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Olga Ladyzhenskaya was on the Fields Medal shortlist in 1958.

The Fields Medal should return to its roots

Forgotten records of mathematics' best-known prize hold lessons for the future of the discipline, argues historian **Michael Barany**.

Like Olympic medals and World Cup trophies, the best-known prizes in mathematics come around only every four years. Already, maths departments around the world are buzzing with speculation: 2018 is a Fields Medal year.

While looking forward to this year's announcement, I've been looking backwards with an even keener interest. In long-overlooked archives, I've found details of turning points in the medal's past that, in my view, hold lessons for those deliberating whom to recognize in August at the 2018 International Congress of Mathematicians in Rio de Janeiro in Brazil, and beyond.

Since the late 1960s, the Fields Medal has been popularly compared to the Nobel prize, which has no category for mathematics[1]. In fact, the two are very different in their procedures, criteria, remuneration and much else. Notably, the Nobel is typically given to senior figures, often decades after the contribution being honoured. By contrast, Fields medallists are at an age at which, in most sciences, a promising career would just be taking off.

This idea of giving a top prize to rising stars who — by brilliance, luck and circumstance — happen to have made a major mark when relatively young is an accident of history. It is not a reflection of any special connection between maths and youth — a myth unsupported by the data[2,3]. As some mathematicians have long recognized[4], this accident has been to mathematics' detriment. It reinforces biases within the discipline and in the public's attitudes about mathematicians' work, career pathways and intellectual and social values. All 56 winners so far have been phenomenal mathematicians, but such biases have contributed to 55 of them being male, most being from the United States and Europe and most working on a collection of research topics that are arguably unrepresentative of the discipline as a whole.

When it began in the 1930s, the Fields Medal had very different goals. It was rooted more in smoothing over international conflict than in celebrating outstanding scholars. In fact, early committees deliberately avoided trying to identify the best young mathematicians and sought to promote relatively unrecognized individuals. As I demonstrate here, they used the medal to shape their discipline's future, not just to judge its past and present.

As the mathematics profession grew and spread, the number of mathematicians and the variety of their settings made it harder to agree on who met the vague standard of being promising, but not a star. In 1966, the Fields Medal committee opted for the current compromise of considering all mathematicians under the age of 40. Instead of celebrity being a disqualification, it became almost a prerequisite.

I think that the Fields Medal should return to its roots. Advanced mathematics shapes our world in more ways than ever, the discipline is larger and more diverse, and its demographic issues and institutional challenges are more urgent. The Fields Medal plays a big part in defining what and who matters in mathematics.

The committee should leverage this role by awarding medals on the basis of what mathematics can and should be, not just what happens to rise fastest and shine brightest under entrenched norms and structures. By challenging themselves to ask every four years which unrecognized mathematics and mathematicians deserve a spotlight, the prizegivers could assume a more active responsibility for their discipline's future.

BORN OF CONFLICT

The Fields Medal emerged from a time of deep conflict in international mathematics that shaped the conceptions of its purpose. Its chief proponent was John Charles Fields, a Canadian mathematician who spent his early career in a *fin de siècle* European mathematical community that was just beginning to conceive of the field as an international endeavour[5].

The first International Congress of Mathematicians (ICM) took place in 1897 in Zurich, Switzerland, followed by ICMs in Paris in 1900, Heidelberg in Germany in 1904, Rome in 1908 and Cambridge, UK, in 1912. The First World War derailed plans for a 1916 ICM in Stockholm, and threw mathematicians into turmoil.

When the dust settled, aggrieved researchers from France and Belgium took the reins and insisted that Germans and their wartime allies had no part in new international endeavours, congresses or otherwise. They planned the first postwar meeting for 1920 in Strasbourg, a city just repatriated to France after half a century of German rule.

In Strasbourg, the US delegation won the right to host the next ICM, but when its members returned home to start fundraising, they found that the rule of German exclusion dissuaded many potential supporters. Fields took the chance to bring the ICM to Canada instead. In terms of international participation, the 1924 Toronto congress was disastrous, but it finished with a modest financial surplus. The idea for an international medal emerged in the organizers' discussions, years later, over what to do with these leftover funds.

