

Objectives and Plans
OF AN
INSTITUTE OF SCIENCE AND TECHNOLOGY
To be Established in Skolkovo

A Manifesto for a 21st Century University

2011

Introduction

In preparing these objectives and plans for the Institute of Science and Technology to be established in Skolkovo, outside of Moscow, we aim to enlist the interest, assistance and counsel of our friends and colleagues who are supporters of science, technology, engineering and innovation.

We believe that a university polarized around science and technology can have significant impact on an innovation system and eventually on society. In our increasingly knowledge-based society, it is imperative to discover new scientific principles and develop innovative technological approaches. Equally important is that these new discoveries in science and technology result in the creation of novel goods and services.

Science, technology, and the goods and services they generate directly stimulate the local economy, attracting scholars, technologists and other knowledge workers. The outcomes of science and technology – new knowledge, goods, and services – diffuse at a regional, and eventually international scale. This diffusion is especially **possible** in a nation with as rich intellectual and industrial tradition as that of the Russian Federation.

The direct outcomes of such a new Institute are discoveries, knowledge, and inventions, as well as skilled students and professionals who can act as agents of knowledge exchange. In an efficient innovation ecosystem, these resources will bring about the creation of novel goods and services. If individually competitive, these goods and services will improve the competitiveness of the national economy. They will also contribute to the improvement of the quality of life, health, and economic stability of the nation.

Of course, there are other important ways that an Institute of Science and Technology can impact society. Sometimes impact is broad and societal, such as in an improved understanding of climate or the spread of disease. Occasionally, it leads to fundamental understanding, such as in the evolution of the universe. These broader impacts that stem from a university are also important contributions.

We believe that, with the help of our partners and friends, it is possible to create a new university polarized around science and technology of high international quality. We have the opportunity to build this Institute on the rich scientific and technological tradition of the Russian Federation. We will not work alone, but with help from colleagues in Russian universities, the Russian Academy of Sciences, and Russian industry. We will incorporate approaches from partner universities around the world. Our founding partner is the Massachusetts Institute of Technology, whose assistance will be invaluable. MIT was itself partially modeled on the “Russian

School” of engineering education observed at the Moscow State Technical University, founded 31 years before MIT in 1830. Universities have always been international, and in this tradition, we will engage many other university and industrial partners from outside of the Russian Federation in creating a uniquely Russian 21st century institution, set in an international context.

The new institute will produce further benefits to the Russian Federation. It will expand the opportunities inside Russia for talented, research-oriented graduates and young scholars to pursue their dreams of being involved into cutting-edge research and collaborating with leading international scholars. This outcome will further the development of a critical mass of brilliant scientists and engineers who are internationally connected, based in Russia, and who would serve as role models for future Russian scholars.

Additionally, the new Institute will become a portal for exchange of ideas and individuals between the Russian Federation and the international community. Both the university and industrial sectors seek more intense interaction. The Institute also enables opportunities to foster collaboration with numerous leading Russian scholars who had previously left the Russian Federation, and who are seeking opportunities to build a stronger scientific, engineering, and economic base in Russia.

There is substantial evidence that, with concentrated effort, new universities can flourish within the worldwide academic community and impact the regional economy and society more broadly. Universities created in the last 60 years have risen to international prominence and contributed greatly to the diffusion of practical knowledge and innovative technologies. Among these are the National University of Singapore, the Indian Institutes of Technology, the Hong Kong University of Science and Technology, and many of the universities created in Europe in the 1960s and 1970s.

With the view of securing the great social, industrial, and educational benefits discussed above, it is proposed that we establish a comprehensive scientifically and technologically based institution. We are convinced we can do this at Skolkovo.

The Objectives of the Institute of Science and Technology

The mission of the Institute of Science and Technology is:

- To have educational, scholarly and economic impact in the Russian Federation and around the world,

- By educating leading graduate students and conducting research programs to address key challenges in science, technology, engineering, and innovation

- Using a fusion of exceptional talent in a new university at Skolkovo.

The first phrase of our mission refers to the three objectives of a modern university, the so-called Triple Helix – to have *impact* on the world’s body of knowledge through scholarship, to have *impact* on the world’s collective supply of talent through education, and to have *impact* on economic development through support of innovation and entrepreneurship. It is the interaction of these three strands that drives economic growth. The second phrase focuses the Institute of Science and Technology on graduate (Master’s and Ph.D. level) education, and on a scope of issues associated broadly with science, applied science, engineering science, technology, and innovation. The third phrase reminds us that universities are collectives of talented and knowledgeable people, working together on common goals. Our plans call for building a community of 200 professors, 300 postdoctoral associates and 1,200 students at Skolkovo by the end of the decade.

