Call for expressions of interest: Strengthening engineering research and training in Africa

A. Summary

There are significant gaps in advanced training and research in the applied sciences across the African continent, particularly in certain counties and regions (e.g., West and Central Africa) where science, technology, engineering mathematics (STEM) skills are often either lacking or not being effectively used to support socioeconomic development. The engineering disciplines, in particular, could benefit from closer links with public and private firms of all sizes to inform training and research.

Through a series of competitive calls, IDRC seeks to bridge the gap between the *supply* of research and training in applied STEM fields and the *demand* in terms of direct applications to socioeconomic development at the regional and national scales. This call for proposals challenges universities as well as a range of public and private stakeholders to propose novel ways of delivering quality and relevant training and research in engineering and applied science fields.

In particular, this call for expressions of interest targets applicants along two distinct streams:

    1) *Industrial research hubs: partnerships for a new applied research agenda*

This stream targets research-intensive universities and public or private firms (or associations, intermediaries, etc.) in West and Central Africa[1], who seek to develop or strengthen mutually beneficial research and training activities. Matching funds are required, either from the collaborating firms, the university itself or from other funding organizations.

2) ***Rethinking the engineering 'ecosystem': new pilots for building capacity in research and advanced training in engineering***
    This stream targets implementing organizations or consortia who aim to inform how national or regional engineering systems operate in sub-Saharan Africa[2], by piloting new research or training modules, building new knowledge of the engineering 'ecosystem' based on these pilots, and developing networks and partnerships that have the potential for scaling-up at a regional or national level. Applicants should have expertise in areas related to engineering research and training, and experience managing and administering funds for research and/or education.

B. Project description

Overall context

Applications of science and the availability of a skilled workforce have the potential to support the achievement of a range of development objectives, including those outlined in the 2030 Sustainable Development Goals (SDGs). STEM skills and research support a range of SDGs, from access to clean water to food security. Perhaps most importantly, SDG 9 focuses specifically on 'infrastructure, industrialization and innovation', where 'infrastructure provides the basic physical systems and structures essential to the operation of a society or enterprise'; 'industrialization drives economic growth, creates job opportunities and thereby reduces income poverty'; and 'innovation advances the technological capabilities of industrial sectors and prompts the development of new skills.' Furthermore, 'innovation and the creation of new and more sustainable industries are spurred by investments in research and development.'[3]

However, investments in STEM fields remain low, and there is evidence of a continued shortage of engineers and applied scientists on the continent, particularly in regions such as West and Central Africa. The African Capacity Building Foundation estimates that there are 35 engineers per one million people on the continent, compared with 168 in Brazil and 4,103 in the US, for example. There is a market and societal need for research-driven innovations to tackle problems associated with themes such as rapid urbanization and rural connectivity. While universities often bemoan the lack of private sector investment

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[1] Countries in this region include: Benin, Burkina Faso, Cameroon, Congo (Brazzaville), Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo. **IDRC reserves the right to exclude an institution or country at any point based on an assessment of various risk factors.**
[2] All countries in sub-Saharan Africa are eligible, except Sudan, South Sudan, CAR, Burundi, Chad, Eritrea, Mali, Somalia, Cabo Verde, Comoros, Seychelles, and Sao Tome and Principe. However, **IDRC reserves the right to exclude an institution or country at any point based on an assessment of various risk factors.**
[3] https://sustainabledevelopment.un.org/sdg9

and engagement, companies note the distribution and skills of graduates don't meet current development needs. There is also a need for those with strong technical skills to develop as leaders in entrepreneurship and project management. This situation contributes to relatively high unemployment among graduates. Another important factor is that university professors themselves rarely have industry experience. This has tended to be less of a focus than increasing the number of professors with PhDs, another challenge which remains important to address.

Overall, a disproportionate number of new technologies are 'imported'. African products tend to be of low added value, and highly-skilled workers in the private sector are often trained abroad. Within the research realm, while Africa's share of global output of papers is increasing significantly in certain areas such as health, the same is not true for engineering and applied science. This is linked to the fact that, in many countries, there is very little funding – national or international – for this type of research. Furthermore, research institutions in sub-Saharan Africa have difficulty attracting and retaining highly-skilled staff and students; many researchers spend only brief periods in a given African institution.

A lack of financial resources is certainly an obstacle to universities playing a leading role, but perhaps more significant are the many structural barriers that pertain to the overall research and training system in applied science and, in particular, engineering. For example, these barriers speak to the role of accreditation bodies in supporting new curricula, the role of national research funding systems, the geographic distribution of R&D activities of multinational companies operating in Africa, the role of professional engineering organizations in supporting the development of the field, and the lack of gender parity in applied science and engineering. With rapidly increasing demand for training in these fields, universities, governments and firms would benefit from additional tools, expertise and resources. Indeed, many universities are experiencing 'over-enrolment' to the detriment of the quality of their research and training activities.

