). Arguably, this could be - at least partially - explained if the long-lasting influence of religious mysticism among leading Russian mathematicians (especially in Moscow) is taken into account; however, a thorough discussion on this issue is far beyond the scope of this paper.

In this context, Soviet authorities introduced several multifaceted policies to alter this situation rapidly. They aimed to reinforce the proportion of workers among students and, upon their graduation, in academia. These efforts proved to be remarkably efficient. It is noteworthy, for example, that between 1928 and 1932, the number of students trebled and the teaching staff doubled (Joravsky 2009, 238). As the Soviet mathematician O. Iu. Shmidt mentions, "a young man who studies our science, has every chance of becoming a professor at twenty-five" (Joravsky 2009, 238).

Among several initiatives aiming to address the challenge mentioned above, one deserves particular attention for our current purposes, due to S. A. Yanovskaya's participation in it.

The Institute of Red Professors of the All-Union Communist Party (Bolsheviks) was founded in February 1921 in Moscow. It was a specialized higher educational institute, meant to address the shortage of Marxist professors. Its programs were training teachers for higher educational institutions, as well as specialists for scientific research institutions and the Communist Party's and Soviet state's organs. Between 1921 and 1928, 1966 students were accepted for study at IKP, Yanovskaya being one of them. Administration's reports highlighted two main channels of employment after IKP: into party journals and newspapers and into "party-pedagogical work", including IKP itself. In 1928 over half of

[5] For further details on those who influenced Yanovskaya's intellectual development and her scholar interests, see (Anellis, 1996).

IKP's faculty was its graduates (David-Fox 1997, 165). It is estimated that almost 25% of IKP graduates continued an academic career.

In the 1930s, higher education and research institutions in the Soviet Union were sufficiently developed. Hence, IKP gradually lost its importance and finally integrated into the system of higher Party schools of the Central Committee of the Communist Party of the Soviet Union.

Yanovskaya's Academic Career

While studying at IKP, Yanovskaya also led seminars on the methodology of science and mathematics at Moscow State University by 1925. In this manner, she came into contact with several prominent Soviet mathematicians.

The need for university professors who could serve the new society was imminent, and Yanovskaya was a promising candidate. Being talented and skilled in mathematics as well as a militant Marxist, she had already earned respect both in academic circles and among her comrades in the Communist Party. Those years, a considerable portion of Muscovite mathematicians were influenced by the so-called "Moscow-school", which had a profound counterrevolutionary and idealistic background. This background was not compatible with what Soviet authorities held that was needed for the training of young Soviet scientists.[6] Yanovskaya portrays a vivid picture of the situation in those years:

> If there is a low percentage of natural scientists sharing Marxist views, then among mathematicians this percentage is even lower [...] the Old Professorship from the so-called "Moscow school", whose authority among the mathematical milieu was unshakable, made every effort to save mathematics from the malicious influence of materialistic philosophy, which did not hide its Party orientation and its class, proletarian character. Even the word "Comrade" was neither accepted at the Institute of mathematics and mechanics, nor at the Mathematical Society [...] in contrast, among the members of this Society, the percentage of white émigrés is rather high. (Yanovskaya 1930, 88, 94)

Accordingly, Yanovskaya was asked in 1926 to teach in Moscow State University's mathematics department, although she was still a student. Being a member of the faculty already for 5 years– and teaching the history of mathematics since 1930 –, she was appointed as a professor in 1931. Simultaneously, she continued her studies and received her doctorate from the faculty of Mechanics-Mathematics of MSU in 1935.

In 1936, she started teaching mathematical logic and in 1943, after the Red Army beat the Nazis, Yanovskaya was appointed Director of Seminar in Mathematical Logic at MSU.[7] As Uspensky notes, she actually founded this seminar, which was the first such institution in the Soviet Union (Uspensky 1997, 459). In 1946, she started teaching formal logic within the Philosophy Department. In 1951, Yanovskaya was awarded the "Order of Lenin", which was the highest national decoration of the Soviet Union.[8]

[6] For a discussion on this complex socio-cultural context and the problem posed to Soviet authorities by the idealistic foundations of Moscow School, see (Kilakos 2018). For a review of Yanovskaya's involvement, see (Levin 2012).

[7] During the war, MSU was temporarily relocated to Perm.

[8] The "Order of Lenin" was awarded to Soviet citizens for outstanding services rendered to the State.

In 1959, Yanovskaya became the first Head of the newly established Department of Mathematical Logic at Moscow State University; she held the Chair in Mathematical Logic until her death in 1966.

Kushner (1991) vividly describes the reminiscences of his first encounter with Yanovskaya in the early '60s, when he attended one of her lectures in the Mathematical School of Moscow University:

> Near the blackboard stood a little old lady in an out-of-fashion black dress (she almost always wore this dress, as I was to learn later). Her face, rather round in shape, was very kind, and big round glasses were in complete harmony with the face. A small, shabby, leather briefcase on the desk was somehow similar to its mistress and completed the picture. All those non-official and old-fashioned attributes immediately charmed me, as well as the very slow and distinct manner in which the lecture was delivered. (Kushner 1991, 67-68)

Bazhanov mentions that it was due to Yanovskaya's efforts that chair in logic and sector of logic were established at Leningrad State and the Institute of Philosophy of the Academy of Sciences of the USSR (Bazhanov 2017, 74).

S. A. Yanovskaya's scientific work

While Yanovskaya is mostly known for her work in mathematical logic and as the editor of the first publication of Marx's "Mathematical Manuscripts", her scientific work ranged in a variety of fields. Her special place in history is not so much due to her original contributions in research, but due to the credit she deserves for making research in mathematical logic possible to others (Uspensky 1997, 459) and her contribution to the promotion of Soviet studies in logic in the 1940s and 1950s[9] (Bazhanov 2001, 4). Yanovskaya contributed to the publication of textbooks, original articles and monographs, and, most importantly, carried out the translation and publication of logical foreign literature (Bazhanov 2017, 74).

Yanovskaya worked on the foundations of mathematics, on mathematical logic and on the philosophy of mathematics and logic (getting engaged with the work of Frege, Russell, Couturat, Cantor, etc.), as well as on the history of mathematics. Among other issues, Yanovskaya dealt with ancient Egyptian and Greek mathematics, Rolle's criticisms of the calculus, Descartes' geometry and Lobachevsky's non-Euclidean geometry.

The titles of some works she published are indicative for the scope of her interests and activities:[10]

- *On the so-called 'Definition by Abstraction'*, 1936
- *On the theory of Egyptian fractions*, 1947
- *Michel Rolle as a critic of the infinitesimal analysis*, 1947
- *The leading ideas of N.I. Lobachevsky - A combat weapon against idealism in mathematics*, 1950

[9] A detailed overview of Yanovskaya's efforts to promote the study of logic in the USSR in the 1940s is offered in (Anellis 1996).

[10] A more comprehensive bibliography of selected works by S. A. Yanovskaya may be found in (Anellis 1987b, 54-55) and in (Levin 2012).

- *On the philosophy of N.I. Lobachevsky*, 1950
- *On the Weltanschauung of N.I. Lobachevsky,* 1951
- *On the history of the axiomatic method*, 1958
- *On the role of mathematical rigor in the creative development of mathematics and especially on Descartes' 'Geometry',* 1966.

She also published two major studies on the history of mathematical logic in the USSR:

- *Foundations of Mathematics and Mathematical Logic*, 1948
- *Mathematical Logic and the Foundations of Mathematics*, 1959

Of significant importance is Yanovskaya's translating work (mostly in mathematical logic), not only because due to it some important works became known to and utilizable by Soviet scholars, but also because of the interpretative introductions Yanovskaya wrote for them, which are of original scientific importance.

Among other works she translated in Russian, of significant importance are the following:

- D. Hilbert and W. Ackermann, *Grundzüge der theoretischen Logik* (Outlines of theoretical logic – the first foreign book in mathematical logic published in USSR)
- A. Tarski, *Introduction to logic and the methodology of deductive sciences*
- G. Polya, *Mathematics and plausible reasoning*
- R. Carnap, *Meaning and Necessity*
- A. Turing, *Can machines think?*

Yanovskaya's Original Marxist Approach of Modern Mathematics

Yanovskaya's scientific work reflects her aspiration to contribute to the needs of the new society from the standpoint of an academic, militant Marxist and member of the Communist Party. As she acknowledged, this was a difficult challenge: "the goal of stratifying mathematicians and defining the truly Soviet components is a difficult and urgent problem. A problem that demands maximal vigilance" (Yanovskaya 1930, 94). Explaining these difficulties, she further notes that "[t]he modern crisis of capitalism robs mathematics of materialistic tools and methods (intuitionism), widens the gap between theory and practice, and aggravates its spontaneous and unplanned character" (Kolman and Yanovskaya 1931, 118-119).[11]

[11] Ernst Kolman (1892-1979), who co-authored with Yanovskaya this paper, was a leading Marxist mathematician, philosopher and historian of mathematics during the first decades of the Soviet Union. He was a member of the Soviet delegation to the 1931 International Congress of the History of Science and Technology, held in London. Kolman is a rather controversial figure in the history of

Her attempts to address these challenges lead several scholars to describe Yanovskaya as a contradictory figure. This view stems from the inclination of its proponents to juxtapose Yanovskaya's commitment to Marxism and to the interests of Soviet society with the importance of her scientific work.

As a Marxist, Yanovskaya severely criticized idealism[12] in mathematics, which, according to her, was apparent in the works of Frege, Russell, Cantor, etc. Yanovskaya argued that their views were close to true idealism and mysticism, "the example of which is Platonism." According to her, "bourgeois science in the imperialist era does not evolve from Hegel to Marx, Engels, and Lenin, but regresses" (Kolman and Yanovskaya 1931, 119). Her commentary on A. Tarski's work is indicative of her understanding of modern philosophy of mathematics. According to Yanovskaya, he was a logical positivist, representing "the blatant type of philosophical conservatism", as she wrote in the preface to the translation of Tarski's '*Introduction to logic and to the methodology of deductive sciences*'.[13]

As Anellis comments, Yanovskaya, in her writings on philosophy of mathematics and philosophy of logic, "took the offensive against the idealist philosophy of the bourgeois West, represented in her mind by Gottlob Frege, and against the so-called Machism, that is, conventionalism, represented by Rudolf Carnap and his Principle of Tolerance, according to which in logic one is free to choose one's rules" (Anellis 1987a, 82).

In her work, S. A. Yanovskaya proffered a profound analysis of philosophical problems of mathematical logic, which was a troubling issue for Marxists. As Anellis notes, Soviet scholars were facing trouble with drawing a line of demarcation between classical logic and mathematical logic – actually, some of them made no essential distinction between the traditional Aristotelian logic and mathematical logic: to them, both were the hated 'formal' logic (Anellis 1987b, 47).

It is impossible to appreciate Yanovskaya's contribution to its full extent, unless one is aware of the context of the relevant discussion among Soviet scholars. Therefore, the following digression is justified.

The relation between dialectical logic, which is constituent of Marxism-Leninism, and traditional 'formal' logic of the Aristotelian tradition[14] was a compelling philosophical issue for Marxists. Some Soviet Marxist philosophers questioned whether formal logic was

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early Soviet science, since he is typically considered as an ideological "watchdog" in scientific issues. However, it is noteworthy that in 1938 Kolman removed from his post as Head of the Department of Science of the Moscow City Committee of the Communist Party. In 1976, Kolman fled to Sweden and gained more fame in the Western world as a Soviet dissident.

[12] A clarification is necessary, since the term 'idealism' is used throughout this paper in the sense it is understood in Marxism, denoting the philosophical views establishing the primacy of mind (or consciousness, or reason) over matter (or reality), as opposed to materialism. This distinction between idealism and materialism bears significant consequences for ontology as well as for the theory of knowledge. For Marxist dialectical materialism, existence in all its forms is material and everything that is real is material and ultimately cognizable. Thus, in this context, idealism is not confronted with realism, since the latter posits the existence of immaterial entities which may or may not be accessible to cognition. Therefore, for example, realistic trends in philosophy of mathematics, rooted in varieties of platonic ideas, are rendered idealistic from a Marxist standpoint.

[13] Bazhanov (2001) offers a different perspective in dealing with Yanovskaya's stance as depicted here, arguing that utterances like those cited here (and by him) resulted from her attempt to compromise with the need to pay tribute to the ideological requirements while at the same time serving the actual needs of an academic community.

[14] In such an account, 'formal' logic could broadly be understood as the traditional logic, developed as an autonomous discipline in the Aristotelian trend, enriched by the contributions of medieval scholars and J.S. Mill's considerations about induction.

bound to its subject matter, due to its pure abstractness. Another hotly debated issue was the relation of logical laws to the laws of reality, which is ever-changing by law-governed processes according to dialectical materialism.[15]

These philosophical questions may seem irrelevant to mathematics. However, they became relevant for Soviet Marxist philosophers, who got worried by the growing interest shown by mathematicians in mathematical logic and the foundational issues of mathematics. According to the current understanding, mathematical logic developed as a discipline, spinning-off from formal logic. Its roots were traced back in the second half of the 19th century when rigorous mathematical methods were introduced in the study of logic and symbolic notations were extensively used in logical reasoning. In the view of many Soviet philosophers, mathematical logic was merely a new phase of formal logic, the latter being understood as an incomplete approach to the study of the laws of thought.

On these grounds, philosophers and mathematicians were engaged in thorough discussions on whether logic is a philosophical discipline or a special branch of mathematics. Those who argued that logic is a philosophical discipline felt rather uncomfortable with dealing with mathematical logic as logic. In fact, several Soviet philosophers dismissed mathematical logic as being of mathematical interest only and perhaps not even logic at all.

In this discussion, Lenin's strictures against 'idealism' and 'formalism' were used to render mathematical logic 'idealistic' and hence incompatible with Marxism-Leninism. The following passage exemplifies the hostile attitude of a portion of Soviet Marxist philosophers:

> The mathematization of logical relations and operations, and the rise of logical calculi, is one of the sources of idealistic delusion and speculation on the interpretation of thought and the process of cognition, just as the mathematization of physical relations was one of the reasons for the appearance of ‘physical idealism’. (Vojsvillo et al. 1959, 176)

The content of these disputes very little in common with today’s discussion about the various positions in mathematical logic. Therefore, it may surprise those who are unfamiliar with Soviet Marxists’ critique of philosophical idealism. However, these discussions are substantial, since, as Bochenski rightfully notes, “not only because they might bring some new insights in this difficult field, but also for the understanding of what is happening in Soviet philosophy” (Bochenski 1961, 34). While Soviet philosophy is not the primary focus of this paper, one should take into account with regard to mathematics that in Yanovskaya’s times, these problems, “which were elaborated in hard struggle by Soviet logicians, have never been sufficiently studied, from the modern point of view, by any school of Western logicians” (Bochenski 1961, 33). Thus, albeit the quite idiosyncratic employment of various terms and “-isms” in these discussions, one should bear them to understand Yanovskaya’s pivotal role in the development of mathematical logic Soviet Union.

To perform this role, Yanovskaya should defend mathematical logic against the misconceptions of those who confused it with the philosophy of mathematics (Anellis 1987b, 47), in which idealistic trends were prevailing. She concisely deploys her views on this issue in a letter to the editors of the highly appreciated Soviet philosophical journal ‘Voprosy Filosofii’ (Yanovskaya 1950). In this letter, Yanovskaya argues that logic is not a special mathematical discipline; it is merely logic. In this argumentation, Yanovskaya endorses the view expressed by Stalin in his 'On Marxism and linguistics' (1950) on the

[15] For a concise yet detailed discussion of this discussion from an anti-Marxist perspective, see (Wetter 1958, 523-535) and Bochenski (1961).

distinction between language and linguistics. Hence, Yanovskaya implies that Stalin's line of reasoning supports her view that mathematical logic should be unconfused with the philosophy of logic or philosophy of mathematics.

It should be noted that Yanovskaya consistently employed this solid view throughout her work – even before Stalin deployed his views on linguistics. For example, she argued for the distinction between the methodological formalism of mathematical logic and the idealism of the formalist philosophy of mathematics, since mathematical logic "can be considered not only as logic of mathematics but also as mathematics of logic, for it is in large part the result of the application of mathematical methods to the problems of logic" (Yanovskaya 1947a, 341).

In the context as mentioned above, Soviet scholars attempted to set up a historical and philosophical study of mathematics based on Marxist dialectics, as A. N. Kolmogorov writes in the entry on mathematics in the *Great Soviet Encyclopedia* (Kolmogorov 1938, 394). Despite its significance, a study on the foundations of mathematics and mathematical logic was an arduous task for Soviet Marxists theorizing on mathematics. Logicism,[16] which was one of the most influential currents for the development of modern mathematics, was rejected by Marxist scholars, who argued that it reduced mathematics to a branch of formal logic, fully detached from the dialectics of practical life and existential conditions (Vucinich 1999, 108). It is reasoning, based on an absolute reign of symbolism, was criticized as "a shortcut to solipsism", as Bammel wrote (Bammel 1925, 57). In short, Soviet Marxists used to accuse logicism of its emphasis on rules and formulas devoid of any specific content. This attitude was extended to several other trends oblivious to content, since –as it was argued- they could not reflect reality. In this line of reasoning, operating on forms without any content inevitably leads to philosophical idealism. Ergo, this kind of mathematics was incongruous with the acute methodological needs of science and the technical needs of society, amid vast transformative process on both domains. As Vucinich notes, Soviet mathematicians "in contrast to Marxist theorists, showed a clear tendency to refrain from any effort to interpret their science in the light of dialectical materialism" (Vucinich 1999, 111).

From a philosophical standpoint, the troubling issue was the accommodation of formal logic within the broader scope of dialectical logic. According to dialectical materialism, formal logic is not capable of grabbing the essence of reality in its motion and its reflection on our understanding and knowledge. At best, formal logic may offer rules for logical inferences and reasoning with fixed concepts and judgments – actually, it is indispensable when one is dealing with such kind of problems. Therefore, any attempt to render mathematics founded on the grounds of formal logic was, in Marxist understanding, detaching them from reality, something unacceptable.[17]

As one would expect, Yanovskaya was aware of this Marxist critique regarding mathematical logic. She held the view that modern science (including mathematics) should be demystified by the idealistic presumptions guiding its development in capitalist

[16] Logicism in philosophy of mathematics tried to define the basic concepts of mathematics by means of logical terms, or, to put it differently, to infer all mathematics from some logical terms. It was grounded on the Kantian doctrine, according to which the truths of logic are paradigm cases of analytic truths, being true only by virtue of internal relations among the linguistic (and mathematical, in the case of mathematics) expressions involved. For a concise yet detailed discussion on logicism and neologicism (the distinction between them is beyond my concerns in this paper), see (Tennant 2017).

[17] For a summary of the main points of contention in the debate between the dialecticians and the formal logicians, see (Cavaliere 1990) and (Anellis 1994).

countries. However, she firmly believed that knowledge of mathematical logic is indispensable for Marxist mathematicians and philosophers. As Yanovskaya explains in her preface to the Russian translation of D. Hilberts's and W. Ackermann's *Grundzüge der theoretischen Logik,* ideological struggle with idealistic perversions of bourgeois science presupposes a command of techniques that enable one to swing the enemy's weaponry against himself" (Yanovskaya 1947b, 6).

Retaining this view of the matter, Yanovskaya argued on the compatibility of dialectical materialism and mathematical logic. Küng (1961, 39-41) concisely reconstructs her argumentation. By referring to the incompleteness of every formalization as demonstrated by Gödel, Yanovskaya refuted the formalist conception, which treats mathematics as a mere abacus. According to her, the principle of non-contradiction of formal logic could be reconciled with the dialectical conception of the contradictory nature of reality. As she argued, an interpreted axiomatic system can be contradictory unless one undertakes precautionary measures concerning the formulation of the axioms and the applicable means of logical deduction. The trouble, then, is only until any particular question is concretely formulated. If one manages to reach to such a formulation – a course which is guided by dialectic principles – then there is only one, completely determined and unambiguous, answer to the question under study. Thus, actually, Yanovskaya pointed to the fact that dialectical logic is about how any dialectical contradiction, being inherent in reality and reflected on the intellect, is resolved. As she further underscored, "a dialectical contradiction has nothing in common with formal-logic contradiction" (Yanovskaya 1959, 118).