We envision that the Institute of Science and Technology, a private and independent institution, will be a central element of the innovation ecosystem of Skolkovo, attracting, educating and engaging the best talent from within the Russian Federation and overseas, interacting closely with research laboratories, ventures, enterprises and industrial partners, and helping to create a crucible of economic and entrepreneurial activity based on the advancement and application of science and technology.

From the great diversity of possible topics that could comprise the plans of the Institute, it is necessary to develop some priorities. We will focus our efforts on those topics that are global challenges and that build on the strengths of the intellectual and industrial traditions of the Russian Federation. The Institute will be organized around five themes:

- Information Science and Technology – ranging from device-level development to networks and advanced computing systems
- Energy Science and Technology – including energy conservation, efficient and environmentally sound production of energy, and future alternative energy production technologies
- Biomedical Science and Technology – ranging from biomedicine to more fundamental exploration of the life sciences and biotechnology
- Nuclear Science and Technology – including the non-power related civil uses of nuclear technology
- Space Science and Technology – the means of transportation and exploration of space, as well as the use of space to support communications and an understanding of our planet and beyond

It is our intention to conduct research that supports these five domains, to educate students who can contribute to these domains, and to support innovation and entrepreneurship in these domains.

Plans for the Institute of Science and Technology

The plans for the Institute of Science and Technology fall into three broad areas: education, research, and innovation and entrepreneurship. The discussion below of these three areas will be preceded by thoughts on the culture and followed by a discussion of governance.

Principles of Culture: Before detailing plans, we will discuss the principles upon which we will build the community that is our university, and which will become the foundation of its culture.

The first and most important principle is that we will *focus on innovation*. This is the distinctive signature of our 21st-century university – designed to be an engine of discovery and economic growth. We will focus on fundamental research, but with a consideration of use. We will build a continuum of endeavors that bridge fundamental research to application. We will integrate fundamental scientific education with what in the 19th century was called an education in useful knowledge - knowledge that is or could be the foundation of new goods and services, to the betterment of humanity. Research programs of the Institute will have some forward traceability to how they will impact the human condition. We will work in teams and communities to solve problems and create new possibilities. We will consciously work to accelerate valuable ideas from the laboratory toward commercialization and other forms of societal impact. In order to build and sustain a community that will accomplish this, we must value all parts of the process from the earliest discovery and conceptualization to the delivery of final products and systems as important contributions.

This focus on innovation will be natural as ours will be *a university organized around problems and opportunities*. An organization around problems and opportunities allows for industry and other stakeholders to more easily engage, and ideas to more easily flow across the membrane of our university in Skolkovo to the outside world. This is an interdisciplinary or some might call it a “post-disciplinary” organization – it asserts the primacy of facing the issues of society, rather than the isolated development of knowledge. Of course within the faculty, there will be more traditionally identifiable disciplinary interest groups around which communities of scholars will work and build. These communities will not be organized around traditional lines (such as science vs. engineering or mechanical engineering vs. aerospace engineering), but will be allowed to develop organically so as to meet today’s problems and be fluid enough to respond to tomorrow’s problems as well.

We will take on these problems and opportunities with a spirit of *intensity, curiosity, and adventure*. We will work with passion and concentrate on the issues of today and those of tomorrow. We will be guided by curiosity and a willingness to explore the unknown. We will do this with a spirit of adventure, embarking on each new enterprise with a commitment to intellectual and commercial exploration.

With the resources that we will have, we must have an approach based on *excellence and limited objectives*. Ours will not be a broadly based university, but one more

focused on science, technology, and their application. When we need expertise beyond these boundaries, we must be effective in forming partnerships with others. Within these boundaries, we must deliver with the utmost of excellence.

For an interdisciplinary or post-disciplinary approach, to be successful we must have *unity of the faculty*. This implies that there are no significant internal barriers to cross-disciplinary cooperation. Professors must be able to rededicate their efforts as they see fit to take on new and more challenging issues. While there may be informal organizations within the Institute, there must be one faculty with no organizational barriers that cannot be easily crossed.

Unity refers to horizontal mobility. Vertical mobility is enabled by what we call the *intellectual continuum*. The Institute will be a meritocracy, with all members of the community being recognized for their contributions. The continuum starts with the entering student and progresses through advanced students, post-doctoral associates, junior, and more senior faculty. All must be free to interact as peers, to contribute equally, and to be recognized for their contributions.