The approach

As a world leader in providing funds, advice, and training to support the development of leading thinkers and research-based solutions in the Global South, IDRC is uniquely positioned to engage in this field. There is an opportunity for IDRC's Foundations for Innovation program to build on its traditional areas of expertise in funding leading-edge research and supporting individual and organizational capacity-building (e.g., support for advanced mathematics training and support for granting councils in Africa). This programming can be viewed as part of a broader spectrum of national and international initiatives that exist to strengthen engineering and applied science in Africa. It aims to build on or complement, not duplicate, existing programming in the region, which ranges from vocational training programs, to global fora for engagement (e.g., the World Federation of Engineering Organizations and the Global Engineering Deans Council), to support for engineering organizations for capacity development (e.g., Global Challenges Research Fund Africa Catalyst programme), to direct support for advanced STEM training and research (e.g., the World Bank's African Centres of Excellence programmes). This initial call for proposals is the fruit of six months of consultation and research with engineering leaders in Africa, Canada and beyond.

There is no "one-size-fits-all" approach, so making applied science and engineering more relevant to regional and national development needs means recognizing different educational structures, different national policy contexts and different priorities. There are currently a range of often informal ways that universities and firms already work together in the region, including through student internships and short-term consultancies. There are also many different modalities for university and, in particular, graduate education in Africa, with marked differences between predominantly Anglophone and Francophone countries. Finally, the context of firms with an interest in R&D is broad, from large multinationals to emerging SMEs or entrepreneurs.

Main objectives

Overall, this initiative seeks to increase the number of highly-skilled and employable engineers trained, and the number of new innovations produced, in sub-Saharan Africa, to support inclusive national regional economic development. To do this, we aim to support:

- World-class applied STEM research in African universities, which can serve as a catalyst for increasing national and international private sector R&D investment, as well as support pressing development issues in the region.
- Advanced training of engineering and applied science students with the knowledge, skills and networks that enable them to effectively find employment in the local labour market, paying particular attention to persistent structural barriers related to issues such as gender equality.
- Strengthened national innovation systems to sustain national and regional economic development, through strengthened linkages between universities and industry, and by focusing on new solutions to connect *supply* (research outputs and highly-qualified personnel) and *demand* (public and private sector development and utilization of technologies) in engineering and applied science fields.

C. The opportunity

This first call targets two different streams as a means to support some of the overall objectives of the initiative, focusing on somewhat distinct parts of the overall ecosystem of engineering and applied science research and training system at a national level (see Figure 1). Both these streams aim to fund specific projects, while contributing to broader system change. While Stream 1 takes a broad view of applied STEM fields, but focuses only on market-driven research, Stream 2 focuses on the engineering profession but leaves flexibility for improving how it operates in a national or regional context. Depending on the geographies and the themes of the selected proposals, there may be opportunities to connect projects in the two streams. Future calls and funding opportunities may build on or complement these two streams.
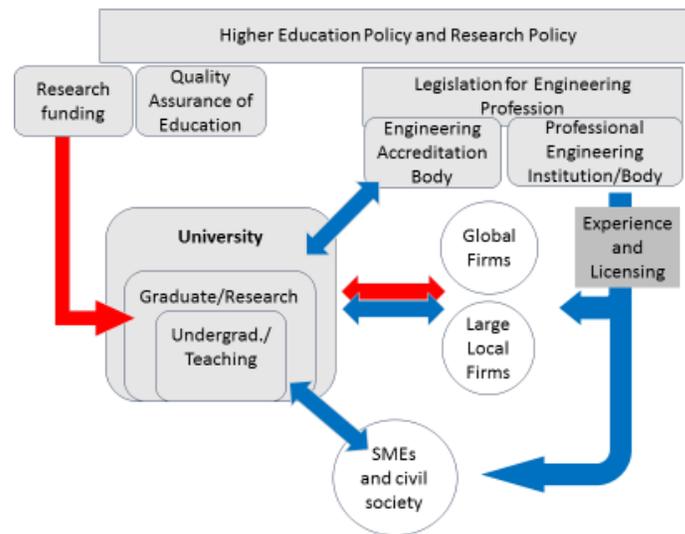
Figure 1. Rough schematic of a national engineering ecosystem. Red arrows indicate linkages targeted through Stream 1, which focuses on research funding and links to large firms. Blue arrows are for Stream 2, which focuses on SMEs, engineers' mobility, transfer of knowledge, innovative training modules, linkages between universities and professional and accreditation bodies, and other systemic challenges.