Moreover, Yanovskaya emphasized on the fruitfulness of the application of mathematical logic in mathematics and cybernetics and stressed on the connections of mathematical logic with its technical applications. According to her, there was a significant development in the field of mathematical logic in the first half of the 20th century due to the rapid development of computational techniques, to which it contributed (Markov, Kuzichev and Kuzicheva 1996, 5). Thus, focusing on relevance with real-world and problems of substantial economic interest, S. A. Yanovskaya disentangled the advancement of mathematical logic from the philosophical discussion on the relation between formal and dialectical logic. In fact, she proceeded even further, portraying the foundations of mathematics as an issue of interest in the advancement of socialism. As she explicitly stated in her contribution for the book *Struggle for Materialistic Dialectics in Mathematics* (1931), "[t]o give a [sound] foundation to mathematics means to rebuild it based on theoretical understanding of the practical problems of constructing Socialism" (cited by Lorentz 2002, 185).

Several scholars who have dealt with Yanovskaya's work (i.e. Bazhanov, Anellis, Kushner, etc.) hold that Yanovskaya's adamant Marxist critique against the idealistic formalism and logicism was a tactical move, serving her purpose to contribute to the establishment of mathematical logic as a discrete discipline in the Soviet Union. However, I maintain that such an understanding diminishes the importance of Yanovskaya's contribution.

As I understand her work, Yanovskaya was striving to proffer an original Marxist understanding of modern mathematics. Besides mathematical logic, this also holds for other fields of mathematics she also worked on –among others, for example, in her interesting deployment of a Marxist view of the infinitesimal calculus. According to Yanovskaya, real analysis is understandable as the algebra of motion or the "mathematics of a variable quantity [which] must be of an essentially dialectical character" (Yanovskaya 1983, XI).

The proposed understanding of Yanovskaya's attitude towards mathematical logic is arguably omnipresent in her writings. For example, in her (1948), Yanovskaya declared that

Soviet mathematicians rejected the view that mathematical propositions say nothing about reality. To support this claim, Yanovskaya pointed to A.N. Kolmogorov's work on intuitionistic mathematics, sharing with dialectical logic the rejection of the Law of Excluded Middle. In her view, the problems faced by mathematical logic and its philosophical interpretation could be responded by the development of constructive logic, in which, for example, the Law of Excluded Middle is rejected. Accordingly, Soviet logicians should axiomatically develop constructive logic while discarding the idealistic philosophy adjoint with Brouwer's intuitionistic logic. In order for this task to be performed, according to Yanovskaya, work should be done on extending the laws of the logic of finite domains to infinite domains. On this line of reasoning, other principles of formal logic, i.e. the Law of Non-Contradiction, could also be eliminated. Notably, if such an attempt proves to be successful, then it would be compatible with dialectical logic. Furthermore, as Yanovskaya argued, Soviet logicians also responded to the logical paradoxes, by developing multi-valued logic (for a detailed discussion on these issues and Yanovskaya's argumentation, see Anellis 1996). Prominent Soviet mathematicians, such as A.N. Kolmogorov, V.I. Glivenko, A.A. Markov, D.A. Bochvar, P.S. Novikov, M.I. Sheinfinkel (Schönfinkel) etc., worked along these lines. It should also be noted that plenty of them were participating in the seminar on mathematical logic in MSU, organized and directed by S. A. Yanovskaya.

The Adventure of Marx's Mathematical Manuscripts

Undoubtedly, one of the most significant milestones in Yanovskaya's fascinating life and career is the fact that she was the editor of the first publication of K. Marx's "Mathematical Manuscripts" in 1933. Let us focus on this milestone. An obvious question that one may ask is why these manuscripts remained unknown and inaccessible to scholars for such a long time after his death. In fact, the story of editing and publishing Marx's Mathematical Manuscripts is a rather adventurous one.

After Marx's death in 1883, these manuscripts passed into Fr. Engels' hands, who unfortunately did not have the chance to publish them. After Engels' death, the entire collection of papers by him and Marx passed into the hands of the German Social Democratic Party (SPD), without any plan for their publication. The Great October Socialist Revolution in Russia in 1917 and the birth of the Soviet State renewed the interest in unpublished work of the classics of Marxism. The manuscripts were discovered in SPD archives by D. Ryazanov, the founding director of the Marx-Engels Institute, who created 'MEGA' (Marx-Engels-Gesamtausgabe) aiming to publish the complete works of Marx and Engels. Ryazanov was rather surprised to discover that many Marx's notebooks were devoted to mathematics, amounting to 865 A4 sheets in very small writing. He photographed them and stored them in the Marx-Engels Institute.

The first attempt to edit them in order to be published was assigned by Ryazanov to E. J. Gumbel, but the result was found insufficient by the new leadership of the Institute under V. A. Adoratskii; thus, this first attempt did not lead to a publication. In 1932, the task was reassigned to a group of mathematicians led by S. A. Yanovskaya – the other members of the group were D. Raikov and Nakhimovskaya.[18] Thus, it was only in 1933 that a selection of them appeared for the first time in public, in Russian translation, in the pages of the magazines *Under the Banner of Marxism* and *Markismi Estestvoznanie*. Yanovskaya also wrote a commentary introduction entitled "On the Mathematical Manuscripts of K. Marx".

Although the complete edition of Marx's Mathematical Manuscripts was expected to take place quickly after the 1933 publication, the outburst of WW2 posed a necessary

[18] For a detailed discussion of this story, see (Alcouffe and Wells 2009).

change of plans. The archives and the library of Marx-Engels Institute were shifted from Moscow to the Far East in order to be secured and did not return to Moscow until the Red Army beat the Nazis. Up to then, S. A. Yanovskaya, who remained in charge of the endeavor was also heavily engaged with her work in mathematical logic. In the 1950's, the appointment of K.A. Rybnikov as her assistant for the edition of Marx's Mathematical Manuscripts seemed to provide a good opportunity for the acceleration of the project, but unfortunately until the end of the decade it appeared only the publication of a note entitled "On The Concept of Function" in the journal *Voprossy Filosofii* (No. 11, 1958). While Yanovskaya died in 1966, her contribution in work done to prepare the complete and annotated publication that finally appeared in 1968, in facsimile and also in Russian and German, was immense.

The present paper is not the appropriate venue to discuss in detail Marx's mathematical reasoning, the influences it portrayed[19] and its relative position in Marxian work. However, I maintain that a hint could be given, to underline the scope of the work done by Yanovskaya not only for the publication of the manuscripts, but also on a thorough study of Marx's perspective on mathematics.

Historical surveys have discovered that Marx's interest and studies in mathematics covered a long period from the late 1850s until the early 1880s and his death. Yanovskaya (1968) notes that Marx's formal studies in mathematics were oriented around the texts that Cambridge students used during this period. Concerning Marx's influences on his mathematical studies, Kol'man and Yanovskaya (1931) stressed the influence of Hegel's *Science of Logic*. Among the several issues they raise, they discuss in particular the issue of Hegel's notion "quantitative infinities". The relation between Hegel's intuitions in *Science of Logic* and Marx's studies on mathematics was also noticed by Engels, who, in a letter, he wrote to Marx notes:

> So old Hegel was quite right in supposing that the basic premise for differentiation was that most variables must be of varying powers and at least one of them must be the power of at least 2 or 1/2. Now we also know why. (Marx & Engels 1992, Collected Works, vol.46, p. 131)

In fact, Engels was so enthusiastic about Marx's interest in mathematics that in a letter he wrote to Lange in March 1865 mentions that the only man who has enough understanding of mathematics and philosophy to be able to edit the mathematical manuscripts that Hegel left behind, was Marx (Marx & Engels 1987, Collected Works, vol. 42, p. 138).

One could barely imagine the impact of the publication of Marx's Mathematical Manuscripts for militant Marxist mathematicians in the early 1930s and what it reflected for the status of the editor of this publication. Given the discussion in the previous section, Yanovskaya's career before and after the publication proves that she was able to bear the burden of responsibility.

Wittgenstein in Moscow

One of the most intriguing (especially for the Western reader) episodes in Yanovskaya's career was her encounter with L. Wittgenstein when he visited Moscow in 1935, almost a year and a half after the first publication of Marx's Mathematical Manuscripts.

19 For a concise yet detailed and well-informed discussion on Marx's writings in mathematics and his influences, see (Matthews 2002), on which I have relied for large parts of this section. Perhaps the most classical paper on the issue is (Struik 1948).

When his five-year Research Fellowship at Trinity College expired, Wittgenstein was looking for the next step in his career. Among other career-paths, he considered, one of particular interest was the possibility of taking up a career in a Soviet academic institution. Although such interest may seem peculiar to a modern reader, the fact is that Wittgenstein's interest in Soviet Russia was not an instant impulse. In fact, the idea of visiting Soviet Russia was occurring in Wittgenstein's mind for quite a long time, since he first wrote about it to a friend in 1922 (Moran 1972) and he had been taking lessons in Russian since 1933. In order to arrange his travel to USSR, Wittgenstein asked J.M. Keynes to introduce him to the Soviet ambassador in London, I.M. Maiski. The travel was finally arranged and on September 12, 1935, Wittgenstein arrived in Leningrad, from where he traveled to Moscow, arriving there on September 14. After spending almost two weeks in the Soviet Union, Wittgenstein returned to Cambridge on October 1, 1935.

Yanovskaya was assigned by Soviet authorities to curate Wittgenstein's stay in Moscow. It is not difficult to think about why she was chosen for that. It is obvious that having such a highly-esteemed visitor from the West, Soviet authorities should assign someone suitable to accompany him. Yanovskaya was an excellent candidate for this task, for several reasons. At first, her partisanship and her commitment to the Soviet state and the Communist Party could not be put into question. Furthermore, she was well aware of the challenges that Soviet academia faced, after its reorganization in the first decades after the Revolution and could convincingly discuss this situation with a Western intellectual of Wittgenstein's caliber. Moreover, even if there is no record that I know of about her possible prior engagement with Wittgenstein's work, the fact that she had studied logical empiricism/positivism and the Marxist critique thereof, made her capable of thoroughly discussing with Wittgenstein on philosophical issues of his interest. Finally, one should not disregard that Wittgenstein's no-content theory of logic in the *Tractatus* was tantalizingly suggestive about how mathematics could be integrated into an overall empirical theory of the world, as Creath (2017) notes. On this particular issue, Yanovskaya had devoted much of her work.

The majority of the scholars who have dealt with Yanovskaya's work and Wittgenstein's visit in Moscow claim that Yanovskaya persuaded him to give up the idea of relocating to Moscow. However, sources close to Wittgenstein offer a different perspective. According to them, Yanovskaya not only did not dissuade him from staying in USSR, but actually (obviously on behalf of Soviet authorities) offered him a job. As Monk recollects from his conversations with Wittgenstein, Yanovskaya recommended Wittgenstein for the Chair of Philosophy at Kazan University (Lenin's old college), as well as for a teaching post at Moscow University (Monk 1990, 351). Cornish also reaffirms the job offer for Kazan University (Cornish 1999, 73-74).

According to the same sources, Wittgenstein and Yanovskaya were impressed by each other, had interesting discussions and continued their correspondence even after Wittgenstein's departure from Russia. Moran (1972), who managed to contact and then elicit several comments from some of the Russians involved in Wittgenstein's visit to Moscow, reports A. Soubotine from the Institute of Philosophy recalling a conversation with the Yanovskaya, who said that Wittgenstein impressed her favorably with his friendly simplicity, that he showed an interest in dialectical materialism and that she gathered from their conversations that he was interested in Soviet philosophic thought and followed its development. Moran also refers to G. H. von Wright, one of Wittgenstein's literary executors, who remember Wittgenstein talking about his meeting with Yanovskaya, "a likable woman philosophy professor". It seems that the conversations between Wittgenstein and Yanovskaya were charming and philosophically interesting. According to them, Yanovskaya advised Wittgenstein to "read more Hegel" (Monk 1990, 351, and Rhees 1984, 209). After his return from Moscow, Wittgenstein continued to correspond with

Yanovskaya and, as Monk further informs us, when he went away to Norway, he arranged with Fania Pascal for Yanovskaya to be sent insulin for her diabetes" (Monk, 1990, 347).

It follows, then, that Yanovskaya not only managed to gain Wittgenstein's respect for her intellectual status and character, but they also developed a friendship. This is certainly indicative of the caliber of Yanovskaya's personality.

To Sum up

Zinov'ev rightfully characterizes S. A. Yanovskaya as "the pioneer of the discussion of the philosophical problems of modern logic" in the Soviet Union, including "the relationship between constructive and non-constructive methods, the introduction and removal of abstractions of higher orders, the application of the criteria of practice to logic and others" (Zinov'ev 1968, 212). The profoundness and the impact of her contribution justify the assessment that Yanovskaya founded a distinct "school in history and philosophy of mathematics and mathematical logic" (Kushner 1996, 67). Research on the work of this school and the context in which it developed is an issue of significant interest. Future research may focus particularly on the impact of the socio-cultural context within which this school proffered its contributions. It may also inform a more profound understanding of how and why this context favored the emergence of woman as a leader of a distinct school. Furthermore, an issue that deserves further research is the impact of Yanovskaya's leading role on the status of women in the philosophical, mathematical and logical community in the Soviet Union.

In this paper, I have attempted to trace the impact of the complex socio-cultural context of the first decades of the Soviet Union on Yanovskaya's intellectual course and academic career. Contrasting other scholars who argue about a purported schism between the "political" and the "scientific" life of Yanovskaya, I argue that her work in its totality was informed by her solid commitment to militant Marxism and her persuasion that she could contribute to the building of the new society by performing her duties as a member of Soviet academia and as a member of the Communist Party.

Regardless of the success of my argumentation, I hope that I have at least managed to show that Yanovskaya's fascinating life and work deserves more scholar attention than it has already drawn.

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Special Issue – Women in Sciences: Historiography of Science and History of Science – on the Work of Women in Sciences and Philosophy

The Impact of Women in Computer Science History: A Post-War American History

Karina Mochetti[1]

Abstract:
Women have always played an important role in Computer Science findings, but their importance has always been overshadowed by men. Nowadays, men outnumber women by 3 times on computing occupations in the US, but still women prove to be essential on the development of technological fields. This work intends to place women at the forefront of computer science's history. In order to demonstrate that their work was essential for the development of current technologies, a broad historical overview is given. This overview is chronologically and thematically structured in several periods, from the early computer machines (before 1900) to our current digital society (after 2010). Finally, an outlook on the role of women in computing is given. A detailed discussion of individual contributions by women would go beyond the scope of this work. Nor can a sociological analysis of the reasons for the gender gap be provided. Nevertheless, the work wants to be more than a mere quantitative enumeration of women's contributions to computer sciences. The essay wants to plea for the integration of these women in the literature, i.e., in the historiography of computer sciences, which requires to reconsider the self-image of this discipline.

Keywords: Women in computing; Gender Gap; Diversity, history of computing

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Introduction

The role of women in computing starts long before the Second World War (Margolis and Fisher 2003). In the 19th century, Ada Lovelace wrote the first algorithm to be tested on a computing machine that existed only on paper. However, through the years, women and their main contributions to the field were slowly decreasing, with the big gender gap appearing only on the 1980s. By this time, concern and follow research about this issue grew (Frenkel 1990), gathering the attention of the community. Nevertheless, the number

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of women in the area is still decreasing every year, attracting researchers trying to explain this phenomenon (Cohoon and Aspray 2006). Moreover, a great number of projects and groups were created in an effort to reverse this issue and encourage woman to engage on computer related fields (Gürer and Camp 2002).

With this issue in mind, this work intends to emphasize women's place in Computer Science history (Tatnall 2010), telling it through the women's eyes, not only showing specific moments and momentary discoveries, but placing women in their actual role throughout the history as equal participants of computing development when allowed.

We will start in 1822 with Ada Lovelace, the first computer programmer, and the Analytical Engine, passing through all main discoveries and developments that lead us to the computer we know nowadays focusing on the female achievements. Besides Ada Lovelace (Hollings, Martin, and Rice 2018), Grace Hopper (Beyer 2015) and Margaret Hamilton (Piazza 2018), we will also talk about some not well-known woman, but equally important, such as Mavis Batey, Elizabeth Webb Wilson and Beatrice Worsley.

Therefore, the main goal of this work is to place women at the forefront in Computer Science history, even though men outnumber women by 3 times of all computing occupations in the US (Ashcraft, McLain and Eger 2016). We want to show how their work was not only one-off, but essential for the development of current technologies, also making clear the impact they have in a traditional male science field.

The Early Computer Machines (before 1900)

Although French weaver Joseph Marie Jacquard invented in 1801 a programmable loom that used punched wooden cards, similar to the one used years later by early computers (Delve 2007), the beginning of computer history is always credited to English polymath Charles Babbage. He is considered "the father of computer" (Halacy 2010).

Babbage created the first mechanical computer, the Analytical Engine. It was first described in 1837, and even though it is considered the greatest achievement of Babbage, he never saw it completely built (Bromley 1982). The Analytical Engine had a structure similar to modern computers: an arithmetic logic unit, control flow with conditional branching and loops, and integrated memory. Henry Prevost Babbage, Charles Babbage's son continued his father's work, but was also not able to finish the construction. Only in 1991, the London Science Museum built a complete and working version of the machine, called Difference Engine No 2 (Markoff 2011).

While working on its inventions, Babbage corresponded with Ada Lovelace (Essinger 2014). Ada was the only legitimate daughter of poet Lord Byron but she and her mother were abandoned by him when she was only one month old. Bitter, her mother, who had studied mathematics herself, raised Ada motivating her interest in mathematics and logic in an effort to keep her from becoming a poet like her father (Moore 1977). Ada's correspondence with Babbage began when she was still a teenager and allowed her to develop an algorithm to calculate a sequence of Bernoulli numbers on the Analytical Engine (Hammerman and Russell 2015). For this creation, she is considered the first computer programmer, even though programming languages had not been invented yet (Fuegi and Francis 2003). As the machine was never built by Babbage, Ada never saw her algorithm running, although it was later proved to be correct.

The late 19th century saw the construction of a punch card system that was used to calculate the 1880 census. Herman Hollerith, its inventor, founded the Tabulating Machine Company that later became IBM (Campbell-Kelly 2018). At the same time, Henrietta Swan Leavitt joined one of the first 'computers' at Harvard, groups of human calculators usually composed by women, since at that time women were not allowed to operate telescopes or other machines (Vishveshwara 2015). She did calculations on measuring and cataloging the brightness of stars, discovering the Cepheid variables, a type of star, that led to the evidence for the expansion of the universe (Johnson 2005).

The Advance During the World Wars (1900 - 1950)

The beginning of the 20th century was marked by the World Wars. These events led to a great advance on several science fields, including computing. It also creates opportunities for women to participate in the process, since many men were fighting at the battlefield.

Women were called during the First World War to do ballistics calculations as human computers. Although Elizabeth Webb Wilson did not take part in the suffrage movement, her actions did reassure it. She had a striking talent for mathematics and refused nine job positions at Washington until she was offered the position of a chief computer (Grier 2013). At the same time, at the United Kingdom, Beatrice Cave-Browne-Cave worked as a human computer for the Ministry of Munitions, carrying out research for the government on the mathematics of aeronautics (Jones 2009). Even after the end of the war, in 1930, NASA kept hiring women to work in their computer pool to analyze data from wind tunnels and flight tests (Atkinson 2015).

During the Second World War, Alan Turing developed the main concepts of a universal machine that would be the base for most of the ideas for modern computers. Also, several American women were recruited to operate the first computing machines such as the WREN Colossus at Bletchley Park (Copeland 2010) and later the ENIAC and MANIAC I computers (Pearson, Frehill and McNeely 2015). Alan Turing is also known for cracking the Enigma Code at age 31. The Enigma was a German naval cipher machine and Alan's work helped to end the war. What is usually forgotten is that Mavis Batey also cracked an Enigma machine, the Italian Naval one, at the age of only 19, along with Dilly Knox. She worked at Bletchley Park and is considered one of the keys to the success of D-Day, breaking important messages from the Germans and Italians. Beside the Italian Naval Enigma machine, she also cracked the Abwehr Enigma and the GGG, considered unbreakable at the time (Batey 2017).