Finally, we will work within the community in a spirit of *equity, diversity, and respect*. All members of the community will be respected, from those who contribute with their intellect to those who contribute through their labor. We will respect diversity of all kinds and treat all who join us with a spirit of **equity**.

Educational Programs: The *raison d'être* of universities is to educate bright young minds, so we will begin our discussion of plans for the Institute by a discussion of education. The guiding principle of the education at the Institute of Science and Technology is the first principle of our culture – to create an education unifying science, technology, and engineering in support of innovation. This will include elements of:

- An education building solidly upon and unifying “scientific knowledge” with “*useful knowledge*” – bringing together the scientific and technical fundamentals necessary for innovation
- An education in the *process of innovation* – so that graduates know what to do in order to innovate
- An education in the *skills of innovation* – so that graduates know how to innovate
- An education that leads to the *self-confidence necessary for innovation* – so that graduates are prepared to take the risks necessary to be successful
- A preparation for *leadership* – so that our graduates will be seen as leaders of thought and action, with eventual influence over the outcomes at their enterprises and in society

The goal of our educational programs is to create and deliver at the Institute an integrated graduate education, which fulfills important learning outcomes in knowledge, skills, and attitudes for research, innovation, and entrepreneurship.

The education will yield students who can contribute to the five themes defined above. The graduate education will be at three levels: the Master's level, occupying the first two years; the doctoral level, about another three or four years; and the post-doctoral associate level, still a learning process, but with important elements for transitions to professional status.

Modern approaches to educational design will be followed in creating our educational process. Well-defined learning outcomes will be established, set in concert with program stakeholders. We will create an integrated curriculum, which weaves into the full set of skills and knowledge that our students should possess. The curriculum, pedagogy, and learning activities will be designed to deliver these learning outcomes, and aligned student evaluation will ensure delivery, or identify areas for necessary program improvement.

A centerpiece of our graduate education will be the integration of theoretical and experiential learning. All of our students will be researchers. Tight links will be maintained with the problem domains in our research centers. Our role as an integral part of the Skolkovo ecosystem will provide a myriad of opportunities for authentic work experiences. Our partnerships with other universities inside and outside of the Russian Federation will create possibilities for exchange of study and research.

At the Master's level, all of our students will be exposed to a spectrum of education in entrepreneurship and innovation. Each student will take an introductory course in innovation and work as part of an innovation project during their Master's experience. For students wishing a more in-depth innovation experience, additional subjects with exposure to leadership, innovation, entrepreneurship, and business fundamentals will be available. The summative work by a Master's student may be either a research thesis or innovation project, or a work that integrates both.

Ph.D. students and postdoctoral associates will continue to study and take courses, but will focus increasingly on research. They will work side by side with researchers and professors of all ranks – the intellectual continuum. Even at this level, there will be options to learn more about innovation and participate in innovation projects. Our graduates will be leaders in several domains – research, innovation, education, and policy and public service. Special programs will be available to our Ph.D. students and postdoctoral associates to prepare them for a future of leadership.

Research Programs: The hallmark of the Institute's approach to discovery and development is the adoption of the principle of "research with a consideration of use." Following the influential work of Stokes, research with a consideration of use implies that we will do fundamental investigations, but guided by a view toward

application. Stokes argues that the epitome of this approach is Pasteur, who consistently performed research that was truly fundamental, but always inspired by the public health needs of France in that era.

The goal of our research programs is to address pressing needs of members of society and society as a whole, which bring together fundamental science and technology, guided by a consideration of use.

Our research programs will support the development of the five themes discussed above. Within each of the five broad themes, we will identify a small number of key barriers that require fundamental efforts to overcome. The Institute will adopt a policy of concentrated excellence, investing in key faculty, strong students, and unique facilities to build a critical mass in about 20 areas of focus spread across the five themes.

The choices of these areas of concentration are key to many other aspects of the design of the Institute. The faculty we hire, the students we attract, the educational programs we design, the innovation efforts we launch, and even the facility we build will depend on these choices. The development of these concentrations of excellence will give the Institute an early leading role in some critical areas, and place it in the ranks of leading research universities in the next decade. It will also strongly help in faculty recruiting. This approach is consistent with the cultural principle of excellence and limited objectives.