1. Industrial research hubs: partnerships for a new applied research agenda

Description:

There is a need to increase the involvement of large public or private firms in the national research and education system, across many countries in West and Central Africa. This project provides an opportunity for one or many organizations with a stake in the development of human capital and the definition of research agendas to engage with leading universities in the region. It can also be a means for universities to improve the relevance of their teaching and research, and for governments to support sectors of national priority. Through increased national and international visibility, the program enables universities, governments and firms to become global leaders in a given area of industrial R&D, and play a key role in supporting inclusive national and regional economic development.

Expected results:

- World-class R&D outputs (publications, patents, etc.) are produced and enable the university and industrial partner to be seen as leaders in the area;
- A significant number of women and men are trained as advanced undergraduate or graduate students in a field of national or regional importance, and are competitive in the labour market;
- Industrial activities undertaken by the private or public sector in the region benefit from research and training at universities;

- Long-term linkages and partnerships, beyond the duration of the project, are created or expanded through new or improved technology transfer mechanisms, internship programs and curricula.
- New opportunities and best practices for partnered research between universities and firms (public or private) inform future programming in this area by IDRC and other funders.

Project details:

- Up to **two projects will be supported, each receiving a maximum of CA $600,000 over four years** from IDRC.
- Parallel 'matching' contributions of a <u>minimum</u> of CA $100,000 (cash and/or in-kind) from the public or private sectors are required to support the project at the selected university. These contributions would most likely originate from the partner firm(s) (see below), but could also be drawn from other private or public bodies such as technology incubators, technology intermediaries, research councils, governmental ministries, or regional or international funding bodies. The research hub could bear the name of IDRC and the partnering organization, if desired.
- The research hub would be co-led by one or more principal investigators at the lead university, as well as by public or private firms with expertise in the area. The partner firm(s) would be expected to engage in the project throughout its duration through: student internships, equipment-sharing, staff exchanges, licensing and utilization of results, defining research projects.
- One university will be designated as the primary point of contact and administrator of funds. Other universities may also be involved as active participants and may receive funding through the main university.
- It is expected that the activities of the research hub would benefit faculty and students at all levels, and would contribute to improvement of curricula at the host university, particularly through new teaching modules (on topics such as product design or prototyping, among many others) of relevance to industrial applications.
- It is expected that funds would go towards the training of students, as well as research expenses, regional mobility, staff exchanges, and some salary funds or infrastructure funds where necessary. Cash and/or in-kind contributions mentioned above could go directly towards these activities. General guidelines for IDRC funded research can be found [here](#).
- Up to $100,000 of additional funding (over four years) could be spent at a Canadian university to support their direct participation in the project. This would have to be justified as being integral to the project's success and having significant added value, based on existing linkages with Canadian universities and/or firms.

Eligibility:

- The lead university (the applicant) must:
    - Have sufficient infrastructure or demonstrate plans to acquire infrastructure required for the research (in-kind support from firms could contribute to this)
    - Have research expertise and recognized advanced training programs in the fields of applied science, ideally at the Masters' or PhD level, and ideally involving some existing relationship with public or private firms in this field.
    - Be based in a country in West and Central Africa (see list of countries on page 1).

- o Identify between one and three researchers currently employed at the university as principal investigators (PIs). They should have expertise in this particular field and its applications to industry.
- Companies, associations, or technology intermediaries collaborating with the project must:
  - o Have demonstrated experience and/or an interest in developing new expertise in the field, and expect to maintain a strong regional presence so as to facilitate some degree of face-to-face collaboration.
  - o Have an interest in the utilisation of results and/or the hiring of graduates.
  - o Be committed to the highest standards of corporate social responsibility, including gender equity, environmental standards and, most importantly, the broad-based economic development of the country or region.

2. Rethinking the engineering 'ecosystem': new pilots for building capacity in research and advanced training in engineering

Description:

There is a need for a better understanding of engineering 'ecosystems' on a national and regional scale, and for innovative models to improve how they can support training and research for socioeconomic development. New approaches need to be articulated to help stakeholders involved in engineering research, education and beyond, work together to address common 'systemic' challenges. This includes, but is not limited to: inadequate access to small and medium enterprises to relevant research, a lack of exchange opportunities (for students and faculty) with firms, a lack of uptake of research into public and private sectors, inadequate engineering and licensure processes, a lack of advanced training modules relevant to national or regional development goals, etc. Building long-term capacity can be achieved by seeding projects for improving research and education linkages, by creating new regional and national networks, as well as by proposing innovative ways to move towards solutions at scale.

Expected results:

- Best practices and new models to inform national and regional engineering education and research systems, through original policy research and the establishment of a network of practitioners, experts and policymakers;
- Successful pilot projects that can be scaled up at a national and regional scale with the participation of new stakeholders and partners, and have the potential to address key development challenges;
- Increased capacity of universities to engage with SMEs and civil society organizations in support of development objectives, through research and training mechanisms.