During the same time, actress Hedy Lamarr, along with George Antheil, developed a radio guidance system that used spread spectrum and frequency hopping technology to prevent radio-controlled torpedoes to be jammed. Although never used by the US Navy, the principles of their work were later incorporated into modern technologies, such as Bluetooth and WiFi. She had no formal training and did not fit into the Hollywood style. She spent her free time inventing rather than attending parties or drinking. Her inventions were taken for granted and she was only recognized in the 1990s, when she was in her early 80s (Rhodes 2012).

Regarding companies, in 1939, David Packard and Bill Hewlett founded theirs in a Palo Alto garage, while a few years later, Ruth Leach Amonette was elected the Vice President at IBM, a company with more than 30 years. She was the first woman to hold that role.

By the end of the wars, women were able to keep their roles as being part of the computer developments at that time. Dorothy Vaughan, who left her teaching job to join Langley Research Center as a human computer, was promoted and became the first black supervisor at NACA in 1948. She later specialized in the FORTRAN programming language by teaching herself, and other women, in order to open more opportunities for them. She raised six children while working at NACA and encourage other women to grow their career (Allen 2017).

Also, Gertrude Blanch led the Mathematical Tables Project group from 1938 to 1948, a computing organizations that was part of the Works Progress Administration (WPA), an American agency. The project was closed after the end of the war and unlike most women, Gertrude Blanch did not keep her position within the government. She moved to the University of California in Los Angeles, leading the computing office of its Institute for Numerical Analysis. Supposedly, she was not allowed to continue her work because there was a suspicion that she was secretly a communist during the Cold War, due to her never being married or having children (Grier 1997).

The late 1940s saw one of the greatest advances on computer history: William Shockley, John Bardeen and Walter Brattain of Bell Laboratories invented the transistor, a semiconductor device used to amplify or switch electronic signals which are the fundamental building block of modern computers (Brinkman, Haggan, and Troutman 1997). Meanwhile, Grace Hopper, a United States Navy officer, programmed on the Harvard Mark I, a large eletromechanical computer with 51 feet in length and 8 feet in height, using more than 765,000 components and hundreds of miles of wire (Williams 1999). She developed the first compiler for an electronic computer, known as A-0 and was one the creators of the COBOL programming language. She is also credited for popularizing the term *debugging* after finding a moth on a relay in the Harvard Mark II computer that was causing faults on its programs (Beyer 2015).

At the same time, Irma Wyman was working on a missile guidance project at the Willow Run Research Center when she visited the US Naval Proving Ground, meeting Grace Hopper. Their encounter changed Irma's life, making her an enthusiastic about new technology which led her life's career (Gilbert and Moore 2012). She later joined Honeywell, an American multinational conglomerate company, and eventually became the first female CIO of Honeywell. She, much like most of the women in this field, enjoyed passing her knowledge to young women in computer science, even endowing a scholarship at the University of Michigan's Center for the Education of Women, her alma mater (Bjorhus 2015). Since the beginning, the support among women was essential for their maintenance on the field.

By the beginning of 1950s, women had made some remarkable part on the development of Computer Science all over the world: Canadian scientist Beatrice Worsley had ran, along with her team, the first program on the Electronic delay storage automatic calculator, also known as the EDSAC computer in 1949 (Campbell 2003); Edith Clarke, an American electrical engineer, had filed patents for a graphical calculator and became the first female professor of Electrical Engineering in the United States in 1947 (Layne 2009); and Austrian mathematician Johanna Piesch published two pioneering papers on Boolean algebra, one of the fundamentals of digital computing (Zemanek 1993). Even proving their importance, women kept being taken for granted. German mathematician Grete Hermann, who finished her Ph.D. under Noether, published a foundational paper for computer algebra in 1926, showing her talents. She criticized John von Neumann's proof of the no-hidden-variable theorem in 1935, but was only recognized by the physics community 30 years later. This fact is considered to hold back the development of quantum mechanics (Crull and Bacciagaluppi 2016).

The Born of Programming Languages (1950 - 1970)

One crucial point of development for Computer Science was the creation of programming languages. These languages popularized computers by the use of a more accessible language, closer to humans than the machines. COBOL is considered the first programming language and it was developed by Grace Hopper in 1953 (Bemer 1971). At the same time, a team of programmers at IBM led by John W. Backus created another programming language, FORTRAN, that focused on numeric computation and engineering applications (Backus 1978). This made programming simpler, attracting researchers from other fields, such as engineering and chemistry.

At the early 50s, Ida Rhodes, which had worked with Gertrude Blanch on the Mathematical Tables Project in 1940 (Blanch and Rhodes 1974), along with Betty Holberton, designed a programming language. The C-10 language was used on the UNIVAC I computer and it is considered the prototype of modern programming languages. Holberton also participated in the early development of COBOL and FORTRAN programming languages along with Grace Hopper (Beyer 2015). She is known for being one of the six women to program the ENIAC along with Kay McNulty, Marlyn Wescoff, Ruth Lichterman, Betty Jean Jennings, and Fran Bilas during World War II. Although they were not classified as "professionals", they performed important calculations for ballistics trajectories electronically having a major impact on Computer Science (Fritz 1996). Later, in 1962, Jean E. Sammet, who also has contact with Grace Hopper and the UNIVAC I team, not only developed a new language, the FORMAC programming language, but also studied the history of programming languages so far. She later became the first female president of the Association for Computing Machinery (Bergin 2009).

The mid-1960s marked the first step towards the popularization of modern computers. Douglas Engelbart developed a machine with a mouse and a graphical user interface (English, Engelbart and Berman 1967). At the same time, women were struggling to maintain their opportunities in the Computer Science field, since men have returned from the battlefield and the Cold War did not demand that from them. While Sister Mary Kenneth Keller became the first American woman to earn a Ph.D. in Computer Science (Gürer 1995), Dame Stephanie Shirley was advocating for the involvement of women in computing. She founded a software company and employed more women than men, having only 1% of male programmers. Unfortunately, that became illegal in the United Kingdom in 1975 (Shirley and Askwith 2017). Due to the extensive sexism, she suffered in her workplace, she decided to adopt the name "Steve" to survive this male-dominant world. She is known to have programmed for the Concorde's black box flight recorder (Tickle 2017).

As Shirley, more women wrote important programs. Mary Coombs, for example, was the first female programmer on LEO, the first business computer back in 1952. At NASA, women kept important roles in the calculation, such as the orbital estimation for the Explorer 1 satellite, done by a group of all-female computers. At the same laboratory at NASA, Dana Ulery, the first female engineer, developed real-time tracking systems using a North American Aviation Recomp II, a 40-bit word size computer, and programmed NASA's Deep Space Network capabilities (Kresser and Sippel 1962). Moreover, some women also achieved high positions, such as Margaret R. Fox who first worked at Naval Research Lab and later changed to the National Bureau of Standards, where she was appointed Chief of the Office of Computer Information in 1966 (Fox 1984).

A great breakthrough happened in 1969, when a group of programmers from the Bell Labs developed UNIX, an operating system written in the C programming language. Its main advantage was to be portable across multiple platforms and it soon became popular among companies and government entities. Personal computers were rare, but UNIX was not the first operating system. A few years before, in 1965, Mary Allen Wilkes designed the first personal computer, the LINC, and wrote LAP, its operating system, considered the first one (Clark 1987). Women were not pioneers only in technical programs, though. Joan Ball started a computer dating service in 1964, years before social networks and dating applications (Ball 2014).

Although not as important as in the Great World Wars, women also played their role in the Cold War especially at NASA. In the late 1960s, Margaret Hamilton worked on the Apollo space program, writing the code for the onboard flight software and its robust architecture. This software was crucial during the abort of the Apollo 11 moon landing (Hamilton and Hackler 2008). She later became a director at MIT Instrumentation Laboratory, where she came up with the term Software Engineering, as the application of engineering to the development of software in a systematic method (Hamilton and Hackler 2007).

The Development of Personal Computer (1970 – 1980)

Great developments on hardware made possible to build smaller and cheaper computers, leading to their popularization. They are not those big machines anymore, only owned by companies, universities and government entities. Now they became also available to consumers. Two inventions from the early 1970s made that possible: the Intel 1103, the first commercially available Dynamic Access Memory (DRAM) chip (Moore 1996) and the floppy disk, developed by Alan Shugart at IBM that allowed data to be shared among computers (Markoff 2006). The British computer scientist Sophie Wilson designed the instruction set of the ARM processor, which will later be used in most smartphones (Garnsey, Lorenzoni and Ferriani 2008). Wilson is a transgender woman and also build the Acorn Micro-Computer leading her to be named one of the 15 most important women in tech history (Bouman 2011).

The communication between computers was the main focus of researches at the time. In 1973, Robert Metcalfe developed Ethernet for connecting multiple computers (Metcalfe and Boggs 1976), initially in a local area network and later expanded for metropolitan area and wide area networks (Santitoro 2003). Two years before, Erna Schneider Hoover, a developer at Bell Laboratories, invents a computerized telephone switching calls method which had software to support large networks. Before working for Bell Laboratories, Hoover was a professor teaching philosophy and logic in 1951, but she was never able to win a tenure-track position, possibly due to her gender (Zierdt-Warshaw 2000). She worked at Bell Labs for 32 years and wrote one of the first software patents ever issued in 1971 (Eckhart and Hoover 1971). Another important advance for networks was the creation of the Domain Name System (DNS). This list of host names is still in use and can be found on most web addresses such as *.gov*, *.edu*, *.org*, and *.com*. It was created by Elizabeth Feinler in 1974, the director of the Network Information Systems Center at the Stanford Research Institute at that time. Feinle, who dropped out of a Ph.D. in biochemistry for this position, also worked as a manager for the NASA Science Internet (Feinler 2010).

With the popularity of personal computers growing, several reach the market by the mid of 1970s, such as Scelbi & Mark-8 Altair, IBM 5100, Radio Shack's TRS-80 and the Commodore PET (Reimer 2005). This encouraged 'computer geeks' into creating their own computers, writing their own software and starting new companies. Therefore, Paul Allen and Bill Gates founded Microsoft in 1975 and Steve Jobs and Steve Wozniak started Apple Computers in the following year (Allan 2001). Both companies are, still today, two of the world's most valuable brands (Badenhausen 2018). Although now more famous, Microsoft and Apple were not the precursors startups in Silicon Valley. In 1972 Sandra Kurtzig founded ASK Computer Systems and became one of the first Silicon Valley's entrepreneurs (Nemeh and Kalte, 2003).

In 1977, Jobs and Wozniak showed the Apple II at the first West Coast Computer Faire, with color graphics and other software features for common users, marking the main feature of Apple Machintosh, its user interface. Yet, many ideas used on this desktop environment came from Adele Goldberg, a researcher at the Xerox Palo Alto Research Center (PARC). She developed the programming language Smalltalk-80 together with various concepts related to object-oriented programming. These concepts became the basis for graphically based user interfaces, replacing the command line systems, such as MS-DOS and UNIX. Steve Jobs became interested in Goldberg's work and wanted a demonstration of the Smalltalk System. Although she first refused, her superiors at PARC ordered her to do it and Jobs ended up using some of Goldberg's concepts on his new system (Cringely 1996).

By the end of 1970s computers were even more popular due to several software releases: VisiCalc, the first computerized spreadsheet software, is released in 1978 by Dan

Bricklin and Bob Frankston (Grad 2007) and WordStar, a word processing program developed by Rob Barnaby, is released in 1979 (Rubinstein 2006). Computers had its usage expanded with Karen Spärck Jones using it for natural language processing, developing algorithms essential to the modern search engines and still used today (Robertson and Tait 2008) and Phyllis Fox trying to deal with the diversity of computers and operating systems by building a portable numerical library (Fox 2005). Due to its popularity, computers also draw attention from several fields. In 1973, for example, Susan Nycum, a computer law scholar, began defining and documenting computer-related crime (Parker, Nycum, and Oüra 1973).

Women kept breaking their way into Computer Science, with Mary Shaw becoming the first woman to earn a Ph.D. in Computer Science from Carnegie Mellon University in 1971 (Shaw 1971) and Irene Greif achieving the same from the Massachusetts Institute of Technology in 1975 (Greif 1975). Also, Christiane Floyd became the first woman to work as a computer science professor in Germany in 1978 (Thumfart 2011), while Margaret Burnett became the first women hired in a management position at Procter & Gamble (Burnett 2017). Burnett is an activist and still as a student created a group for professional women at her hometown and nowadays researches methods to check how gender-inclusive a software is (Beckwith and Burnett 2004). The foundation of the Association for Women in Computing (AWC) by Donnafaye Carroll Finger and Diane Haelsig in 1978 marks the will of women to grow professionally in Computer Science and to support each other in this task (Gay 2000). This support was done informally until now, but showed to be crucial to some women.

Video Games and Computer as a 'Boy-Thing' (1980 - 1990)

Together with the commercialization of personal computers, the development of video games began. The console generation of the early 1980s saw its golden age with Atari and the popular Space Invaders game. Although mainly sold as a 'boy-thing', aiding in the computing unpopularity among female users (Henn 2014), many women contributed to the development of video games. Carol Shaw worked for Atari Corporation developing games for the Atari 2600 console. She later joined Activision, where she designed the major hit River Raid (Suellentrop 2014). She is considered the first female game designer together with Dona Bailey and Carla Meninsky. Bailey created the arcade video game Centipede in 1981 and was the first female developer to work at Atari. Carla Meninsky was the game designer and programmer for several Atari 2600 games, such as Dodge Em and Indy 500 (Kent 2010). Also, Janese Swanson was one of the developers of the Carmen Sandiego game, which had a female protagonist, something uncommon in 1983 (Hocks 1999). Swanson later found Girl Tech, a company that develops products to encourage girls to use technologies (Davidson 2005).

Meanwhile, IBM releases its first personal computer, Acorn, designed by Sophie Wilson (Garnsey, Lorenzoni and Ferriani 2008) and admits its first female fellow, Frances E. Allen (Steele 2011). Microsoft releases MS-DOS operating system and Apple releases Lisa, a personal computer with a user-friendly operating system (Edwards 2013). A couple of years later, Microsoft announces Windows, which also features icons and menus just like Apple's system (Magid 1990). Both systems are considered revolutionary due to the graphical user interface which had its original interface elements created by Susan Kare (Gonzalez 2016). Some of her icons and typefaces are still used today and her work can be seen on Microsoft, IBM, Pinterest and Facebook software. (Kastrenakes 2015).

The start of the Internet occurs in the mid-1980s, with the first *.com* domain being registered by Symbolics Computer Company in 1985 (Moore 2009) and the creation of the HyperText Markup Language (HTML) and the Hypertext Transfer Protocol (HTTP) by British scientist Tim Berners-Lee. Five years later he founded the World Wide Web as we know today (Berners-Lee 1989). Internet services are now becoming more common and several companies are founded, such as Linksys, selling data networking hardware products. It was co-founded by Taiwanese hardware engineer Janie Tsao and her husband Victor (Lansner 2015). At the same time, Radia Perlman invented the Spanning Tree Protocol (STP), also contributing to Internet development (Perlman 1985). Perlman began her interest in computers during a high school programming class and, although having fears and doubts by being the only girl in the class, she decided to follow a technological career obtaining her Ph.D. in Computer Science from MIT in 1988 (Rosen 2014). Besides working with networks, she is also a pioneer in teaching programming for children, developing TORTIS and the LOGO educational robot Turtle (Morgado, Cruz, and Kahn 2006). This is common for women in computing history, as they usually get involved in teaching young people, especially girls, trying to reverse the gender gap.

While Compaq brings the Deskpro 386 into the market, women kept leaving their marks: Lorinda Cherry developed the dictionary for the Unix spell checker and the Writer's Workbench while working for Bell Labs (Mahoney 1989). Éva Tardos, a Hungarian mathematician, earned the Fulkerson Prize for finding minimum cost circulations in strongly polynomial time in 1988 (Tardos 1985), and later the Gödel Prize for laying the foundations of algorithmic game theory (Roughgarden and Tardos 2002). Although the number of women kept dropping during these years and computing was now known as part of the male culture, some women kept breaking through even whilst not recognized as equals.

The Main Modern IT Companies Emerge (1990 - 2000)

With the Pentium microprocessor advance of graphics and music on PCs, they start to also be used as gaming machines at the mid-1990s. The gaming industry has raised computer sales, but also help to increase the gap for the female users and programmers (Andrews 2017). Even so, some women kept making breakthrough discoveries, such as Donna Dubinsky, which in 1992 introduced the first personal digital assistant, or PDA and later became CEO and co-founder of Palm, Inc. (Marlow 2000). She is now CEO of Numenta and works with machine intelligence (Markoff 2005).

Theoretical computer science was also impacted by women, especially due to its close connection with mathematics. Since computers started to be related to men, many women found their way through math. Shafi Goldwasser graduated in mathematics and science from Carnegie Mellon University and is the inventor of zero-knowledge proofs, an important advance for complexity theory and cryptography (Goldwasser, Micali and Rackoff 1989). It led her to win the Gödel Prize twice, once in 1993 and once in 2001 (Israel 2017). Barbara Liskov also earned her BA in mathematics and in 1993 along with Jeannette Wing, developed the substitutability, an important principle in object-oriented programming (Liskov and Wing 1994). Liskov also developed two programming languages, CLU and Argus and has received several awards, including the Turing Award (Weisman 2009), the most prestigious award in Computer Science.

The year of 1996 marks an important event in computing history with the development of the Google search engine at Stanford University by Sergey Brin and Larry Page (Battelle 2006). But it would take 3 years before they hire their first female engineer, Marissa Mayer (Sutter 2012). She would later be named vice president of Search Product and User Experience at Google until she became the CEO of Yahoo! in 2012 (Chang 2012). As many women, Mayer also taught computer programming at Stanford and changed Yahoo!'s maternity leave policy, lengthening its time allowance. She has been ranked in several lists and she was the first woman to reach the number one position on Fortune magazine's annual list of the top 40 business stars under 40 years old (Morrison 2013).

At the late 1990s, the Internet became popular with about 8 million teens online (McCullough 2015) and Wi-Fi starts to become a common term since now users can connect to the Internet without wires. The system behind the Internet is based on several protocols that make possible all the information to correctly reach its destination. In 1994, Sally Floyd, a computer scientist from Berkeley, worked on the standard for TCP, the Transmission Control Protocol still in use today (Paxson and Floyd 1997). She later invented the Random Early Detection (RED), a queue management scheme used by almost all Internet routers (Floyd and Jacobson 1993).

The 1990s are also marked by the creation of several awards and institutes to honor women who contribute to Computer Science in an effort to revert the alarming decrease of its female representation. The Grace Hopper Celebration of Women in Computing Conference was first held in 1994 with 500 attendees (Barr 2014) and two years later the Women in Technology International Hall of Fame was established by the Women in Technology International (WITI), founded by Carolyn Leighton (Mardesich 1994). In 1997 Anita Borg, who also organized the first Grace Hopper Celebration along with Telle Whitney (Goyal 1996), founded the Institute for Women and Technology (IWT), renamed Anita Borg Institute in her honor in 2003. She worked in email communication and in 1987 started Systers, the first email network for women in technology providing a private and safe space for its only-female members (Borg 1999). All these organizations are still active today and have a crucial role empowering women in the field, with the Grace Hopper Celebration having 20 thousand attendees in 2018 (Morris 2018).

A Digital Society (after 2000)

The 21st century began with the development of Apple Mac OS X operating system and Microsoft Windows XP. These releases now have a great impact on the population, since computers now are the basis of society, with almost 300 million computers being sold worldwide in 2008 (Bhattacharya 2017). Moreover, internet usage kept growing, with the creation of Mozilla's Firefox, an internet browser, in 2004 (Khomh et. al 2012) and of Facebook, a social networking site (Boyd and Ellison 2007) and YouTube, a video sharing service in 2005 (Gueorguieva 2008). At the same year of its creation, Facebook hires its first woman engineer, Ruchi Sanghvi (Bosker 2011). Sanghvi is an Indian computer engineer and became the product lead for Facebook the following year, due to her work on the platform's new feed. She left Facebook to found her own company after receiving the Best Engineering Leadership Award in 2011 (Peak 2012). Women now are able to reach higher and more important positions: Sara Catz becomes the president of Oracle Corporation (Hesseldahl 2011), Carol Bartz becomes the CEO at Yahoo! (Pepitone 2009) and Meg Whitman becomes CEO of Hewlett-Packard (Yang 2011), more than 70 years after its foundation. Women also contributed with some breakthrough discoveries, such as the crack of the MD5, SHA-0 and SHA-1 data security algorithms by Xiaoyun Wang in 2005. She and her colleagues received a standing ovation for their work at CRYPTO conference (Randall 2005).