Of course, this approach places more priority on selecting, with some accuracy, the choices of these 20 or so areas in which to invest. We must choose strategically, conducting careful foresight exercises, engaging representatives from society, industry, and academia. Those who speak for the broad needs of society and for industry will be asked to identify the critical problems that must be addressed. Those from academia and research communities will be asked what science and technology might provide a breakthrough to meet these critical problems. We would strongly consider investing in the topics which overlap between needs on one hand and scientific or technical opportunities on the other. Our investments will form a portfolio of balanced risk, with some investments where we are more confident of the resulting outcome, and some where there are higher risks, but if successful will produce higher rewards.

It is likely that beneath these problem-driven themes will be underlying domains, which we must also develop. These should build on historical or evolving strength in the Russian Federation and should be at the cutting edge in the next decade. When taken as a whole, these underlying domains can contribute fundamentally to overcoming barriers on issues from topical themes (IT, Energy, etc.). Probably, addressing these issues in these underlying domains will require new capital facilities that the Institute and its partners in the Skolkovo infrastructure will develop, which can be a source of competitive advantage for Skolkovo. Of course,

ultimately the direction of research, as in any university, will be determined by the faculty.

Candidates for these underlying domains might be:

- Advanced computational environments – math and computer science applied to modeling of physical, social, and other phenomena
- Advanced materials – metals, nano-materials, and biomaterials
- Energy/Environmental systems – advanced generation, storage, and transportation technologies
- Human engineering and cognition – how to design for and with humans
- Complex systems – how to model and engineer for technical and nontechnical aspects

Our approach to creating research programs is to rely heavily on working with Russian research universities, institutes of the Russian Academy of Sciences, and industrial research institutes, co-developing fundamental breakthroughs, and helping to orient blue-sky research results toward a consideration of use. We will build the research capacity of the Institute and its faculty by using three mechanisms: Centers for Research, Education and Innovation, research mentors, and bilateral research efforts.

A Center for Research, Education and Innovation (CREI) brings together, in a decentralized model, multiple researchers focused on investigation into important shared problems. CREIs will be multi-investigator communities with a Russian partner, an International partner, and a participant from the Institute. The multi-institutional team will have multidisciplinary capabilities. The research centers will develop a continuing source of research questions suitable for Ph.D. and Master's students. The CREI will also develop educational approaches that can be shared with others. A stakeholder community of government, industry, and others will also be cultivated that cares about the outcomes and supports and stimulates the innovation activities of the CREI, and facilitates exchange of knowledge between the CREI and eventual agents of innovation and entrepreneurship.

Early in their careers, many of the Institute's faculty will be in unique mentoring programs, spending a year at another institution, working with a research mentor. Under funding from the Institute, this research relationship will continue after the faculty return to our campus. In some cases, the Institute may also create funded bilateral research efforts.

Innovation and Entrepreneurship: Along with education and research, the third and co-equal strand of the activities of the university is our endeavor in innovation and entrepreneurship. Our goals in this domain are to create programs that will engage our students and faculty in innovation and entrepreneurship, and will accelerate research outcomes toward commercialization and other forms of societal impact.

An essential principle behind our entrepreneurship and innovation programs is a deep and meaningful focus on knowledge exchange – the exchange of knowledge at the boundary of our Institute with the outside community. It is this diffusion of knowledge that allows the founding of new companies and the development of new products and contributions to the solutions of societal problems. At the Institute, we will emphasize the human elements of knowledge exchange, building on long-term contacts to build relationships of trust and open communications. We will seek sustained relationships with industry, Russian and International universities, and other stakeholders. We will engage industry to help shape the research and educational program, building on structured engagement with industry, in order to understand their needs. This knowledge exchange must be supported by appropriate structures, especially with active support for knowledge exchange outward. We will promote a culture of knowledge exchange and empower people in our community to work in this way.

Entrepreneurship efforts will also be organized around the five themes discussed above. They will be of two primary types – those that directly support innovation, and those that build capacity for and understanding of the process of innovation.

The direct support of innovation and entrepreneurship primarily relies on managing and enriching the interface between the Institute and the outside community. First, we must draw industry and other stakeholders in, and identify their long-term needs. This requires structured engagement, bringing representatives of industry to campus, engaging them in our Centers for Research, Education and Innovation, and encouraging them to spend time with us. This is facilitated by programs that encourage long-term industrial affiliation or liaison. Our Skolkovo ecosystem will be an important enabler of this effort.

An important way to engage industry is to use students as a mechanism of knowledge exchange. This involves connecting students with authentic activities at companies, in both shorter- and longer-term engagements. Encouraging students to lead the development of new companies in student in-seminator and incubator is another form of knowledge exchange.