Fields forced the issue from his deathbed in 1932, endowing two medals to be awarded at each ICM. The 1932 ICM in Zurich appointed a committee to select the 1936 medallists, but left no instructions as to how the group should proceed. Instead, early committees were guided by a memorandum that Fields wrote shortly before his death, titled 'International Medals for Outstanding Discoveries in Mathematics'.

Most of the memorandum is procedural: how to handle the funds, appoint a committee, communicate its decision, design the medal and so on. In fact, Fields wrote, the committee "should be left as free as possible" to decide winners. To minimize national rivalry, Fields stipulated that the medal should not be named after any person or place, and never intended for it to be named after himself. His most famous instruction, later used to justify an age limit, was that the awards should be both "in recognition of work already done" and "an encouragement for further achievement". But in context, this instruction had a different purpose: "to avoid invidious comparisons" among factious national groups over who deserved to win.

> ***"Fields stipulated that the medal should not be named after any person or place."***

The first medals were awarded in 1936, to mathematicians Lars Ahlfors from Finland and Jesse Douglas from the United States. The Second World War delayed the next medals until 1950. They have been given every four years since.

BLOOD AND TEARS

The Fields Medal selection process is supposed to be secret, but mathematicians are human. They gossip and, luckily for historians, occasionally neglect to guard confidential documents. Especially for the early years of the Fields Medal, before the International Mathematical Union became more formally involved in the process, such ephemera may well be the only extant records.

One of the 1936 medallists, Ahlfors, served on the committee to select the 1950 winners. His copy of the committee's correspondence made its way into a mass of documents connected with the 1950 ICM, largely hosted by Ahlfors's department at Harvard University in Cambridge, Massachusetts; these are now in the university's archives.

The 1950 Fields Medal committee had broad international membership. Its chair, Harald Bohr (younger brother of the physicist Niels), was based in Denmark. Other members hailed from Cambridge, UK, Princeton in New Jersey, Paris, Warsaw and Bombay. They communicated mostly through letters sent to Bohr, who summarized the key points in letters he sent back. The committee conducted most of these exchanges in the second half of 1949, agreeing on the two winners that December.

The letters suggest that Bohr entered the process with a strong opinion about who should win one of the medals: the French mathematician Laurent Schwartz, who had blown Bohr away with an exciting new theory at a 1947 conference[6]. The Second World War meant that Schwartz's career had got off to an especially rocky start: he was Jewish and a Trotskyist, and spent part of the French Vichy regime in hiding using a false name. His long-awaited textbook had still not appeared by the end of 1949, and there were few major new results to show.

Bohr saw in Schwartz a charismatic leader of mathematics who could offer new connections between pure and applied fields. Schwartz's theory did not have quite the revolutionary effects Bohr predicted, but, by promoting it with a Fields Medal, Bohr made a decisive intervention oriented towards his discipline's future.

The best way to ensure that Schwartz won, Bohr determined, was to ally with Marston Morse of the Institute for Advanced Study in Princeton, who in turn was promoting his Norwegian colleague, Atle Selberg. The path to convincing the rest of the committee was not straightforward, and their debates reveal a great deal about how the members thought about the Fields Medal.

Committee members started talking about criteria such as age and fields of study, even before suggesting nominees. Most thought that focusing on specific branches of mathematics was inadvisable. They entertained a range of potential age considerations, from an upper limit of 30 to a general principle that nominees should have made their mark in mathematics some time since the previous ICM in 1936. Bohr cryptically suggested that a cut-off of 42 "would be a rather natural limit of age".

By the time the first set of nominees was in, Bohr's cut-off seemed a lot less arbitrary. It became clear that the leading threat to Bohr's designs for Schwartz was another French mathematician, André Weil, who turned 43 in May 1949. Everyone, Bohr and Morse included, agreed that Weil was the more accomplished mathematician. But Bohr used the question of age to try to ensure that he didn't win.

As chair, Bohr had some control over the narrative, frequently alluding to members' views that "young" mathematicians should be favoured while framing Schwartz as the prime example of youth. He asserted that Weil was already "too generally recognized" and drew attention to Ahlfors's contention that to give a medal to Weil would be "maybe even disastrous" because "it would make the

impression that the Committee has tried to designate the greatest mathematical genius."

Their primary objective was to avoid international conflict and invidious comparisons. If they could deny having tried to select the best, they couldn't be accused of having snubbed someone better.