Although many human computers during the wars were composed by African American women (Grier 2013), making them essential for numerous advances in Computer Science, only in 2006 the first African American woman was able to hold a patent for a software invention in her name (Bashen, Roach and Moore 2006). Janet Emerson Bashen created a software to aid with web-based Equal Employment Opportunity investigations, after being refused to debate about equity on her previous company (Lynn 2016). She started her own company and was one elected of the most 100 influential African-Americans by Ebony magazine (Ebony 2012).

In the early 2000s, women began to finally be recognized by their contribution to Computer Science. In 2003, Margaret Hamilton received the NASA Exceptional Space Act Award for scientific and technical contributions (Braukus 2003) and in 2006 Frances Allen earned a Turing Award (McGee 2007), being the first woman to do so for her seminal work in compilers, program optimization, and parallelization (Allen and Cocke 1976). She was followed by Barbara Liskov in 2008 (Weisman 2009) and Shafi Goldwasser in 2012 (Abazorius 2013). Also, Lixia Zhang a Chinese professor of computer science won the IEEE Internet Award in 2009. She was the only woman at the initial Internet Engineering Task Force, an organization to promote internet standards and is one of the creators of the RSVP protocol (Zhang et. al 1993). Finally, in 2018 Gladys West is inducted into the Air Force Space and Missile Pioneers Hall of Fame (Augustin 2018). She worked at the Naval Surface Warfare Center Dahlgren Division. She was the second black woman ever employed in 1956 (Butterly 2018). She was a human computer, collecting data from satellites, and helped develop GPS technology that is widely used today (West 1986). She was recognized more than 30 years after her discovering.

The late 2000s continued the launch of software and hardware closely watched by the general population. In 2007 Apple releases the iPhone, bringing computer functions to the smartphones (Mather 2007) and a few years later it launches the iPad, changing the dormant tablet computer segment (Kiss 2010). Computers begin to be the basis of our society, which can be supported by Facebook reaching 1 billion users in 2012 (Smith, Segall and Cowley 2012). At the same time, Ginni Rometty becomes the first female president and CEO of IBM, more than one hundred years after its foundation (Metz 2011). Rometty has also been involved in organizations for empowering women, such as its IBM Women in Technology Council (Sim 2018), and has been listed in important rankings, like the world's most powerful people by Forbes in 2014 (Howard 2014). Also, Yoelle Maarek founded and directed the Google Haifa Engineering Center, developing autocompletion for Google search queries in 2006 (Carmel et. al 2008). She is now vice president at Amazon (Orbach 2017).

Computers now are evolving into new paradigms and models. In 2016 the first reprogrammable quantum computer was created by Shantanu Debnath (Choi 2016) and one year later the Defense Advanced Research Projects Agency started developing a program that uses molecules as computers (Hinchliffe 2018). Women, although still outnumbered in the field, kept being pioneers such as Michelle Simmons that founded in 2017 the first quantum computer company in Australia (Davey 2016). Simmons is a professor of quantum physics at the University of New South Wales and her team was the first in the world to develop a working single-atom transistor, essential for building a quantum computer (Fuechsle et. al 2012).

The gender gap on Computing Science has gathered more attention since the 2010s with several groups and organizations being created trying not only to empower and maintain women already engaged in computing, but also to motivate young girls into enrolling in technological courses. In 2011, Ladies Learning Code, an organization aimed at promoting collaborative and technological learning among women, is launched in Toronto by Heather Payne, Melissa Sariffodeen, Breanna Hughes and Laura Plant (Kienapple 2011) and PyLadies, an organization of women who code in Python, is started in Los Angeles by seven women (Shah 2012). Several other nonprofit organizations were creating focusing on encourage girls to pursue careers in software development: Girl Develop It (GDI) was founded in 2010 by Vanessa Hurst and Sara Chipps (Shattuck 2010) and two years later Girls Who Code was founded by Reshma Saujani (Guynn 2014). Focusing not only on the gender issue, but also in race equity, Black Girls Code (BGC) was created in 2010 by Kimberly Bryant and provide technology education for African-American girls (Gilpin 2014). However, one of the first organizations created was LinuxChix, founded in 1999 by Deb Richardson to provide technical and social support for female Linux users (Bowman 1999).

These organizations are important and although giving attention to the gender gap issue, the number of women in Computer and Technological courses remains low. One of the issues is the lack of representation of women in computer history. Since it has been written mainly by men so far, women's contribution has been shadowed and the most popular and famous computer scientists are men. Trying to reverse this scenario is essential for reaching equal rights, moving towards a new computing environment, one with equality not only of gender, but also race, class, sexuality and disability.

The Role of Woman in Computing

The role of woman in computing nowadays is a complex problem involving several topics, such as the role of woman in society, feminism and pedagogy. Women's accomplishments in any professional field are followed by questions, doubts and hesitation. Few would argue when we say that Alan Turing broke the enigma, although he worked with Dilly Knox (Batey 2017), or that Steve Jobs founded Apple, although Steve Wozniak and Ronald Wayne were also founders (Warner 2012). However, many would complain if we stated that Ada wrote the first algorithm, remembering of Charles Babbage, or that Beatrice Worsley ran the first program on the EDSAC computer, complaining that there were several other programmers on that team. Women's accomplishments carry a bias: while a man can easily achieve a goal by himself, a woman must always have some help. And, although science is usually not done by only one person, it is common to give credit to a single individual, but only when we highlight a woman's role this becomes an issue.

This leads to a misrepresentation of women in all science fields, especially in STEM and Computer Science, and has had a great impact on the number of female newly engaged in it. One of the reasons for keeping women from Computer Science is that they tend to underestimate their abilities to be successful (Ehrlinger and Dunning 2012). This can be closely related to two factors: the lack of role models (Marx, Stapel and Muller 2003) and the use of traditional pedagogy methods in schools (McClure 2000).

The importance of role models to students, not only corresponding to gender but to other characteristics as well, can be essential to diversity. Role models can create an impact, enhancing self-confidence and decreasing stereotype expression. For Computer Science, this includes not only non-male scientists, but also other minority groups such as Afro-Americans (DiSalvo et.al 2011) and LGBT+ representatives (Stout and Wright 2016). Unfortunately, diversity is rare in Computer Science courses, reflecting on the difficulty of recruiting and retention of these groups. This creates a vicious circle, in which there are few role models, attracting even less diverse students, creating even fewer role models and representation. Therefore, there is an urgent need of highlighting women in Computer Science, since it creates role models to female students, helping to recruit them and later retain them in the field, creating more role models and finally, one day, breaking the circle.

Moreover, this lack of representation can clearly be seen on the dissemination of knowledge and websites such as Wikipedia. Not only more than 85% of its registered users are men (Herring 1992), but also, most pages of female scientists are not complete or are frequently the target of vandalism (Stratigakos 2016). Men tend to write about what they know and female scientists receive less attention from editors. This contributes even more for the lack of female role models, aiding to the already stated vicious circle of recruiting and retaining women in the STEM. Although these editors are not historians and usually do not write papers or books, they are writing history for our digital society. Wikipedia, and the internet in general, are the primary source of knowledge nowadays and women do not appear to be welcome in it (Hess 2014). A simple freshmen activity done in a Brazilian university can show not only how women are mistreated on this male-dominant environment but also, how prominent and famous female computer scientist, such as Grace Hopper and Ada Lovelace, are not known by most undergraduate students, either male or female (Mochetti et. al 2017).

It is also important to notice that this gender gap has social and political causes, not biological ones. Women are as capable as men in STEM and Computer Sciences (Fausto-Sterling 2008). Teaching methods, though, can be the producers of a gender distinction.

Education builds society at the same time it is built by society. Thus, it is also necessary to analyze the representations of gender and how they are reaffirmed or questioned during the formation of an individual. Traditional pedagogy tends to reflect all types of inequality, starting with the segregation of adults, the teachers, those who are active in teaching and are already "ready"; from children, passive beings in education who must be shaped by knowledge (Mizukami 1996). Moreover, traditional pedagogy can also increase the distinction by ethnicity, economic class, and even gender, offering different classes and types of knowledge to specific groups of individuals.

Disciplines such as Gym Classes have more explicit gender segregation, using Biology and Health to justify the division of female and male students. However, exact classes, such as math, have a more subtle process of gender distinction. A study showed that when female students have a higher math result than male students, teachers' explanation usually states that female students have worked hard while male students have behavioral and focus problems. Words like "bright" or "potential" are never used to describe girls in exact or science classes (Walkerdine 1995).

Education and pedagogy methods have a fundamental role in the creation of the individual and the implication of power relations. It is its role to problematize this average behavior, allowing subjects to have different thoughts and views, even if this breaks the social rules of "normality" (Louro 1997). In this scenario, gathering the political ideologies of the Feminist Movement of the 60s, feminist pedagogy was created. Its main idea is to bring a new standard in the classroom addressing the power imbalances present in society. This new view of education can be essential in increasing the number of female students enrollment in STEM and Computer Science, but it is still uncommon in most schools around the world.

Thus, the low representation of women in computing can be due to several social factors related mainly to the role of women in society. As pointed out by Simone de Beauvoir years before "Representation of the world, like the world itself, is the work of men; they describe it from their own point of view, which they confuse with absolute truth." (De Beauvoir 1989). Feminist studies, such as Beauvoir's, have analyzed the forms of oppression women suffered and the differences between men and women created by society. Women did not have the same rights and opportunities than men for a long time and even when they finally begin to occupy their professional space, they had only auxiliary and collaborator roles. This becomes clear when we differentiate the role of a school teacher and a university professor. A teacher is usually related to a woman and her maternal role of raising and caring for children, while a professor is related to a man that has great knowledge in some area. For this reason, the number of women in seminal areas that are parts of elementary education, such as math and physics, are not as alarming as in engineering and computing. In society's view, women should not have this function unless teaching and caring for children.

Therefore, the gender gap in Computer Science will only be solved with a deep change in society. Women should have their own space, not only in STEM but in all society's roles. This should not be defined by men, but by the whole society. Women should not be allowed to work in the STEM field only when men are at the battlefields of war. Furthermore, advertisements should not target only a gender such as done with computers and video games in the early 80s. Gender equality is a human right, not a woman's right.

Conclusion

Women were essential to the development of computing and their role was outshined by men, leading to the alarming number of women occupying less than one quarter of all computing occupations in the US (Ashcraft, McLain and Eger 2016). This underrepresentation leads to a male dominant environment, hostile to women, as can be seen in recent issues with big companies such as Google (Wakabayashi 2017) and Facebook (Conger and Frenkel 2018), affecting their development, since diversity is important in any field (Hicks 2017).

Another problem arises from their recognition through rewards and awards. The ACM Turing Award, for example, is an annual prize given by the Association for Computing Machinery (ACM) to individuals with a major technical contribution to the computer science field. By 2019, from the almost seventy awards given, only three were given to women: Frances Elizabeth Allen, Barbara Liskov and Shafi Goldwasser. All were given after 2006, showing how women were erased from the history of computing until recently.

In an attempt to revert this issue, several groups and organizations were created, such as Grace Hopper Celebration of Women in Computing Conference (Gabbert and Meeker 2002) or the Association for Computing Machinery's Council on Women in Computing (Gürer and Camp 2002), with over 36 thousand members. They try to support and empower women already active in the field while encouraging girls to engage in Computer Science and related areas.

In this work, we try to contribute to changing this scenario by not only highlighting these important women, but also showing them throughout the view and heart of a woman in computing. Therefore, although still suffering from several years of shadowing by men, women in computing are fighting for their space and hopefully, with time, we may have a field with more equity.

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Appendix

The following women were presented at this paper:

- Frances Elizabeth Allen (1932 –)
- Ruth Leach Amonette (1916 – 2004)
- Joan Ball (1934 –)
- Carol Bartz (1948 –)
- Janet Emerson Bashen (1957 –)
- Mavis Batey (1921 – 2013)
- Dona Bailey
- Fran Bilas (1922 – 2012)
- Gertrude Blanch (1897 – 1996)
- Anita Borg (1949 – 2003)
- Margaret Burnett (1949 –)
- Sara Catz (1961 –)
- Beatrice Cave-Browne-Cave (1874 – 1947)
- Lorinda Cherry
- Edith Clarke (1883 – 1959)
- Donna Dubinsky (1955 –)
- Elizabeth Feinler (1931 –)
- Christiane Floyd (1943 –)
- Sally Floyd (1953 –)
- Margaret R. Fox (1916 – 2006)

- Phyllis Fox (1923 –)
- Irene Greif
- Adele Goldberg (1945 –)
- Shafi Goldwasser (1958 –)
- Margaret Hamilton (1936 –)
- Grete Hermann (1901 – 1984)
- Betty Holberton (1917 – 2001)
- Erna Schneider Hoover (1926 –)
- Grace Hopper (1906 – 1992)
- Betty Jean Jennings (1924 – 2011)
- Karen Spärck Jones (1935 – 2007)
- Susan Kare (1954 –)
- Sister Mary Kenneth Keller (1913 – 1985)
- Sandra Kurtzig (1947 –)
- Hedy Lamarr (1914 – 1953)
- Henrietta Swan Leavitt (1868 – 1921)
- Ruth Lichterman (1924 – 1986)
- Barbara Liskov (1939 –)
- Ada Lovelace (1815 – 1852)
- Yoelle Maarek
- Marissa Mayer (1975 –)
- Kay McNulty (1921 – 2006)
- Carla Meninsky
- Radia Perlman (1951 –)
- Johanna Piesch (1898 – 1992)
- Ida Rhodes (1900 – 1986)
- Ginni Rometty (1957 –)
- Jean E. Sammet (1928 – 2017)
- Ruchi Sanghvi (1982 –)
- Carol Shaw (1955 –)
- Mary Shaw (1943 –)
- Michelle Simmons (1967 –)
- Dame Stephanie Shirley (1933 –)
- Janese Swanson (1958 –)
- Éva Tardos (1957 –)

- Janie Tsao (1953 –)
- Dana Ulery (1938 –)
- Dorothy Vaughan (1910 – 2008)
- Xiaoyun Wang (1966 –)
- Marlyn Wescoff (1922 – 2008)
- Gladys West (1930 –)
- Sophie Wilson (1957 –)
- Elizabeth Webb Wilson (1896 – 1980)
- Mary Allen Wilkes (1937 –)
- Jeannette Wing (1956 –)
- Meg Whitman (1956 –)
- Beatrice Worsley (1921 – 1972)
- Irma Wyman (1928 – 2015)
- Lixia Zhang (1951 –)

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Article

Peaks and Cliffs:
An Example of the Power of Analogy Across Disciplines

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Abstract
The aim of this paper is to show how the studies in Energy field are intrinsically cross-disciplinary. Energy undergoes to the general Physics laws and, in particular, to the Thermodynamics ones, but often we think it like a separate field, regard, for example, to the Ecology. We show some example useful to see the analogy between those fields of study and how these analogies could enlighten the scientific explanation in both fields.

Keywords: Peaks; Cliffs; Analogy; Renewable and no renewable energy resource; Energy depletion; Energy return on investment (EROI).

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Introduction: The Power of the Analogy

One of the most powerful instruments for the development of a specific field of knowledge is, sometimes, look at other fields and try reasoning "outside the box" and using the analogy. In History of Science, there are many examples of this kind of "contamination" and a first way to distinguish them is the similarity that can be internal (the same field of study) or external (different field of study). We proceed with a couple of examples.

The internal one is, for example, the case of Pierre de Fermat (1601-1665) who announce the theorem: an equation in the form $x^n+y^n=z^n$ have no solution for n>2. Fermat wrote, in a book border, to have found the solution of this theorem (which from then on took his name), but this solution was never found.

Only in 1993, Andrew Wiles found the solution (and for that, he won the Fields' medal). In a popular science book (Singh 1997) is reconstructed the story who lead Wiles to this discovering and – without going down into details – the main point is that discovery it was possible thanks to the analogy between two fields of mathematics far from each other and

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without common points: the numbers' theory and the differential geometry. Both of them contribute to the solution:

> The value of mathematical bridges is enormous. They enable communities of mathematicians who have been living on separate islands to exchange ideas and explore each other's creations. Mathematics consists of islands of knowledge in a sea of ignorance. For example, there is the island occupied by geometers who study shape and form, and then there is the island of probability where mathematicians discuss risk and chance. There are dozens of such islands, each one with its own unique language, incomprehensible to the inhabitants of other islands. The language of geometry is quite different to the language of probability, and the slang of calculus is meaningless to those who speak only statistics. The great potential of the Taniyama-Shimura conjecture was that it would connect two islands and allow them to speak to each other for the first time. Barry Mazur thinks of the Taniyama-Shimura conjecture as a translating device similar to the Rosetta stone, which contained Egyptian demotic, ancient Greek and hieroglyphics (Singh 1997, 219-220).

This example shows the dynamic inside a single discipline: mathematics. Obviously, there are many examples of productive exchange, for example, between physics and mathematics. One of the most famous in recent times is the relationship between the tensor calculus and the general relativity theory. Indeed, the "engine" of Einstein's theory of general relativity, one of the most scintillating gems of twentieth-century science, is the work of an Italian mathematician: Gregorio Ricci Curbastro. Albert Einstein, after having been the victim of a real "block of the scientist", found in the Ricci tensor calculus the algorithmic apparatus that allowed him to transform an elusive intuition into a solid physical theory. That famous theory that represents the perfect condensation between Einstein's physical genius and the power, synthesis and elegance of mathematics created by Ricci Curbastro (Toscano 2004).

Another example of the powerful prediction involves mathematics and astronomy and it is quite famous: the discovery of Neptune. Probably the liveliest description of this episode comes from the Nobel Prize in Physics Richard Feynman:

> If we have confidence in a law, then if something appears to be wrong it can suggest to us another phenomenon. [...] Jupiter, Saturn and Uranus were big planets that were known, and calculations were made about how slightly different from the perfect ellipses of Kepler the planets ought to be going by the pull of each on the others. And at the end of the calculations and observations it was noticed that Jupiter and Saturn went according to the calculations, but that Uranus was doing something funny. Another opportunity for Newton's Laws to be found wanting; but take courage! Two men, Adams and Leverrier, who made these calculations independently and at almost exactly the same time, proposed that the motions of Uranus were due to an unseen planet, and they wrote letters to their respective observatories telling them – 'Turn your telescope and look there and you will find a planet'. 'How absurd', said one of the observatories, 'some guy sitting with pieces of paper and pencils can tell us where to look to find some new planet'. The other observatory was more… well, the administration was different, and they found Neptune! (Feynman 1965, 23-24).

A quite singular case, where the mathematics was better than a telescope.

In the following part of this paper, we show analogies between energetic resources, ecology, and a quasi-economic theory.

The concept of EROEI (or EROI) and what the EROEI means

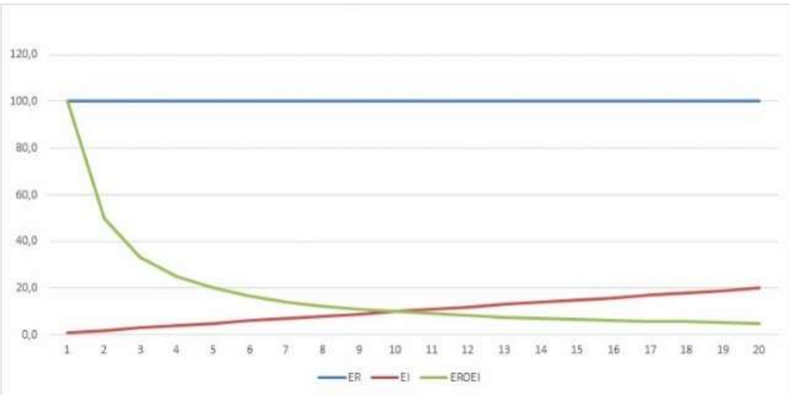
Inside of the Energy field study, one of the most important concepts is the EROEI (or EROI), the acronym of Energy Return on (Energy) Investment. The concept comes from the Ecology, it is relevant for many disciplines and Charles Hall developed it, in Energy field (Hall 2017).