It is evident that the extraction of research ideas and acceleration toward innovation is a key agenda for programs in innovation and entrepreneurship. These programs play an important role in helping faculty formulate the consideration of use that distinguishes our research programs. When discoveries are made and technologies developed, these programs have an equally important role in identifying outcomes that can lead to innovation and other more tangible impacts on the problems of society.

In a more evolved state, typified by the Knowledge Integration Communities of the Cambridge – MIT Institute, and the Knowledge Integration and Innovation Communities of the European Institute of Innovation and Technology, the engagement of industry in knowledge exchange becomes embedded in the research

programs. In time, support of such efforts will play a key role of our innovation programs as well.

Finally, at the boundary of the Institute and industry is the formalization of knowledge exchange, through patent and licensing activity. This too will evolve at our Institute. However, it should be emphasized that this formalization will not enable knowledge exchange in the interest of innovation – it will merely facilitate it. Knowledge exchange in support of innovation is a fundamentally human activity, which relies on long-term close contact between trusted agents with and outside the university.

The second major type of effort in innovation and entrepreneurship is the building of capacity and capability. Communities with whom we will work include our students, our professors, and professionals in the Skolkovo ecosystem. We must be prepared to help students and other community members develop a skill base in several areas: innovation, the creation of new products; entrepreneurship, the simultaneous creation of new enterprises; business fundamentals, how to plan and manage the affairs of a commercial enterprise; and leadership, how to create visions, bring about change, and influence others toward common goals.

A key element in the preparation of innovators and entrepreneurs is not only the skill set, but also the attitudinal development. Innovation and entrepreneurship involve taking risks. Students must develop the specific self-confidence, what Bandura called self-efficacy, that they are able to innovate and plan new ventures. This is only done through authentic experiences in innovation and entrepreneurship – involving students in business planning, and allowing them to actually deliver products on schedule and budget.

By comparison, further development of these same skills and attitudes among practicing professionals is more clearly understood. At Skolkovo, we will endeavor to develop professionalism, and indeed a profession of entrepreneurship. We will certainly have informal support programs, such as organized mentoring of members of the community. However, one of the main ambitions of the Institute in this domain is the creation of more structured approaches to help young entrepreneurs through the difficult first year of their enterprise. We will put into place organized supporting seminars, networks, and programs to help in this effort.

Governance, Quality and Organization: The Institute will be governed by the Board of Trustees of the Institute, who will select the President. The President will be the chief executive, and together with the key academic and administrative leaders will be responsible for and oversee the programs of the Institute. The President will appoint the key academic and administrative leaders, upon advice from the appropriate community. This leadership group of the Institute, together with the larger faculty of the Institute, *will be one* in making the major policy decisions of the Institute – leaders of the faculty will sit on decision-making groups of the leadership,

and the President will be a member of and preside over the meeting of the faculty. This is the principle of *unity of the faculty*.

Incentives will be based on an evaluation of the impact and contributions that professors and staff have made toward the goals of the Institute. For the faculty, these contributions will include: consideration of research impact on scholarship and practice; education success and innovation; contributions to knowledge exchange in support of innovation and entrepreneurship; and personal growth, development, and recognition.

Quality will be the responsibility of program leaders, but most effectively measured through independent international peer review, including through an International Advisory Panel. This group of international scholars and industrialists will form a set of standing committees that will meet regularly to review the efforts of the Institute and provide guidance to the program directors and leaders of the Institute.

The organization will be flexible and allowed to evolve as the Institute grows. Administrative overhead and responsibilities will be kept to the minimum level that is consistent with good and responsible governance. Decisions will be made promptly by decision makers, based on consideration of merit, evidence, shared values, and the careful consideration of peer input.

Summary

In the features of the plan that has been outlined, it will be apparent that the education we seek to provide, the research approach we aim to take, and the intertwining of innovation and entrepreneurship reflects a 21st-century evolution of the role of universities. The Institute of Science and Technology will be an education and research engine based on the development of fundamental knowledge, inspired by a consideration of use. We see repeatedly in history that this synthesis of fundamental understanding inspired by urgent need or utility is the source of practical discovery and leads to social and economic progress.

We ask for your encouragement and active support. It will be seen that education at the Institute will build on and complement the strong tradition of education in the universities of the Russian Federation. We will develop a new tradition in the community at Skolkovo, and we ask our colleagues at universities and institutes throughout the Russian Federation and the world to collaborate and support our development.

We ask those in industry, enterprise, and government to enthusiastically support the development of knowledge and the education of talent that will occur at universities such as the Institute. With the help of many, we believe that the Institute of Science and Technology will be recognized in time as a significant addition to our means of educational and industrial development, and to societal prosperity.