Project details:

- Up to two projects, **worth up to CA $300,000 each over 3 years** will be awarded to an implementing organization or a consortium.
- It is expected that at least half of the funding will be devoted to implementing (e.g., through sub-grants) pilot initiatives related to research and advanced education. These individual initiatives will inform a better understanding of the engineering 'ecosystem', which can include the role(s) of professional bodies, granting agencies, accreditation organizations, technology intermediaries, universities, SMEs and/or large firms.
- These initiatives should engage universities, have an explicit advanced training and/or research component, and could include the following, among many other types of programming:
    o Small collaborative research projects (e.g., students working with SMEs, prizes targeting social benefits);
    o Faculty mobility (e.g., between universities and local firms), at a national, regional or sub-regional level;
    o New pedagogy and innovative training solutions targeting issues such as gender sensitivity, entrepreneurship or technical skills (e.g., data analytics) in high demand for global competitiveness.
- It is expected that remaining funds would be devoted to undertaking policy-oriented research or research synthesis, convening key stakeholders (e.g., through one or more workshops), providing training to universities to build capacity on the selected issue(s) (e.g., faculty mobility, technology transfer, entrepreneurship, gender sensitivity), and working towards scaling-up new capacity-building approaches. General guidelines for IDRC funded research can be found here.
- Engagement of national granting councils would be considered an asset, and could take various forms, including (but not limited to) direct financial contributions, assistance in program design, in-kind support, and regular exchange of knowledge and best practices.

Eligibility:

- The organization or consortium must have a strong presence, and well-developed networks, in sub-Saharan Africa, preferably with experience working directly in more than one country. It must engage with the institutions relevant to the proposed project (e.g., granting councils, accreditation organizations, companies, chambers of commerce, technology intermediaries, international engineering organizations).
- The organization or consortium must have expertise in fields such as engineering education, research policy, or higher education policy, with links to national or regional policymakers, as well as key engineering organizations.
- The organization or consortium must have extensive experience in administering funds, preferably on a competitive basis, for research and education.

D. Application and review process

1. **Expressions of interest**
   Referring to the descriptions of the streams and their requirements (see above), **a letter of 1000 words or less will be submitted to IDRC and clearly indicate, for both streams**:

- Which funding stream is of interest;
- How the applicant intends to approach the problem and what concrete results (e.g., specific targets) can be expected during the timeframe, as well as a brief outline of the methodology;
- Which individuals will lead the project, and which other organizations will be involved;
- How the applicant (individuals and organizations) are suitable to lead the project, as per the eligibility criteria.

Additional requirements for **stream 1**:
- The letter must be signed by the vice-chancellor, deputy vice-chancellor, (or equivalent) of the lead university;
- The letter must outline the university's readiness to lead on this project, in terms of existing research, training programs, and, if applicable, linkages to users or employers;
- An additional, short letter from the industrial partner, indicating support for the project, including intent to co-design the research agenda and accompany the project throughout and, as applicable, intent to secure funding to contribute.

Additional requirements for **stream 2**:
- The letter must explicitly: 1) articulate the systemic problem to be addressed, linked to national or regional development gaps, 2) provide evidence for this problem, and 3) articulate the proposed 'pilot' solution, including how (and with whom) it can be scaled up;
- The letter must provide some details on how funds might be allocated and managed by the lead organization, including where the work will be performed;
- If the project involves multiple organizations (e.g., as part of a consortium), the letter must provide some details about the nature of the proposed collaboration and the added value derived from it.

Expressions of interest meeting the basic eligibility criteria will be assessed based on the applicant's demonstration of a sound understanding of the issues, the feasibility of their proposed approach, and the suitability of the applicant to undertake the project.

2. **Full proposals**
- Following review of expressions of interest, successful applicants will be invited to submit full proposals (building on the expressions of interest), which will include detailed budgets, methodologies, CVs of applicants, and firm commitments from partners.
- The detailed requirements will be communicated to the prospective applicants at this stage, as well as the criteria for scoring applications.
- Full applications will be reviewed by an independent committee of experts, as well as by external technical advisors, as needed. Final decisions will be made by IDRC.

E. Timelines

August 14, 2017: Call for expressions of interest launched

September 24, 2017: Expressions of interest due

October 5, 2017: Successful applicants invited to submit full proposals.

December 10, 2017: Full proposals due

January 12, 2018: Successful candidates notified

February 28, 2018: Some grant agreements finalized and funds allocated[4]

Please note that timelines may be subject to change.

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[4] It is expected that some awards may not be allocated until April 2018, depending on the size and number of successful proposals.