The simplest example of this cross-disciplinary approach is about the case of hunter-croppers' tribe. We can imagine a tribe that arrives in a savanna. They establish their camp and the men go hunting. Initially, they find much prey but in few days the animals turn away from the camp and the men have the necessity to cover more distances to find new preys. How much time the camp remains in that piece of savanna?

The (qualitative) answer is quite simple: they remain there until the energy spent to hunt preys (for themselves and tribe) is balanced by the number of preys (and then the number of calories they have). In other words: the Energy Return (ER) must be greater than Energy Invested (EI) and, in particular, the value of EROI (= ER/EI) must be bigger than one.

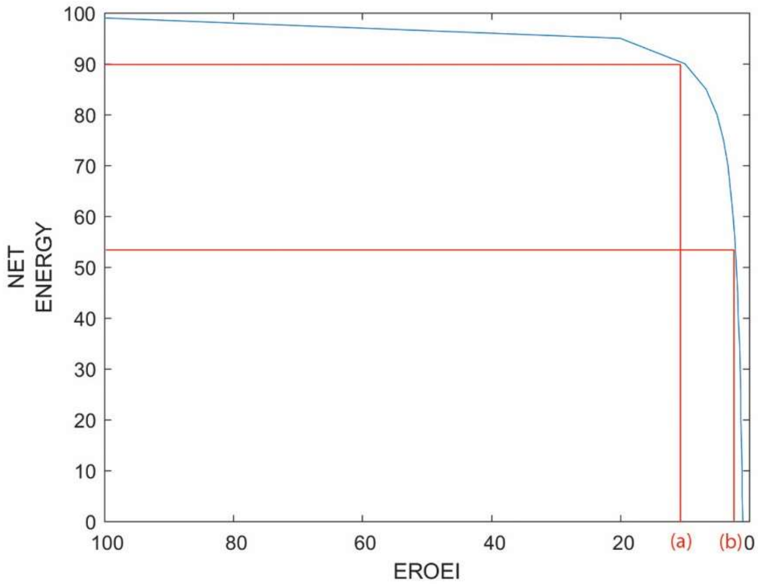
This concept can be applied to the tribe but also to the energy resource like oil, PV panels and so on. In the case of oil, the quality (and the slope) of the curve for declining about energy comes from the study on the EROI. Classical examples of this count are the extraction of oil. To have a qualitative measure of an implant is necessary having the net value of extraction (for example 100 barrels/day) and the value of energy necessary for the correct functioning of the implant (for example: 2 barrels/day). Therefore, the EROEI is 50.

If we imagine using simple numbers to show the quality of the curve, the results are the following (with ER = 100 and EI = from 1 to 20):



Picture 1: The hypothetical graph for a declining EROI, with Energy Investment from 1 to 20

However, to better understand "where we are" in the graph (always for the example of the oil extraction) a more useful parameter is the Net energy, defined as: Net Energy (NE) = Energy Return - Energy Investment. If we divide all terms for a single quantity ER, the result is: NE/ER = 1-(1/EROI), and, under the theoretical hypothesis of the ER always equal 100 for the society, the NE value can be expressed in percentage. So, the equation is: NE(%)= [1-(1/EROEI)]*100. Now, if we make a graph NE vs. EROEI the result is the following:



Picture 2: The "Net energy cliff" and the bias of perception about this

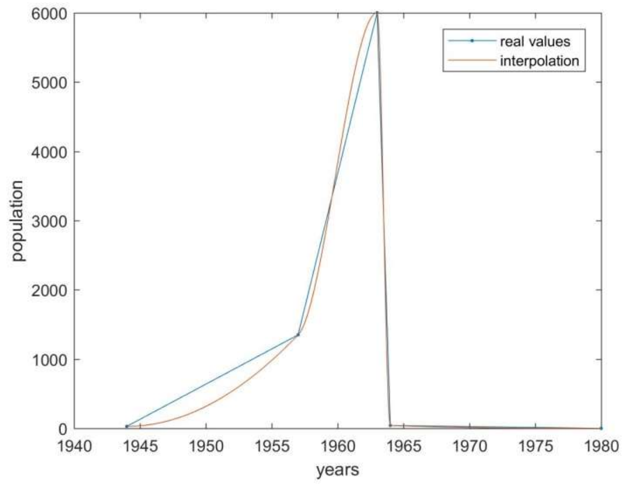
The red lines are precisely the meaning of the carrying capacity of the (eco)system: with EROI = 10 (more or less the point (a)) nothing seems to happen, but if EROI goes down again - from 10 to 2, for example: so more or less the point (b) - the decreasing of net energy is dramatic.

The (Real) History of St. Matthew Island' Reindeer Population: When the Renewable Resources become no Renewable

Some scientist uses the analogy between Mankind and what happened in this remote angle of the world since 1944. Almost at the end of WWII, the US Coast Guard colonized the St. Matthew Island for logistic reason. This Island – in the middle of the Bering Sea – before 1944 was deserted. Technicians and soldiers arrived to install a device useful for the navigation of ships around the area, and they brought with them 29 reindeer as food back up in case of bad weather or war problems.

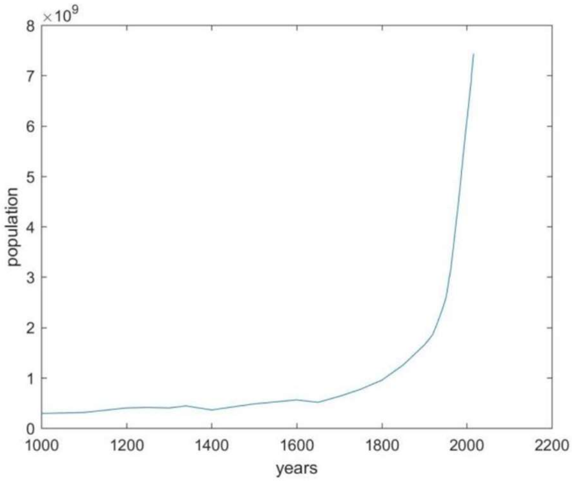
Some months later the war was finished: the people go home, and the reindeer are vacated in an optimal habitat for them, without natural predators. For years, the entire world forgets the reindeer and in 1957 some researchers go to the Island and found more or less 1,350 healthy animals. Only six year after, in 1963, there are 6,000 reindeers but their conditions were not a good one: they ate all lichen in the Island and they are only capable to grazing the sedge grass, but... also this resource of food is coming to the end.

In 1964 the population dramatically fell down and there are on the Island only 42 members: the entire population died for starving. The problem is that 41 are female and only 1 male, the last one infertile for the scarcity of food. So, in the Eighties, also the last reindeer died. Here, the curve of the population:



Picture 3: Trend of reindeer's population. This graph – made in Matlab with few points – shows the real values (broken line) and the interpolation (smooth line).

And here the graph of world population since 1000 b.C.[2]:



Picture 4: World population since 1000 b.C.

The analogy between reindeer' population and the Humankind is evident: our Island is the entire Earth planet, but, as what happens to the reindeer, we have no natural competitors for thousands of years. From the Industrial Revolution, the human population grows substantially linear to the availability of energy per capita with high EROI. What about our future? Something must change.

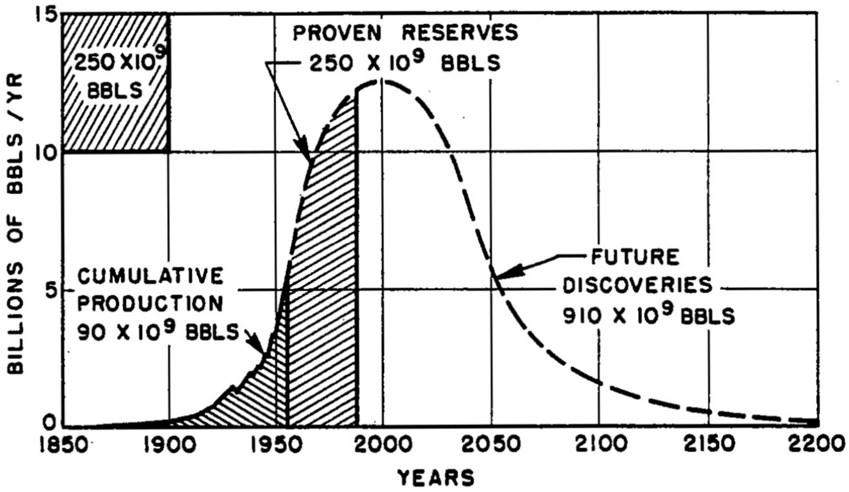
From the Hubbert's Peak to the Seneca Cliff

In 1956 Marion King Hubbert, a Shell geologist, in a meeting in Texas, had predicted the US oil crisis in 1973: many colleagues did not believe him, but he had all the elements to do this: the amount of oil extracted per year in the USA and the growing consumption of the society. He became famous for a kind of theory[3] that said something like this: "One day in the past we extracted the first oil barrel. One day in the future, we will extract the last one. In the

[2] Source: U.S. Census Bureau.

[3] Really closer to a formalization of a commonsense consideration than a theory *tout court*.

middle probably there is more or less a bell curve that indicates the maximum amount of oil extracted worldwide: the peak oil". The peak oil became the Hubbert's peak.[4]



Picture 5: Hubbert's peak oil and his depletion prevision

Could be the Hubbert prevision changed? Many things happened from 1973 and the world itself is changed, but focusing our attention on the curve, to what kind of force it is subjected? There is a force that transforms the peak into a cliff[5] because the consumption is faster than the past, and the main cause is basically the population growth. Another force (in the opposite direction to the previous) "extend" the time we have to make an energy transition: the technology enhancement. This happens with a greater ecological cost,[6] but all can be measured with the EROI index.

Fast or Not?

One of the most relevant aspects of our society is the tendency to grow up in terms of capacity and speediness (we have constantly under the eyes cars faster and bigger than thirty-forty years ago). Generally speaking, our society requires constantly a surplus of energy to perform jobs faster than before.

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[4] There is a little video clip where he personally explains, in a TV program, his theory: https://www.youtube.com/watch?v=usJoqXTvGZ0 (all links are checked on June 30th, 2018). In this brief video, he shows another important thing: if we take a graph with the *Human history from the 5000 BC to 5000 AC*, the oil peak becomes something more similar to a Dirac impulse that a peak. In other terms: our society has available a lot more energy than they have had the past societies (and probably the future one). Recently a young Australian scientific communicator, Stuart McMillen, wrote a comic about the life of Hubbert: http://www.stuartmcmillen.com/comic/peak-oil/. The picture comes from the original Hubbert's work, presented to the Geologists Congress in 1956 at Austin (Texas): *Nuclear Energy and The Fossil Fuels*.

[5] The cliff paradigm comes from Ugo Bardi and his intense activity of dissemination, in many blogs (http://thesenecatrap.blogspot.it/, http://cassandralegacy.blogspot.it/) and mailing list management (Energy Transition). Recently he reorganized his work in a new book (Bardi 2017).

[6] A way to have an idea of this ecological devastation is sufficient a brief search: with Google images look at "tar sands Canada".

Ugo Bardi, lecturer of Chemistry at University of Florence, uses a kind of paradigm to show his students this phenomenon: the higher will be the intensity in use of energy, the faster our society will fall down. In particular, Bardi has used a famous sentence that comes from the ancient philosopher Lucio Anneo Seneca: "It would be some consolation for the feebleness of ourselves and our works if all things should perish as slowly as they come into being; but as it is, increases are of sluggish growth, but the way to ruin is rapid"[7]. Useful cases, in both animal and human populations, show this: in the next paragraph, we will suggest a linguistic analysis about a best seller like *Collapse* (Diamond 2005).

Jared Diamond, famous for his previous book (Diamond 1997), in *Collapse* has analyzed the way in which ancient populations – often in uncertain balance with the environment – have faced the question of their survival and in which cases their strategies have had success or not.

The *leitmotiv* about the decline is the same of the growth: "fast" and "rapid". In particular: «Writers find it tempting to draw analogies between those trajectories of human societies and the trajectories of individual human lives – to talk of a society's birth, growth, peak, senescence, and death – and to assume that the long period of senescence that most of us traverse between our peak years and our deaths also applies to societies. But that metaphor proves erroneous for many past societies (and for the modern Soviet Union): they **declined rapidly** after reaching peak numbers and power, and those rapid declines must have come as a surprise and shock to their citizens» (Diamond 2005, 6, bold mine). And talking about events happened on the Easter Island, we have found:

> Around 1680, at the time of the military coup, rival clans switched from erecting increasingly large statues to throwing down one another's statues by toppling a statue forwards onto a slab placed so that the statue would fall on the slab and break. Thus, as we shall also see for the Anasazi and Maya […], **the collapse of Easter society followed swiftly** upon the society's reaching its peak of population, monument construction, and environmental impact (Diamond 2005, 110, bold mine).

Again, along with the book, when he writes about the Anazasi population:

> That should make us modern Americans hesitate to be too confident yet about the sustainability of our First World economy, **especially when we reflect how quickly Chaco society collapsed** after its peak in the decade a.d. 1110-1120, and how implausible the risk of collapse would have seemed to Chacoans of that decade (Diamond 2005, 155, bold mine).

We don't give here extra examples, but it is relevant to underline that Diamond cannot avoid an explicit parallelism with our society:

> Like Easter Island chiefs erecting ever larger statues, eventually crowned by pukao, and like Anasazi elite treating themselves to necklaces of 2,000 turquoise beads, Maya kings sought to outdo each other with more and more impressive temples, covered with thicker and thicker plaster – reminiscent in turn of the extravagant conspicuous consumption by modern American CEOs. The passivity of Easter chiefs and Maya kings in the face of the real big threats to their societies completes our list of disquieting parallels (Diamond 2005, 177, bold mine).

[7] Lucius Anneaus Seneca, *Letters to Lucilius*, n. 91. The complete description of this paradigm, called *The Seneca Cliff*, can be find online at:http://thesenecatrap.blogspot.it/2015/11/the-seneca-effect-why-decline-is-faster.html

In nature, societies of animals normally find a balance with the environment (1) for the normal prey-predator dynamics[8], or (2) for the particular hard condition of the environment itself. However, in some (not properly natural) cases, it is possible to find out that, without natural boundaries (weather conditions and prey-predator dynamics), the populations grow up until the limit of carrying capacity of the ecosystem, like the history of the reindeer in St. Matthew Island's suggests us.

There are also some independent researchers (Greer 2008) that thinking in another way the shape of declining. The society is more resilient than we expect and the time of transition between phases could be sufficiently long to allow a social adapting to the new phase.

Another Peak (and Cliff) in History of Science: The "Guano Age" in Peru

There are examples in History of Science (and maybe in History *tout court*) where we can see applied the Hubbert peak or/and the Seneca cliff? We have seen some cases (Diamond 2005) and we can see them from an energetic point of view when also the renewable resources can become no renewable because of the consumption intensity (Celi 2017).

One of them, not listed in Diamond and did not found elsewhere, is the "guano case". The socio-political condition of Peru in the mid-19th century knew a period of stability and prosperity thanks to revenues generated by the export of guano and the strong leadership of President Ramón Castilla, in 1845, when he started his first administration.

Guano, or bird droppings, had been accumulating on the coastal islands of Peru for hundreds of years when, due to scientific breakthroughs in Europe, it was suddenly discovered to have great value as a fertilizer. For forty years, the young Peruvian State knows the prosperity, but in the 1870s was for Peru's economy "a decade of crisis and change" (Greenhill, Miller 1973). Nitrate extraction rose while guano extraction declined and sugar cane dethroned cotton as the main cash crop. Guano exports dropped from 575,000 tons in 1869 to less than 350,000 tons in 1873 and the Chincha Islands and other guano islands were depleted or close to be so. Deposits elsewhere were of poor quality (Greenhill, Miller 1973) and the "guano era" ended. A typical case of (low) renewable resource depletion, similar to the whale case at the beginning of the 19th century[9].

A few years later, as in the whale case, the question was resolved by a technological discovery: the Haber process (also called the Haber-Bosch process), an artificial nitrogen fixation process and is the main industrial procedure for the production of ammonia and mainly used to produce fertilizer today. For the Peruvian State, according to government experts, to only way to cope with the guano depletion was to supplement this one with synthetic fertilizer. Foreign companies were brought in to construct plants, which used the Haber-Bosch process to create fertilizer. As a result, the Guano Administration Company was renamed the Corporacion Nacional de Fertilizantes (CONAFER).

[8] See the Lotka–Volterra equations, explained also in an old book (D'Ancona 1942).

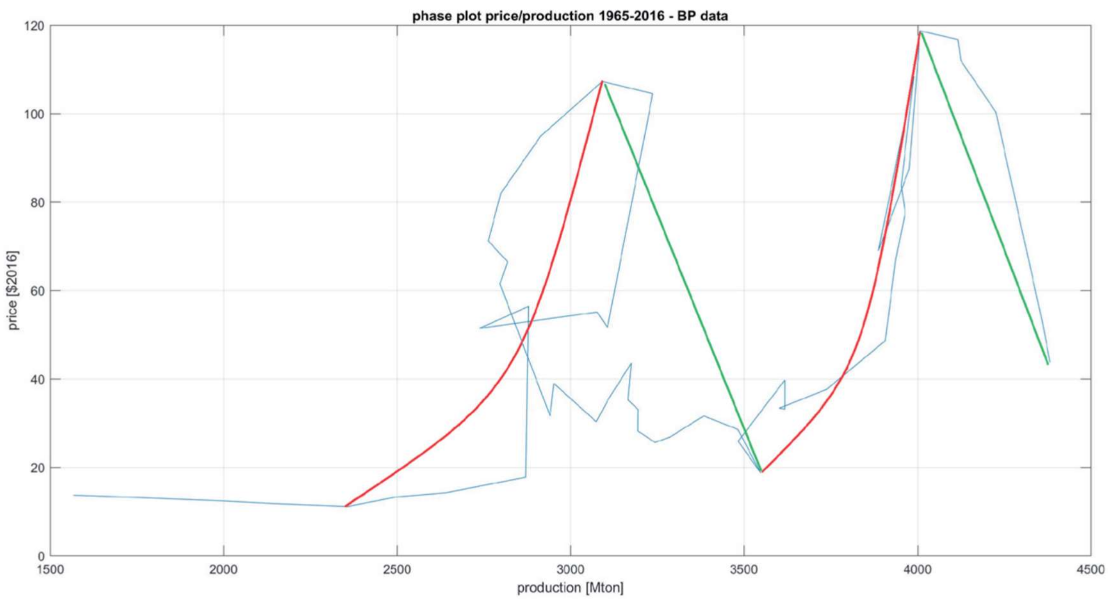
[9] This case is well described in a book (Bardi 2014) and ironically, the whales, hunted for the (whale) oil, are saved by the beginning oil production.

Last (Ecological) Example:
Oil Dynamics Market and the North American Spruce Budworm[10]

The behavior of complex systems is one of the most intriguing phenomena investigated by recent science; natural and artificial systems offer a wide opportunity for this kind of analysis. The energy conversion is both a process based on important physical laws and one of the most important economic sectors; the interaction between these two aspects of the energy production suggests the possibility to apply some of the approaches of the dynamic systems analysis. In particular, a phase plot, which is one of the methods to detect a correlation between quantities in a complex system, provides a good way to establish qualitative analogies between the ecological systems and the economic ones, and may shed light on the processes governing the evolution of the system.

This section aims to highlight the analogies between some peculiar characteristics of the oil production vs. price, and show in which way such characteristics are similar to some behavioral mechanisms found in Nature.

In a previous study (Celi, Della Volpe, Pardi, Siboni 2017), we tried to show how a phase plot of oil production (vs. the price) has an irregular trend (*random walk*) with two important features that identify as inelastic the oil market (The two lines in red, in the following picture). The relationship, even if only qualitatively, shows two peaks upward where the oil price became very high in few years, and then rapidly decreases (green lines: obviously, we are looking at the general trend, without considering the "random walk behavior" in the middle).