But Weil wouldn't go away. Committee member Damodar Kosambi thought it would be "ridiculous" to deny him a medal — a comment Bohr gossiped about to a Danish colleague but did not share with the committee. Member William Hodge worried "whether we might be shirking our duty" if Weil did not win. Even Ahlfors argued that they should expand the award to four recipients so that they could include Weil. Bohr wrote again to his Danish confidant that "it will require blood and tears" to seal the deal for Schwartz and Selberg.

Bohr prevailed by cutting the debate short. He argued that Weil would open a floodgate to considering prominent older mathematicians, and asked for an up or down vote on the pair of Schwartz and Selberg. Finally, at the awards ceremony at the 1950 ICM, Bohr praised Schwartz for being recognized and eagerly followed by a younger generation of mathematicians — the very attributes he had used to exclude Weil.

FURTHER ENCOURAGEMENT

Another file from the Harvard archives shows that the 1950 deliberations reflected broader attitudes towards the medal, not just one zealous chair's tactics. Harvard mathematician Oscar Zariski kept a selection of letters from his service on the 1958 committee in his private collection.

Zariski's committee was chaired by mathematician Heinz Hopf of the Swiss Federal Institute of Technology in Zurich. Its first round of nominations produced 38 names. Friedrich Hirzebruch was the clear favourite, proposed by five of the committee members.

Hopf began by crossing off the list the two oldest nominees, Lars Gårding and Lipman Bers. His next move proved that it was not age per se that was the real disqualifying factor, but prior recognition: he ruled out Hirzebruch and one other who, having recently taken up professorships at prestigious institutions, "did not need further encouragement". Nobody on the committee seems to have batted an eyelid.

Of those remaining, the committee agreed that Alexander Grothendieck was the most talented, but few of his results were published and they considered him a shoo-in for 1962. John Nash, born in the same year as Grothendieck (1928), came third in the final ballot. Although the 1958 shortlist also included Olga Ladyzhenskaya and Harish-Chandra, it would take until 2014 for the Fields Medals to go to a woman (Maryam Mirzakhani) or a mathematician of Indian descent (Manjul Bhargava). Ultimately, the 1958 awards went to Klaus Roth and René Thom, both of whom the committee considered promising but not too accomplished — unlikely to provoke invidious comparisons.

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The nomination of French mathematician André Weil divided the 1950 Fields Medal committee.

A SWEEPING EXPEDIENT

By 1966, the adjudication of which young mathematicians were good but not too good had become testing. That year, committee chair Georges de Rham adopted a firm age limit of 40, the smallest round number that covered the ages of all the previous Fields recipients.

Suddenly, mathematicians who would previously have been considered too accomplished were eligible. Grothendieck, presumably ruled out as too well-known in 1962, was offered the medal in 1966, but boycotted its presentation for political reasons.

The 1966 cohort contained another politically active mathematician, Stephen Smale. He went to accept his medal in Moscow rather than testify before the US House Un-American Activities Committee about his activism against the Vietnam War. Colleagues' efforts to defend the move were repeated across major media outlets, and the 'Nobel prize of mathematics' moniker was born.

This coincidence — comparing the Fields Medal to a higher-profile prize at the same time that a rule change allowed the medallists to be much more advanced — had a lasting impact in mathematics and on the award's public image. It radically rewrote the medal's purpose, divorcing it from the original goal of international reconciliation and embracing precisely the kinds of judgement Fields thought would only reinforce rivalry.

Any method of singling out a handful of honorees from a vast discipline will have shortcomings and controversies. Social and structural circumstances affect who has the opportunity to advance in the discipline at all stages, from primary school to the professoriate. Selection committees themselves need to be diverse and attuned to the complex values and roles of mathematics in society.

But, however flawed the processes were before 1966, they forced a committee of elite mathematicians to think hard about their discipline's future. The committees used the medal as a redistributive tool, to give a boost to those who they felt did not already have every advantage but were doing important work nonetheless.

Our current understanding of the social impact of mathematics and of barriers to diversity within it is decidedly different to that of mathematicians in the mid-twentieth century. If committees today were given the same licence to define the award that early committees enjoyed, they could focus on mathematicians who have backgrounds and identities that are under-represented in the discipline's elite. They could promote areas of study on the basis of the good they do in the world, beyond just the difficult theorems they produce.

In my view, the medal's history is an invitation for mathematicians today to think creatively about the future, and about what they could say collectively with their most famous award. ■

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