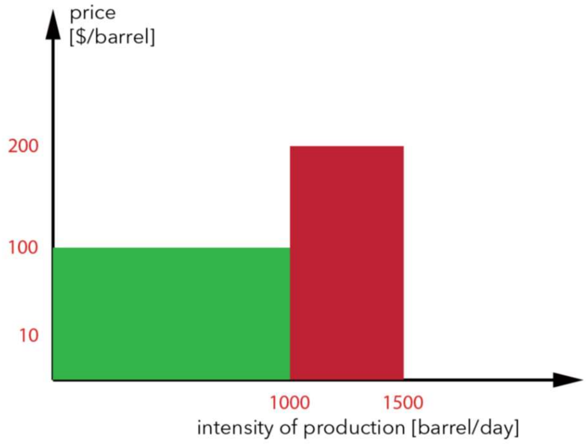


Picture 6: Phase plot oil production vs. price, years 1965-2016

This kind of "swinging behavior" recalls some typical phenomena, investigated by some theories in the domain of complex systems. In particular, this is the case of Thom's catastrophe theory (Thom 1972, cited in Scheffer 2009). The behavior shown in the phase

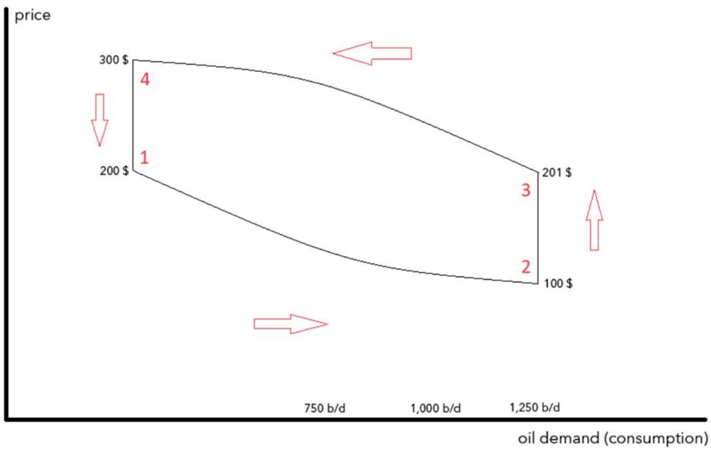
[10] This contribution was a part of the speech *Spruce budworm and oil price: a biophysical analogy* held in the Annual Conference of the International Society for BioPhysical Economics, *Developing Economics for a resource constrained world*, Wells College, Aurora, NY, USA, June 2018, 13-17th. This work had also the contribution of Claudio Della Volpe, Stefano Siboni (University of Trento) and Luca Pardi (Italian National Research Council, Pisa). It is also a part of Celi (2019).

plot (picture 6) in his simpler version could be represented as follows. We can imagine having two oil wells: one at a lower cost of extraction (i.e. 100 $/barrel) and one higher (200 $/barrel), as schematically shown in picture 7.



Picture 7: Intensity of oil production vs. price

If in our hypothetical world the consumption is in the range between 0 and 1,000 barrels/day, we use the oil at a lower price (green rectangle), with a price (ideally) inside the range 0-100 $/barrel. If the intensity of consumption grows, we need to use the second stock of oil at the higher price (red rectangle). In this case, the oil price increase quite rapidly, and the phase plot should be the following, in picture 8.



Picture 8: Phase plot consumption vs. price

The ecological model

The phase plot should be like this because in our ideal world we expect that, if the oil price increases rapidly, the consumption decrease and, sooner or later, the society come back to the previous range of intensity of extraction (so in the green rectangle, picture 7). The main characteristic of this simple oil-price dynamics, here described, is that there are two rapid movements on the cycle (rise and descent of the price: phases 4-1 and 2-3) and two slow (consumption that goes up and down, to adjust itself to the oil price: phases 1-2 and 3-4)[11].

[11] The graph in picture 6 has higher prices because take into account the inertia of the social system.

The analogy between this characteristic of the oil market and some dynamics in Ecology (for example Kar, Batabyal 2010; Piltzy et al. 2017) is suggested at least by a model well studied (Royama 1984; May 1977), where we have three species in competition between them, following a variant of the Lotka-Volterra model:

1. prey: the American spruce, whose needles are the food of caterpillars of the species *Choristoneura Fumiferana* (this is the slow variable since the regeneration of the leaves – and not only - is a process that lasts several decades);

2. predator: the population of the caterpillars *Choristoneura Fumiferana*, considered able to vary rapidly (fast variable, since there are periodically observed demographic outbreaks of this species, considered a real scourge);

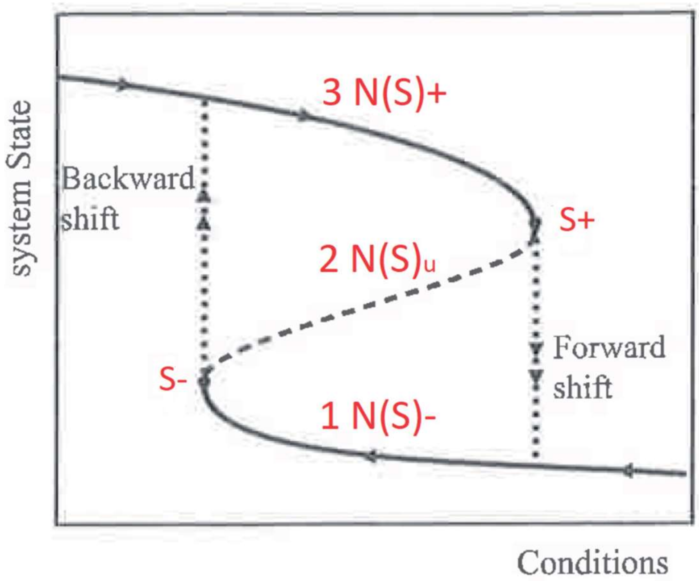
3. "super-predator": the population of birds, which eat the caterpillars, but do so at a rate that we can consider constant (identified as a "natural" rate of mortality of the caterpillars themselves) because this predator actually does not feed exclusively on these caterpillars. The demographic explosion of the latter, however, saturates the space for all prey (the needles of the spruce). In this sense, we will not take into account, in the following discussion, this variable.

In the construction of the ecological model, we start with a preliminary model in which the caterpillars' population N is the only variable, while the spruces' population S is introduced as an assigned parameter. We define a range S- ≤ S ≤ S+ of values for S, inside the caterpillars' population could have three state of equilibrium (indicated in picture 9):

1. a "low" value of equilibrium N(S)-, asymptotically stable;

2. an intermediate value of equilibrium $N(S)_u$, unstable, and

3. a "high" value of equilibrium N(S)+, also asymptotically stable.



Picture 9: Equilibria of the system.[12]

[12] (Scheffer 2009, 20).

This notation recalls us that all equilibrium states are function of the parameter S. Because of its instability, the equilibrium level $N(S)_u$ is inaccessible to the caterpillars' population, inasmuch as any variation of the population determine a rapid leaving from equilibrium and a fast convergence of the system towards N(S)- or N(S)+. For S < S- only the stable equilibrium N(S)- is defined, while for S > S+ we have only the stable equilibrium at N(S)+. The preliminary model explains the outbreaks and collapses of caterpillars' population as imputable to slow variations imposed by the parameter S, which due to these variations "crosses" the critical values S- and S+. The variations of S are assumed "almost-static", i.e. so slow to ensure that almost instantly the population of caterpillars settles at the corresponding equilibrium value (the relaxation times at equilibrium of the N population of the caterpillars are considered much shorter than those of variation of the parameter S).

The typical cycle of outbreaks and collapses of the caterpillars' population N is described as follow:

1. The process can start from a value S < S-, for which the caterpillars' population corresponds to the equilibrium value N-;

2. Then, we increase the value of the parameter S, corresponding to an increment of the spruce biomass. The parameter reaches and overtakes the critical value S- and still grows up until the critical value S+. In this interval, the caterpillars' population grows up but stands to the asymptotically stable equilibrium level N(S)-, because of all the possible fluctuations are lessened and reabsorbed. The compresence of the equilibrium $N(S)_u$ is not relevant, because of its instability;

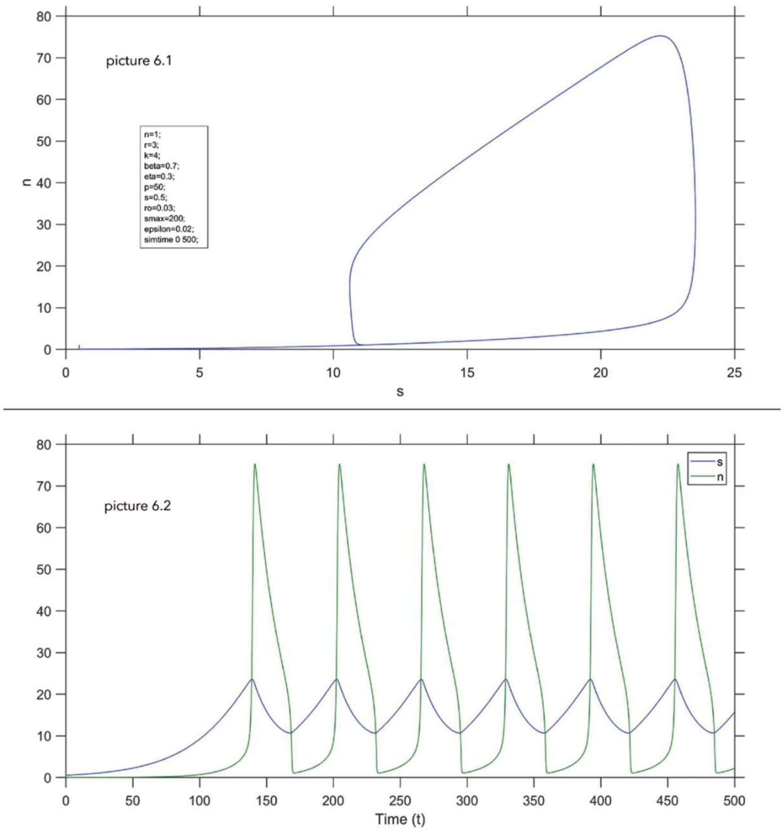
3. The parameter S overtakes the critical value S+. The equilibrium N(S)- suddenly disappears, along with $N(S)_u$, and the population rapidly grows up to reach the "high" equilibrium value N(S)+, the only available and asymptotically stable. Further increments of the parameter S determine a further, but contained, increase of the caterpillars' population, in any case always corresponding to the equilibrium value N(S)+;

4. The next step is reducing the parameter S, to simulate what in reality happens: the overpopulation of caterpillars depletes the spruce biomass and determines its reduction. The parameter S reaches and overtakes the critical value S+, following its decrease until S-. The caterpillars' population slowly decreases, maintaining itself, as long as possible, close to the asymptotically stable equilibrium point N(S)+,. Also in this part of the cycle the intermediate equilibrium $N(S)_u$, even if defined, does not play any role because of its instability;

5. The last step: the parameter S finally passes below the critical value S-. This results in the destruction of the equilibrium N(S)+, as well as that of $N(S)_u$, with a consequent rapid collapse of the caterpillar population to the only available equilibrium value N(S)-. Any further decrease in S leads to a reduction in the population of the caterpillars, which however remains at the equilibrium value N(S);

6. Now the caterpillars' population is at the minimum level, the spruces biomass can start to grow up again, so that the parameter S grows up in turn and the cycle restarts.

The previous model with a variable (N) and a parameter (S) suggests a more complex two-variable model in which the population of caterpillars and the biomass of spruces are considered both as dynamic variables, in mutual interaction. In the further differential equation that governs the dynamics of S the characteristic constant parameters are chosen to ensure that the variation of S over time remains relatively slow. In this way, we can consider that the trends observed in the preliminary model with a single variable persist also in the new two-variable model, giving rise to a stable limit cycle characterized by two rapid growth and decrease phases of the caterpillars' population N. These rapid variations of budworm population alternate with two relatively slow growth and decrease phases of the same population, while the biomass of spruces varies always rather slowly, both increasing and decreasing, throughout the cycle.



Picture 10: 10.1: The Matlab simulation for the phase plot caterpillars' population vs. spruces foliage and (10.2) the same values in time.

The Transition to Economics

The shift from Ecology to the Economy (oil price-EROI cycle) is suggested by the following qualitative considerations:

1. the price of oil is potentially able to undergo very rapid changes, being linked to the delicate balance between supply and demand. On the contrary, EROI presents itself as a parameter that changes slowly because its decrease naturally derives from the exploitation of deposits, while its increase can be obtained through the implementation of cultivation technologies already available (at best), the search for new deposits, or the improvement of the technologies themselves, operations that require time and significant investments;

2. a very low level of EROI can be associated with a rapid increase in average prices, due to the difficulty of extracting the resource at low energy costs; on the other hand, a very high EROI will favor high levels of production and a general decline in the price of the resource.

These observations suggest identifying: (a) the population N of the caterpillars with the average price of oil and (b) the biomass S of the spruces with the reciprocal of the EROI, variable that assumes low values when the EROI is high and vice versa. This is an index of the energy cost that must be borne to obtain a unit of useful energy.

The interesting aspect of the model is that the price is not described as a function of the EROI, because two different price levels correspond to the same value of EROI, according to the historical phase of the economic cycle where the system is placed. Basically, we are faced with two zones of stability, one with high content and one with a low content of "predators" (price), which are alternately reached. The reason why the sizes were chosen is that, in the oil model, the quantity that varies faster is the price, while both the total production and the EROI (which depends on technology and investments) are sizes with too many constraints to be able to vary quickly. EROI does not succeed because of the technical conditions of production, while production because of the constant energy hunger.

Conclusions

The concept of EROI here described is used to look at the quality of an energy resource (in the broader sense of the term). As shown, this is not only a good parameter of evaluation but also a way to compare different energy sources, because, from a mathematical point of view, the EROI is a dimensionless number.

This concept is powerful: we have shown its use in different fields of study and it could be seen as a method or a point of view to teaching science in a cross-disciplinary way, with the aim to enlighten with analogies, the typical dynamics of disciplines apparently far from each other.

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Interview: Ilana Löwy[1]

Ilana Löwy (née Zelmanowicz), born in Łódź, Poland, is a biologist, historian of biomedical sciences and a feminist. She is "directrice de recherche" (senior researcher) at an interdisciplinary and cross-institutional research unit CERMES-3 (*Centre de recherche médecine, sciences, santé, santé mentale, société*, Inserm-CNRS-EHESS), Paris, France. She is also affiliated with other institutions, Department of Global Health and Social Medicine at King's College London, and the Department of the History of Science at Harvard University and is an associated researcher of Casa Oswaldo Cruz, Fiocruz, Rio de Janeiro. Ilana Löwy holds a BSc and MSc degrees in microbiology and biochemistry from Tel Aviv University, and a doctorate in immunology from Paris VII University. She then retrained as a historian of science. She had studied Ludwik Fleck's epistemology, history of bacteriology, immunology tropical medicine and cancer, women's reproductive health, and more recently, congenital disorders and prenatal diagnosis.

Interviewed by:

Ana Carolina Vimieiro Gomes[2] in May 2019

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Ana Carolina Vimieiro Gomes (ACVG): You started your academic and scientific training as a biologist and has a Ph.D. in immunology. How did you become interested in the history of biomedical sciences?

> **Ilana Löwy:** I was very lucky. When I decided to switch to the history of science, I had already a tenure-track job at the French Institute of Medical Research (Inserm). When I decided to retrain as a historian of science, I was able to persuade my hierarchical superiors – with some difficulty but also with the important support of

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my mentors – that changing orientation to social and cultural studies of science is not only a personal whim, but can benefit the institution too.
I was always interested in history and art history, and followed lectures on these topics during my undergraduate and graduate studies in biology. However, at that time I was not aware of the existence of a discipline called "history of science". I first became interested in history and philosophy of science after my doctorate, when I was invited to collaborate with clinicians on a research project on Buerger disease, a rare and scary pathology. The patients, usually young men, develop inflammation and thrombosis in their fingers which may lead to gangrene, and a need to amputate the fingers, and sometimes the whole limb. Buerger disease is linked to smoking and is believed to be an autoimmune condition (a pathology produced when the body's immune system mistakenly attacks healthy tissue). My task was to develop a mouse model of Buerger disease. I had regular meeting with the clinicians at a hospital, to report about the progress of my research. The clinicians and my colleagues at the laboratory were very pleased with my results. I was less happy with myself. Although I was able to induce autoimmune reactions in mice, and show that the immune cells of these mice had some similarities with immune cells from the patients' blood, I was not sure how relevant laboratory findings are for the understanding of a human pathology; I was even not sure that they are relevant at all.

I asked a friend, who taught philosophy of science, whether he knows studies about the theoretical underpinnings of the use of animal models in science, and especially the modelling of human diseases in the laboratory. Today there are numerous such studies, but this was not the case at that time. My friend lent me an introduction to epistemology which discussed the ideas of thinkers such as Kuhn, Feyeraband, Hempel, Polanyi, Lakatos. I found some of the ideas of these scholars very interesting, but their wrings were focused mainly on physics and astronomy, were often very abstract, and were not relevant to my practice-related preoccupations. I reported my disappointment to my friend, and the next time we met he told me: I think that I found something for you. You should read a book written in the 1930s by a Polish microbiologist called Ludwik Fleck.

ACVG: You have been interested in the epistemology and scientific work of Ludwik Fleck since the very beginning of your academic and scientific career in the history of science. Why your interest was first drawn by Fleck's reflections on medicine and science? What does attract you so much about his thinking?

Ilana Löwy: I had a real "Eureka" moment reading Fleck's *Genesis and Development of a Scientific Fact*. Finally, an epistemological text which discussed the concrete experience of working in a biology laboratory, and dealt with human diseases. Fleck's book spoke directly to my preoccupations and provided some answers to my queries. I immediately photocopied the whole book (this was before Amazon times, and purchasing a book published abroad was a complex enterprise) then heavily underlined and annotated my photocopy. I was especially impressed by Fleck's fine-grained description of laboratory practices. Fleck argued that epistemologists who only read what scientists write, and fail to examine what the scientists do cannot understand what science is about. He was faithful to his own advice, and provided a highly insightful description of scientific work at the bench, and then of the long and sometimes very complicated process of production, stabilization and diffusion of "scientific facts" produced in the laboratory.

In a traditional view of science, dominant in Fleck's time, science was seen as an activity conducted by "greats scientists" (as a rule white, Western, upper class men) who unmask hidden "facts," and discover the "laws of nature". Fleck proposed a very different view of science. He saw science as a dynamic, situated collective human activity. So, since science was a situated endeavor, it cannot be studied outside its historical and social context. Fleck had shown that the production of scientific facts always included their validation by relevant communities, and thus activities such as talks in scientific meetings and publications in scientific journals. In 1935, when he published his book, scientific publications were already frequently authored by several researchers, for him a telling display of the collective and social nature of science. Fleck was also interested by the multiple ways specific knowledge claims and practices circulate outside the professional group ("thought collective") which had initially developed and validated a given "fact". Facts, he argued, migrate from the group that produced them, and are modified during their circulation among different "thought collectives," professional and lay ("imperfect translations"). This process stimulates in turn innovation in science and society.

ACVG: Many of your works are inspired by Fleck's approach to the history of science. One example is your recent book "Imperfect pregnancies" where you mention Fleck's claim that [citing you] "epistemology without historical and comparative investigations is no more than an empty play of words, or an *epistemologia imaginabilis*". In your opinion what are the most relevant methodological contributions of Fleck's thinking for the theory and historiography of science today?

Ilana Löwy: Fleck's work has many reading, all of them legitimate, of course. Many scholars focused on Fleck's theoretical/ epistemological views. Others, such as Ian Hacking, extended his understanding of styles of scientific thought. Other still, such as Bruno Latour, were mainly attracted by Fleck's focus on epistemology as a collective practice that involved learning and change. I was especially interested in a more "prosaic" aspect of Fleck: his involvement with public health. The historian of science Barbara Rosenkrantz, who was one of my mentors, explained in one of the first reviews of the English translation of Genesis and Development of Scientific Fact that Fleck worked nearly all his life in public health. This is, I believe a very important point because public health is a discipline at the crossroads of biology, clinical medicine, sociology, economy, politics and law. Fleck was interested in all these dimensions and the ways they interact. He can still teach us much about the complex, multidimensional interaction between science and society.

Fleck lived in dark times. His book was published in 1935 when to quote the writer Victor Serge "it was midnight in the century": the consequences of the economic crisis of 1929, the rise of fascism, Stalin's repression in the Soviet Union. *Genesis and Development of a Scientific Fact*, a book written in German, was published in Switzerland because at that time no German publishing house would publish a book written by a Jew. During the Second World War, Fleck and his family were interned in the Lwow Ghetto, then he was sent to Auschwitz concentration camp, and finally to the Buchenwald camp. In the latter camp, Fleck witnessed Nazi murderous experiments on humans. He testified about these experiments in the Nuremberg Trial of Nazi doctors, in 1948. His wife and son survived the war, but other members of his family were killed by the Nazi.

In spite of his first-hand observation of horrors made by the Nazi in the name of scientific research, Fleck did not lose his faith in science. Just the opposite is true;

he passionately believed that such horrors teach us that we need a better science: more open, and more democratic. To achieve this goal, he proposed, it is crucial to educate the public how precisely science works, what scientists do, and how to judge which knowledge statements are sound and which are not. His theory of "scientific styles of thought" aimed to do precisely this: favor the public's critical engagement with science, very different from passive divulgation of "scientific facts". Such a widespread and well-informed public engagement with science is, I believe, especially important today, in an era of "alternative facts," in which false information often spreads faster than the true one, and leading politicians attempt to undermine science and propagate ignorance.

ACVG: One special hallmark of your trajectory in the history of science is an interdisciplinary approach, and you work in an interdisciplinary research institution in France, CERMES-3 (*Centre de recherche médecine, sciences, santé, santé mentale, société*). You often acknowledge the contribution of anthropologists, sociologists, philosophers and biomedical scientists' reflections to your research. Could you please tell some more about this interdisciplinary approach and its importance for your empirical work, analytic choices and historical interpretations?

Ilana Löwy: I believe that it is not possible to study the history of medicine without an interdisciplinary, comparative approach. Perhaps one partial exception is a philological approach to the study of old medical texts, central to "old" history of medicine, focused on the investigation of classic works in this domain. However, when one moves beyond the establishment of a critical edition of Hippocrates or Vesalius's writing – of course, a very important scholarly task – studying medicine is, by definition, a multidisplinary endeavor. Medicine is a socio-biological phenomenon: an individual can feel pain, have other distressing symptoms, be disabled – but to define individual's distress as "disease" is a collective time-and place-dependent act. It is not possible to dissociate the sociocultural elements of a disease from its biological ones, either on the individual or the society level. Our understanding of "disease" is shaped at the same time by the experience of perturbation of a physiological function (in psychiatric disease, a mental function), and by the social imagery linked with this perturbation. Hence the need to study it from multiple disciplinary points of view. As Fleck had already eloquently argued in 1926 such points of view are partly incommensurable. It is not possible to have a single, fixed understanding of a human pathology even when there is a simple definition of this pathology, a good diagnostic test and an efficient cure; even less when the pathology is complex and its causes are not fully understood. Syphilis is an infection by *Treponema pallidum,* it can be reliably detected by a blood test, and rapidly cured by penicillin. However, today too, the disease "syphilis" cannot be dissociated from the social context in which it manifests itself. The existence of efficient diagnosis and treatment may not be enough to contain the spread of infection. Or, to take a more dramatic example: the new vaccine against Ebola seems to work well, but it is not sufficient to stop the ongoing epidemics of this disease in the Democratic Republic of Congo, and health experts ask sociologists and anthropologists to help them to better understand peoples' resistance to the proposed health measures.

ACVG: You have also been working on the history of biomedical science in Brazil, as can be noted in your association to Casa de Oswaldo Cruz/Fiocruz and some of your publications (for instance: Portuguese translation: *Virus, mosquitos e modernidade: A febre amarela no Brasil entre ciência e política*, Rio de Janeiro: Fiocruz, 2005). Do you think there would be an essential lesson to the historiography of science that you may have learned over the years from investigating the history of biomedical science in Brazil?

> **Ilana Löwy:** I learned that Brazil is a fascinating place for a historian. It is at the same time "developed" and "developing" country, with an impressive tradition of scientific and clinical research and public health, but also agitated history and immense tensions and contradictions. The now defunct Parisian department store Samaritaine has a slogan "one can find everything at the Samaritaine". One can find (nearly) everything in Brazil, including great colleagues and excellent students. Brazil is, I believe, an especially interesting place to study the interactions between "center" and "periphery," or rather the complexity and indeterminacy of these terms, and a great site to look at tensions and contradiction of diffusion of new biomedical approaches. In the era of global health, it is also an especially good place to investigate the intersections between the global and the local and to examine global health from the point of view of "globalized" populations.

ACVG: You are also involved in current political debates on public health in Brazil, such as your participation in local and international public and scientific debates on the recent Zika's virus outbreak. How do you think these political experiences in the present, shape your interests in and contribute to your approaches to the history of biomedical science?

> **Ilana Löwy:** It is difficult to live outside one's time, or isolate hermetically one's opinion as a scholar from one's views as a citizen. On the other hand, historical and sociological research is a specific activity. The role of academic, the British classics scholar Mary Beard explained, is to make issues more complicated. This may be somewhat easier when studying ancient Rome than when studying recent developments such as the development of genomics or the Zika epidemics. Scholars who deal with difficult topics and fundamentally unresolved profound moral and material questions are frequently caught in a tension between an aspiration to be policy-relevant, and thus to simplify the debated issues, and the wish to be faithful to their material, and therefore to be especially attentive to contingency and complexity. I am trying to find the right balance between these two standpoints, but I am not sure how successful I am in avoiding the multiple traps of such "in between" position.

ACVG: Your latest books *Preventive Strikes: Women, Precancer and Prophylactic Surgery*, Johns Hopkins University Press, 2009 (Prized by the European Association for the History of Science); *Woman's Disease: A History of Cervical Cancer*, Oxford University Press, 2011; Imperfect Pregnancies. A History of Birth Defects and Prenatal Diagnosis, Johns Hopkins University Press, 2017, and *Tangled Diagnoses: Prenatal Testing, Women and Risk*, Chicago: Chicago University Press, 2018 tackle issues of gender related to biomedical science. How and why do you have become involved in gender reflections in science? Could you please situate the historiographic relevance of these publications to the contemporary debates on gender studies?

> **Ilana Löwy:** I was always interested in gender/ gender studies and their intersection with my scientific specialty, biology, at least from the time when, as a graduate student in biology. I read studies of scholars such as Evelyn Fox Keller, Anne Fausto Sterling and Ruth Hubbard (all biologists and feminists) From the mid-1990s I also participated actively in collective debates on the place of gender studies in a science studies curriculum. However, until the early 21 first century, gender was on the "back burner" in my own empirical research. At that time, I participated in collective

projects the introduction of testing for genetic predisposition to breast cancer. Through these studies, gender moved to a more central place in my work. I became then interested in gendered topics, female cancers, contraception, prenatal diagnosis, and now the Zika epidemics, a topic closely related to the thorny issue of severe constraints on women's sexual and reproductive rights in Brazil.

I am surely not the right person to discuss the relevance of my work to scholarship in gender studies. I can only hope that my focus on the concrete patterns of "manufacture of gender" through the material practices of science and medicine can stimulate more studies that look not only on rare and exceptional developments, but also mundane, routine and therefore often invisible acts, which are nevertheless the backbone of medical practices.

ACVG: After investigating the history of diagnosis techniques in 20th-century, such as cancer and prenatal diagnosis, what comes next? What have you been working on recently?

Ilana Löwy: I am still deep in the study of Zika epidemics in Brazil, a complex multilevel event with numerous ramifications. I hope to write a book on this epidemics which will combine historical insights with an analysis of present-time events. The work on Zika led me to my earlier interest in transmissible diseases, among them syphilis, since Brazil is now affected by an important epidemics of syphilis, including congenital syphilis, something I want to understand better. Thus, recent developments bring me back to my beginnings as a historian of science: the study of the diagnosis of syphilis, at the center of Fleck's book *Genesis and development of a scientific fact*.

ACVG: Thank you so much!

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Book review

After American Studies: Rethinking the Legacies of Transnational Exceptionalism

Herlihy-Mera, Jeffrey. *After American Studies: Rethinking the Legacies of Transnational Exceptionalism*. New York: Routledge, 2018. 188 p. ISBN: 9781138054059 – Hardback; 9781315167053 – eBook. $ 150.00

David Lorenzo Izquierdo[1]

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After American Studies, by Jeffrey Herlihy-Mera of the Universidad de Puerto Rico, is a critical Cultural-Studies examination of the foundational theses in the Transnational Turn in American Studies. However, it is aimed, at the same time, to rethink and deconstruct some of the key tenets of the field. Indeed, *After American Studies* engages a post-national and post-cultural argument, the core of which provides important nuance to the transnational turn.

The book is comprised of an introduction and nine chapters, parts of which were previously published in academic journals. Herlihy-Mera's purpose is made clear in the Introduction: "*After American Studies* is a critique of national and transnational approaches to community, their forms of belonging and patriation, and initiates a theoretical gesture toward new considerations of postgeographic and postcultural communities" (p. 1).

The chapters are grouped in three large sections. In the first section are chapters 1 and 2: "The Ontology of Cultural Groups in Modernity" and "Place-Making". In them, the author explains how state-supported (and ostensibly non-state) cultural canons attempt to influence the individuals exposed to them. The analysis uncovers how the US political body has used the physical spaces of the American continent to build myths, symbols and values, and then imposes them somewhat uniformly on the population (on every individual) as a function of the geographical location of their residence.

The second section is comprised of chapters 3 to 7: "Literature as a Device of Cultural Appropriation", "A Coda to Literary Canons", "Art and Power", "Forced Acculturation" and "Transmedia Storytelling"; these chapters are presented as "Case Studies" by Herlihy-Mera. In them, the author illustrates, with examples from different areas (literature, art, media and public policies), the ideas explained in the two initial chapters.

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The third section includes chapters 8 and 9 ("Colonial Problems, Transnational American Studies" and "Imagining New Communities"), that function as a conclusion (chapter 8) and a proposal on new forms of cultural study (chapter 9).

Herlihy-Mera argues that the concepts of "nation" and "national culture" (and other related or derivatives) are based on canons that, in most cases, are little beyond a dominant group's "common" cultural prescriptions, imposed on a group of people who live in a geographically delimited area, a process which leaves other characteristics or realities aside or subordinates them through hyphenation (p. 20).

In this dynamic, he argues that space itself is used as an element of homogenization and control (p. 21). Once that space is delimited and constructed, and the values that "characterize" the dominant group are created, the difference between "us" (those who inhabit that space and identify with the myths communicated in the physical material) and "them" (everyone else) is established, thus implementing the center of the cultural system. The controlled space is the base, scope and access to certain cultural realities: it is saturated with the same language, the same symbols (pp. 26, 31) and thus foreignizes many cultures and languages that are native to the regions.

In this regard, and in reference to the US, Herlihy-Mera states: "The 'American' space is constructed on social and cultural pillars that seize the fundamental blocks of human communication, including language, spirituality, time; and the rituals surrounding birth, death, and betrothal. It is also common for specific elements of the preexisting cultures – sometimes words, imagery, icons, heroes, and so on – to be appropriated into the dominant myth, a syncretization of material that interpellates it as an inferior component of the broader system" (pp. 35-36). The process of building "an American" implies, for example, exposure to unified language system (centered on English), habits and time (the same calendar, the same hours to organize the day) and spaces (the configuration of the public spaces where people live and interact).

In chapters 3 to 7, the author illustrates (with examples from various areas, including literature, art, media and public policies) the ideas explained in the preceding chapters. In chapters 3 and 4, Herlihy-Mera analyzes the role of literature as a means to generate collective identity feelings. He describes literature as a "device of cultural appropriation" (p. 52). The authors considered 'canonical' and their works (their characters, language, and landscapes) have buttressed and echoed the political claims of the US government (pp. 53-55). Herlihy-Mera comments, as examples, works by María A. Ruiz de Burton, Jack Kerouac, Ernest Hemingway, Cormac McCarthy, among others, making the case that these works should not be labeled as 'American literature' per se. In doing so, the author intends is to characterize "American" as an artificial, fantasy construct, even when the authors themselves use that term. For that reason, Herlihy-Mera argues that "the atomization of literary studies and abandonment of 'American' and other such prescriptions will open a new set of spaces of inquiry, analyzes that are not dependent on supposition, imagined affiliations, or identities" (p. 69).

In chapter 5, the analyses examine visual art as a means of domination or power over communities and individuals. "Art", affirms Herlihy-Mera, "is part of the ecosystem of ideology. The ways ideas are given physical form (in paintings, buildings, photography, currency, and so on) and the structure of the environment where these objects are displayed for public review, are a dimension of how the dominant groups use physical and nonverbal entities to promote and legitimize sets of ideas, as well as to inaugurate specific affiliations and cultural norms" (p. 96). To this end, the author analyzes the use of certain colors (red, white, blue) in notable paintings of American art, symmetry in buildings or spaces (such as the White House and the National Mall), the image of the ideal human being and the story that certain representations convey" (pp. 100-102).

In chapter 6, Herlihy-Mera explains how the construction of the "nation" and "culture" of America is manifested in public policies, with particular emphasis on immigration regulations (detailing the discriminatory process of obtaining a visa). Next, in chapter 7, he analyzes how the values and criteria that the US considers natural and common are transmitted to individuals through unofficial means or instruments, such as advertising, sports, among other commercial material. He comments on the advertising used by brands such as Chevrolet, MacDonald's, and Coca-Cola.

In an argumentative – not merely descriptive – sense, chapters 8 and 9 are the most important in the book. In them, the author not only analyzes a reality but proposes another reality (or series of ways) to improve the existing reality (especially in chapter 9). His work in this section demonstrates how American Studies has not jettisoned the national ballast, or the limits of the concept of nation by engaging a transnational vision: as "the transnational iteration relies on the national frameworks" (p. 149). Therefore, "transnational American Study is an exercise in distortion" (p. 153).

Also, what is an alternative to the concept of a nation? "Age" – responds Herlihy-Mera. The author argues that Age should emerge as a criterion – or the main criterion – to re-center cultural studies relating to behaviors, feelings, expressions and experiences of individuals. "As an alternative to the national and transnational; the religious, linguistic, and ethnic; and the geographic and cultural, the broad-based fraternity of an Age system could elide some of the demographic discriminations of the present and gesture toward a universal community" (p. 171). Cultural studies (and other disciplines) could be organized by age, not by country, culture or movement (ideological, aesthetic, etc.), the author maintains, as such a system would be emancipated to a degree from the rigidities of other forms of cataloguing, including geographic and cultural.

If relationships between individuals were based on age, "the preexistent political territoriality (often based on location) would be modified and / or abandoned. The members would be reorganized democratically (universal voting rights and public representation), have access to the same resources (education, health care, and infrastructure) without consideration of region. Each community would have an internal democratic structure, with delegates (number of representatives based on the population of each Age community) who would participate in a global governing body" (p. 179).

It is certain that *After American Studies* is a *critical* book. It is so in a tripartite sense. It is "critical" because, in the first place, for the depth and comprehensiveness of the analysis. It aims to uncover the concealed foundation of concepts such as "nation", "culture", "trans-national", "American" (and its derivative terms), as well as "identity". In a second sense, it is "critical" because, when evaluating those concepts, Herlihy-Mera shows their limitations – their *negative* character, both socially and academically. So, it is "critical" (third sense) because, in making this analysis and formulating this evaluation, he aims to generate or open a critical break the discipline of American Studies – to separate it from the Transnational and national traditions. (This is appropriate, as, in Greek, "crisis" means "separate".) The book aims to rupture the limiting parameters and concepts of the status quo, exhausting them to the degree that a new stage of engagement may arise; that is, a proposal of new inquiry parameters and new interrogative concepts (like "Age").

The book, therefore, moves or has proposals in two different areas: the epistemological / methodological and the ontological. For Herlihy-Mera, American Studies (even when oriented towards a transnational duality), as a knowledge discipline, as a medium or domain of knowledge (epistemological aspect), are unreliable because they are based on a reality that, in effect, does not exist in the ways critics imagine: the concept of "nation" or "culture" as an explanatory reality of the individual (ontological aspect). Thus, that which does not exist (ontology) cannot be the basis of a knowledge discipline (epistemology).

American Studies or Transnational American Studies are based on the assertion that "America" is stable and unified, and that – says the author – does not occur in the ways prescribed by critics (page 6). The "US political body" as an entity has been constructed through diverse means (political, economic, literary, artistic, etc.) that force or "violate" reality (p. 2). Similarly, as Herlihy-Mera's dialogue with studies in psychology reveal, personal and cultural identity lack the stability necessary to maintain the critical grammars common in American Studies (pp. 9-10). In this way, Herlihy-Mera's book poses many challenges for the transnational base and for scholars who work use those concepts in research (p. 8). As the author pithily makes clear, "When the circumstantial nature of identity and affiliation occupies a more central position in critical interpretation, concepts like patriotism, (trans) nationality and cultural identity in general lose traction" (p.160).

After American Studies is an achievement. The post-national and postcultural stances represent new ground that is yet unresolved in American Studies and in the Transnational Turn; indeed, the book aims to reframe the fundamental core on which the discipline (American Studies) exists, and raises many questions that the American Studies establishment – including scholars like Janet Radway, Winfried Fluck, Rita Felski, Wai Chee Dimmock, and Donald Pease, among others – have yet to consider. As the author states: "It is time to unplug American (and other areas) Studies from geographies, languages, citizenships, collectivities, cultures, and political molds, and their emancipations of already power" (p. 150).

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Obituary

François Delaporte (1941 – 2019)

Marlon Salomon[1]

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On the 28th of May, the French philosopher and historian of sciences, François Delaporte died in Amiens at the age of 78. He was an emeritus professor at the Université de Picardie Jules Verne (UPJV). His death is an irreparable loss to the philosophy and historiography of the sciences.

The initial trajectory of François Delaporte did not follow the traditional path of a philosopher in France. After completing his high school studies, he was accepted to the *École de Beaux-Arts* in Paris in the early 1960s with the intention of becoming an architect and following his father's, Edouard Delaporte, footsteps as an architect, painter and sculptor.

The 1960s marked a profound philosophical renewal and innovation that would predominate French intellectual life. Authors like Claude Lévi-Strauss (*La pensée sauvage*, 1962), Louis Althusser (*Pour Marx* and *Lire le capital*, 1965), Michel Foucault (*Naissance de la clinique*, 1963; *Les mots et les choses*, 1966), Jacques Lacan (*Écrits* 1966), Jacques Derrida (*La gramatologie*, 1967), Gilles Deleuze (*Différence et répétition*, 1968; *La logique du sens*, 1969), as well as others, radically transformed the image of thought and understanding. Philosophy ceased to be an exclusively academic affair and reached the general public via mass media, which had an enormous impact and repercussion on culture and knowledge.

After reading these works, Delaporte was intellectually excited and influenced by this philosophical environment. He immediately decided to leave the *École de Beaux-Arts* and enroll in a philosophy course; however, he did not turn his attention to Marxism – as was prevalent at that time. Later in 1966, he enrolled in the philosophy program at the Sorbonne to further his studies in the history and philosophy of sciences. The Sorbonne University housed the *Institut d'Histoire des Sciences et Techniques* (IHST), which was directed by Georges Canguilhem since 1955. The IHST was created in 1932 by Abel Rey, a professor of history and philosophy of science at the Sorbonne. Rey directed the IHST until Gaston Bachelard replaced him in 1937. This Institute was essential for the institutionalization and renewal of the history of science in Europe. Generations of historians and epistemologists received their training and formation there, where its institutional and intellectual approach was a decisive feature and strongly focused on philosophy. The history of science in France at that time was institutionalized as a philosophical discipline, and this would not be

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indifferent as to how researchers like François Delaporte thought of this history. From 1966, Delaporte began to regularly attend Canguilhem's courses, and soon after in May of 1968, he began his master's studies under his professor's guidance. Two years later, he presented his master's dissertation, on issues surrounding the notion of vegetality in the eighteenth century.

Delaporte then started to work on a doctoral thesis (*troisième cycle*). Georges Canguilhem, however, could no longer advise him, since he would retire in 1971, so Canguilhem asked Michel Foucault, who used to attend the *Institute* and was elected at the end of 1969 to be the chair of the History of Systems of Thought at the *Collège de France*. Canguilhem had not only been Foucault's teacher, but had also advised his doctoral thesis on the history of madness in the Classical Age. At the time, Foucault was interested in the theme of sexuality, and Delaporte's research project proposal on the history on the concepts of vegetal sexuality pleased him – if I am not mistaken, this was the only thesis Foucault ever advised.

Early in 1976, Delaporte defended his thesis entitled *Les questions de la végétalité au XVIIIe siècle*. There was a noticeable shift concerning the original project. Instead of a history of the notion of plant sexuality, it became a study of "the historicity of a knowledge whose object is the very nature of the vegetable" and an analysis of "the practices" through which the objects of knowledge "are elaborated according to precise rules" (Delaporte 1979, 205). The emergence of a "problematic" around "vegetable issues" is of the utmost importance because, as we know, before Lamarck, there was no definite criterion for indisputably distinguishing animals and plants (Delaporte 1977, 49-59). It is not, however, in the Classical Age that one should locate the birth of plant physiology belonging to nineteenth century biology. At the same time, it is a little bit surprising that the Classical Age, often described as the "period of representation", based mainly on the taxonomic model derived from botany, finds in the case studied by Delaporte a great inversion. The study of the prehistory of plant physiology showed that knowledge of the animal provided the models of intelligibility of vegetable knowledge. In 1979, Delaporte published *Le second règne de la nature.* The title of the book was suggested by Foucault himself.

After defending his doctoral thesis in the "troisième cycle", Delaporte participated in Michel Foucault's seminars at the *Collège de France* from 1977 to 1979. At that moment, he decided to write a thesis of doctorate of state [*doctorat d'etat*]. He wanted to move away from the history of biology, and spend some time researching something related to the history of medicine. Foucault advised him and suggested at least three possibilities of research that included a study which became the subject of his analysis, the cholera epidemic of 1832 in Paris (Salomon 2012, 248-262). Foucault again agreed to advise him. Delaporte resumed, to a certain extent, the study of *Naissance de la clinique* at the place where Foucault had left it.

From 1971 to 1979, Delaporte worked as a technical collaborator of the *Centre National de Recherche Scientifique* (CNRS). During the academic years of 1980-1981, he worked as a guest researcher at the Department of History of Science at Harvard University with a grant from the Arthur Sachs Foundation. At Harvard, Delaporte was associated with Barbara G. Rosenkrantz and Everett Mendelsohn. It was at this institution that he was able to advance his project on the cholera outbreak of 1832. It was not just a matter of "restoring" the stages of history to a precise epidemic outbreak. The purpose of his study was to research this phenomenon from the medical practices mobilized during the epidemic outbreak and to understand how the working classes and medical theories were put to the test by the events of 1832. This episode was a decisive event that radically transformed the history of medicine.

Thanks to the use of registration methods and statistical notation, the "analysis of the conditions of existence" of the population became the "central problem" (Delaporte 1990, 177). Within the history of this epidemic emerged the theme of society's medicalization and the normalization of the popular classes. "The population and the environment were then judged according to certain standards of life and health" (Delaporte 1990, 177). Delaporte describes this process as the constitution of biopolitics, a political medicine, and a government of the people and their first medical dispositifs (Delaporte 1990, 65). At the beginning of 1984, the first version of his *doctorat d'etat* thesis was ready. The doctorate of state was, however, finished in France that year, so this work moved away from its original proposal. Foucault, who died in June of that year, still had the opportunity to read it. In 1986, it would be published in English under the title, *Disease and civilization: The cholera in Paris, in 1832*, with a preface by Paul Rabinow.

In 1982, Delaporte went to Mexico where he remained until 1989 as a visiting professor at the Institute of Historical Research at the National Autonomous University of Mexico (UNAM). The years he spent in Latin America led him to reflect seriously on the need to constitute singular objects of research in this new field of work. Latin American medical thinking was confronted with questions and problems of orders different from that of Europe. It was necessary to realize the uniqueness of this history. Instead of merely studying the spread of bacteriology outside Europe or dealing with general public health issues in different Latin American countries, Delaporte looked for singular events, "disconcerting stories" (Delaporte 1999, 183), unprecedented encounters of medical thinking with problems that marked and deeply reconfigured the history of medicine. For Delaporte, the history of medicine is always the repetition of difference. Hence the importance, in his works, and their use of the archaeological and epistemological analyses (and their transformations) of the fields of knowledge. The image of medicine that emerges from the Delaportian historiography is not homogeneous, uniform, or standardized, but plural, multiform, and surprising. For Delaporte, an archaeological and epistemological analysis inevitably provides a greater complexity of the history of medicine.

Published in 1989, *Histoire de la fièvre jaune: Naissance de la médecine tropicale* was the first result of this effort. A new form of knowledge and medicine was born from the moment the vectors became the object of knowledge, and its role in the transmission of certain diseases were defined. From then on, new disciplines could be configured, such as in experimental parasitology and medical entomology.[2] Through a series of unprecedented procedures put into action, the very definition and scope of epidemiology had radically been transformed. However, it was not a matter of saying that through the revelation of a complex set of interactions between microorganisms, hosts, vectors, the environment, and man, the invisible had finally become visible. The birth of tropical medicine implies a transformation of the very field of visibility of medical thinking. It would not be exaggerated at last to say that Delaporte founded in this book, what we might call retrospectively, a global history of medicine. Only an accurate historiographical perspective could reconstitute and establish a set of relations not admitted by his contemporaries and ignored by medical historians among research carried out at one point in China, Cuba, and India. In 1990, *Histoire de la fièvre jaune* was awarded with the Prix Medec for its contribution to the history of medicine. In 2013, Gérard Jorland defined this work as one of the two most essential books on the history of medicine in the last 50 years.

Ten years later, in 1999, Delaporte published *La maladie de Chagas: Histoire d'un fléau continental*. Again, it was "the history of a meeting between Brazilian medical thinking and an insect" (Delaporte 1999, 17). It was no longer Central America, but South America, a history of a series of medical research studies being done in Brazil and Argentina. From the history of an epistemological problem: if the Brazilian doctor Carlos Chagas had even discovered the "disease" that bears his name, why did it take almost three decades for it to become a "continental scourge"? In order to deal with this problem, Delaporte describes the constitution of an episteme from 1909: definition of an object, formation of a concept, and elaboration of a theory. With the work of the Argentinian physician Cecílio Romaña, from the

[2] On the birth of medical entomology, see (Delaporte 2009, 101-131).

1930s onwards, there was an epistemological transformation in this field of knowledge, that is, a profound epistemic reconfiguration of what had previously been understood as Chagas' disease. A transformation of the object of medical knowledge makes it possible to understand this time span between Chagas and Romaña. His effort in *La Maladie de Chagas* was precisely to reconstitute the historicity of this object. In this book, perhaps more than in any other, Delaporte explains his way of conceiving the history of medicine. The object of the history of science, he affirms, "is the never foreordained historicity of what men do in order to be able to speak about things" (Delaporte 1999, 20). It is a history of practices that make certain types of discourse possible. Hence, his refusal to accept as "data" the objects of the history of the sciences. Some of his critics did not understand the kind of historical thinking that was at stake here.[3]

In 1989, Delaporte returned to France intending to establish himself institutionally. Until 1993, he worked on several specific projects through temporary contracts. He was a guest researcher at *Institut National de la Santé et de la Recherche Médicale* (INSERM) and the Natural History Museum in Paris as well as a fellow of the National Center of Letters and the Medical Research Foundation. He also worked at the *École des Hautes Études en Sciences Sociales* (EHESS) as *chargé de conférences*. Through a project funded by the *Association Française Contre les Myopathies* (AFM), Delaporte began to research the history of the knowledge of muscular affections. In 1998, he co-authored the *Histoire des myopathies* with Patrice Pinell. In 1995, Delaporte fulfilled a publisher's request to publish a short book entitled: *Les épidémies,* after the *Cité des Sciences et de l'Industrie* conference on the history of epidemics in Paris. The book is a history of the "attitudes towards collective pathological phenomena" (Delaporte 1995, 8), from the Renaissance to the modern bacteriological and epidemiological revolution.

Delaporte never lost contact with his former teacher from the Sorbonne. Georges Canguilhem, who had already prefaced his book on vegetality in the eighteenth century, also wrote the preface for his *Histoire de la fièvre jaune*. During the years that Delaporte was outside of France, they regularly corresponded. On his return to France, Canguilhem entrusted him with the manuscripts from the period in which he wrote his thesis on *Le normal et le pathologique*. For editorial reasons, it was not possible to publish this book in French, which only came out in English in 1994 with a preface by Paul Rabinow and a critical bibliography organized by Camille Limoges (Canguilhem 1994).

The book on the history of myopathy was the occasion of a meeting concerning the French physician Duchenne de Boulogne's work on the clinical applications of electricity – and what such applications made possible – by exploiting electro-muscular properties. With the work of this physician with whom Charcot called the "master", it became possible, for the first time, to deal with the problem of laughter, as Stendhal wanted, "in anatomy style, not academy style" (Delaporte 2003, 1). Until the mid-nineteenth century, no one doubted that the problem of expression of emotions had an anatomical origin. However, facial myology had hardly advanced until then. It was necessary to develop a technique and a method capable of apprehending the structure and understanding the function of the facial muscles, which could not be observed when they were dissected by a scalp. This became only possible with Duchenne de Boulogne's *Eléctrisation localisée*.

However, the *Anatomie des passions* is not restricted to a description of the distinctiveness of the anatomical-physiology of the facial muscles. It is an archeology of the knowledge of expression, resulting from the emergence of a new style of anatomy in the mid-nineteenth century. A fundamentally superficial knowledge: the emotions happen as a surface effect that are produced by muscular stimulation. For Delaporte, therefore, it is not in Descartes that there is a more significant event in the study of the problem of this locus of passion, but in Duchenne de Boulogne. With him, the relationship between physiology and

[3] See (Delaporte 2009, 159-185).

psychology or between body and soul was radically altered. From Duchenne de Boulogne, there is no more emotion without skin, passion without a body. In the last quarter of the nineteenth century, the results of his research study would be presented at the *École Nationale de Beaux-Arts*.

More than three decades after leaving it, this nomadic historian of sciences returned to the *Beaux-Arts*, or more precisely to its archives, and then revolutionized the philosophical reflection of passion. In an erudite and eloquent way, *Anatomie des passions* articulated a transdisciplinary set of fields of study that were typically segregated in disciplines reserved for specialists: anthropology of body, art history, physics, medicine, photography, philosophy and aesthetics. This fruit of patient, meticulous, and gray work, was based upon original texts, many of which were largely unknown and neglected by the philosophers and historians of the passions, Delaporte recreated this field of study by showing the importance that figures – hitherto ignored such as Duchenne de Boulogne – had been apart of this history. In 2004, the *Société Française d'Histoire de la Médecine* awarded him with the book prize of the year.

In 1993, Delaporte became a professor at the Université de Picardie Jules Verne (UPJV). He lived with his family in Amiens, and was actively involved in university life. He was a member of the Board of Directors and the Council of the Doctoral School at UPJV. He was responsible for the research team in "epistemology, history of the biological and medical sciences" and later co-founded the "Center of History of Societies, Sciences, and Conflicts", which was responsible for putting together a transdisciplinary team of historians, historians of sciences, physicians, and philosophers. Even after his retirement in 2010, when he became professor emeritus at UPJV, he remained active and worked on many projects. Of all the projects and meetings that were born there, I would like to highlight one that has notably marked his trajectory of work in the last decade and a half, his meeting with Bernard Devauchelle.

At the end of November 2005, the surgeon and professor at the UPVJ – University Hospital Bernard Devauchelle led, in Amiens, the team that conducted the first face transplant in the world. Certain ethics professors soon after attacked the need for this surgical procedure, and considered it irresponsible from the medical point of view as well as questionable from the moral perspective. The media widely reported this transplant at that time. In March 2006, Delaporte published an article that applied the philosophy and historiography of medicine to confront the criticisms raised by those who spoke in the name of morality (Delaporte 2006, 28).[4] The repercussion of his response was significant in the public debate. Bernard Devauchelle did not fail to thank him publicly for what he called "the most beautiful response to criticism that could be formulated by the different media" against the first transplant of the face of history.[5] The example of this meeting between the two teachers in Amiens on the frontiers of knowledge – Devauchelle participated, years before, in the colloquiums that Delaporte organized on the history and philosophy of medicine[6] – seems interesting because it brought together on the same front, the leading research in medicine and the history of medicine, medical knowledge, in the present, taking a step towards the unknown and defying its own limits, and the knowledge of the past of medicine understood as the history of an adventure, that is, of a *chéminement* toward a new realm of understanding with unpredictable risks. Here we can certainly observe the vitality and timeliness of an epistemological and archaeological history of medicine. This is a type of meeting that seems

[4] Later, he would return to this problem in another work. See (Delaporte 2009, 77-102).

[5] See: "Vivre avec un visage d'un autre". *Identités. 8e printemps des sciences humaines et sociales*. Université de Lille, 11-31 mars 2016. https://live3.univ-lille3.fr/video-recherche/vivre-avec-le-visage-dun-autre.html

[6] In 2000, "The enigmas of the face", and in 2004, "The unthinkable and the unthinking".

to characterize the work of this nomadic historian of sciences, of this *epistemigrant* of knowledge and wisdom.

Delaporte and Devauchelle organized several transdisciplinary colloquiums around issues that approached medicine and history of medicine, which they turned into a book in the years that followed. In 2010, they presented *La fabrique du* visage: *de la physiognomonie antique à la première greffe* (Delaporte and others 2010). In 2015, *Transplanter: Une approche transdisciplinaire: art, médecine, histoire et biologie* (Delaporte and Others 2015). These books bear witness to the vitality of the Delaportian approach I mentioned above. It allows, for example, to inscribe the disconcerting novelty of Devauchelle's surgical gesture in history, that of the "factory of the face", "from Duchenne de Boulogne to Devauchelle d'Amiens" (Delaporte, Fournier 2010, 8).

It should be worth mentioning here that there were two other collective projects in which Delaporte participated. He was one of the editors, in 2004, of the *Dictionnaire de la pensée médicale*, directed by Dominique Lecourt. This reference book for the history and philosophy of medicine brought together more than 200 authors of diverse nationalities contributing hundreds of entries. Delaporte himself personally wrote eighteen articles for this dictionary. More recently, in 2015, he was responsible for the critical edition of *Naissance de la clinique: Une archéologie du regard médical*, for the first volume of Michel Foucault's *Oeuvres* published by Bibliothèque de la Pléiade.

Delaporte also published two books that gathered a sparse set of texts published over the years. In 2002, *Filosofía de los acontecimientos – Investigaciones históricas: biología, medicina, epistemología* was published in Colombia with a preface by Alberto Castrillón Aldana and complied texts published between 1977 and 2000. In addition to the specific epistemological problems addressed in the texts, this book brought together a series of Delaporte texts on theoretical, historiographic and methodological questions related to the history and philosophy of science for the first time. Prefaced by Emmanuel Fournier, in 2009, Delaporte published *Figures de la médecine*, a book that gathered the result of an unprecedented set of investigations into the history of medicine (on the history of blood transfusion, rhinoplasty, birth of medical entomology and Robles disease), a combative text about the facial transplant, and a historiographical text in which he challenged criticism of his *La maladie de Chagas*.

Delaporte worked on several other projects, such a history of organ transplants and on a history of artificial fertilization in collaboration with his dear wife, Cecília Delaporte (Delaporte, F.; Delaporte, C. 2004, 481-488). For more than two decades, along with all the research and projects I mentioned above, Delaporte worked on a history of vivisection. The outline of this project most likely emerged at the time of his research on the history of knowledge of expression. It was not a history of animal experimentation, from the Renaissance to the eighteenth century, and the discoveries that were made possible by it. His objective was to understand the reasons that transformed vivisection, in the eighteenth century, into a philosophical, political, and epistemological problem.[7] The history of a "big division" in Western culture. From Vesalius at the end of the seventeenth century, the vivisectionist practice developed unnoticed and without posing any problem. This changed radically in the next century. "In the eighteenth century, the will to end vivisection is the expression of an intolerableness within Western societies: the torture of the condemned generates a problem" (Delaporte 2015, 1). As always in Delaporte, it was a question of a problem: "Why we need to wait until the eighteenth century for philosophers, not the less important ones, to start defending the animals?" (Delaporte 2015, 3).

At the end of 2017, Delaporte delivered two conferences in Brazil related to this investigation. The first of these was entitled "The Anthropology of Vesalius" and the second,

[7] Delaporte presented on several occasions the partial results of this investigation. See, for example, (Delaporte 2015, 1-30).

"The Questions of Experimentation in the Classical Age". At the beginning of this second lecture, he joked – as he used to joke – that the title chosen for his presentation was too academic and that the book he was working on would have a more agreeable title: "History of Vivisection in the Classical Age: Essay on the threshold of intolerances".[8] There is not solely a history of man's attitudes towards animals, but also the relations between men and beasts and, consequently, of man's relationship to himself. A history of the invention of sensitivity before animals. At that time, Delaporte said he would need one to two years to complete his book. Unfortunately, death took him before he could complete it.

In addition to the books and projects I mentioned above, François Delaporte has written hundreds of articles and book chapters. He was a member of the French Committee on the History and Philosophy of Sciences, and a corresponding member of the International Academy of History of Sciences. His books and works have been translated and published in several countries. He has been a visiting professor at numerous universities around the world.

He was a tireless, extremely disciplined worker. His workspace was in the mansard roof of his house, which he had converted into an office. Bookshelves took up most of the space on the walls with numerous books and folders neatly arranged and sorted according to the themes of his research topics. Except for one wall, where one could read Jacques Prévert: "Mangez sur l'herbe / Dépêchez-vous / Un jour ou l'autre / l'herbe mangera sur vous" (Eat on the grass / hurry up / One day or the other / grass will eat on you). In the middle of the office, there was a large drafting table, in which he worked as an architect on his books. From the window of the mansard roof, there is a little back garden of the house, where one could see the beautiful city of Amiens, and its main historic buildings. So as not to get away from work, he slept right there, close to the ideas and texts that he worked on day after day. He never left his ideas and writings, they always accompanied him. Delaporte worked seven days a week. His intellectual journey began at 6 a.m. in the morning and lasted until noon. He would then take a "pause" from work and walk for an hour in the *Parc de la Hotoie*. However, he kept working. He carried a notebook with him to record the ideas that came to him during his walk.[9] He did not doubt the importance of body movement for getting ideas flowing. In this way, he was a Nietzschean. In the afternoon, he would resume work until dinnertime. A regulated and disciplined life was, for him, a determinant of intellectual work. Deleuze said that a man who works hard lives in absolute solitude. Not sad loneliness, but a solitude populated with ideas, concepts, stories, problems, epistemic adventures. "A multiple solitude, creative" (Deleuze 1992, 51). In a radio documentary produced by France Culture, Delaporte was rightly presented as an "ascetic" leading a "monastic life", totally devoted to intellectual work. He was not a simple "teacher" of philosophy and history of the sciences. His life was the philosophy and history of science.

[8] In November 2017, François Delaporte gave a series of lectures for the Graduate Program in History at the Federal University of Goiás (UFG) in Brazil. His first lecture was entitled "Anthropology of Vesalius", the second, "The Questions of Experimentation in the Classical Age", the third, "Georges Canguilhem and the History of Sciences", and the last "A History of the Philosophical Notion of Being in the true [*être dans le vrai*]". The last two conferences took place in the framework of a colloquium on Georges Canguilhem. All of these conferences – except for the latter – are available on YouTube in Spanish: https://youtu.be/oBIzncJgVC4.

[9] See: "François Delaporte: vie monastique, pensée en mouvement". *France Culture,* L'atelier de la création, December 19, 2013. https://www.franceculture.fr/emissions/latelier-de-la-creation-14-15/francois-delaporte-vie-monastique-pensee-en-mouvement

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