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A startup postdoc program as a channel for university technology transfer: the case of the Runway Startup Postdoc Program at the Jacobs Technion–Cornell Institute at Cornell Tech

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Abstract
Academic entrepreneurship at universities allows students to leverage entrepreneurship education, entrepreneurial activities and university resources, when exploiting the deep knowledge of their research. The establishment of a new research university in NYC—Cornell Tech—offered the opportunity to experiment with a startup postdoc program, initiated there, called Runway, examining technology transfer by postdoc startups based on the notion that committed postdocs could be effective agents in commercializing their research. The program has unique features that differentiate it from incubator and accelerator programs. It is framed and structured as a postdoctoral program embedded in and legitimated by the university's research and education institutions; it provides entrepreneurial postdocs with a structured educational program for translational research and company founding to transform them from scientists into entrepreneurs; and it offers a simple, startup-friendly intellectual property and financial model. Action research, common in educational program experiments, was used as the research model. The program was launched in 2014 and has incorporated 25 postdocs and their startups. This program shows that a university startup postdoc track can be an effective channel for technology transfer, and provide a career option for Ph.D. graduates. Contributions to technology transfer and academic entrepreneurship research are discussed.

Keywords Academic entrepreneurship · Graduate students' startups · University spinoffs · Translational research · Technology transfer · Action research

JEL Classification I23 · L26 · M13 · O31 · O32 · O34

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1 Introduction

A recent analysis of technology transfer research published between 1980 and 2015 showed a dramatic increase in research on the subjects of universities as technology transfer agents and university-based academic entrepreneurship (Noh and Lee 2019). This research trend reflects the changing role of universities in knowledge economies, where universities are considered to be a source of technologies and entrepreneurs as well as leading actors in regional innovation systems (Audretsch 2014; Marzocchi et al. 2017; Reichert 2019; Siegel and Wright 2015).

The founding in 2012 of an applied research university in New York City—Cornell Tech—and within it the new institute, the Jacobs Technion–Cornell Institute (the Jacobs Institute), was driven by the vision of the city's leadership of these institutions becoming leading actors in the NYC high-tech ecosystem. It was tasked with providing interdisciplinary graduate level education with an emphasis on entrepreneurship and technology commercialization and engaging in academic research having uses outside academic settings both to achieve direct societal impact and to inform academic directions.

The establishment of this greenfield university provided the opportunity to design and experiment with innovative technology transfer and academic entrepreneurship programs, and to use an action research approach by employing research knowledge in the design of the program and by collecting and analyzing data for research and learning for practice This allowed us study and apply three recent trends in technology transfer and academic entrepreneurship research and practice: (1) The broadening of universities' research and teaching missions and institutional capabilities in entrepreneurship and innovation (Abrue et al. 2016; Wright et al. 2017), (2) the shift from technology transfer through licensing to incumbent companies to licensing and taking equity in university spinoffs (Feldman et al. 2002; NSF Science and Engineering Indicators 2018), and (3) student entrepreneurship both on undergraduate and graduate levels (Astebro et al. 2012; Boh et al. 2016; Marzocchi et al. 2017).

The authors of this paper initiated, implemented and participated in an experimental postdoc program, as an additional channel for applying and commercializing academic research and to offer an alternative career option for Ph.D. graduates that would fit the mission of Cornell Tech and the Jacobs Institute alongside leveraging the objectives and resources of New York City. The program's unique features, which differentiate it from incubator and accelerator programs, are: It is framed and structured as a postdoctoral program embedded in and legitimated by the university's research and education institutions, it provides entrepreneurial postdocs with a structured educational program for translational research and company founding, and it offers a simple, startup-friendly intellectual property and financial model. Postdocs can remain in the program for up to 2 years. It accepts Ph.D. graduates with a background in digital technologies in a broad sense. In the initial experimental period, up to six postdocs per annual cohort were accepted. The 2-year startup postdoc program was called Runway to distinguish it from Launchpad accelerator type programs.

Action research has been discussed and practiced for over 70 years (Cassell and Johnson 2006) and has evolved into a diverse family of study in many professional fields—in particular, in education (Chen et al. 2018; Sagor 2011; Van de Ven 2007). Our experimental action research case included the following stages: (1) specifying the participants' needs and the program's objectives; (2) designing the program utilizing knowledge available from research and evidence-based practices; (3) implementing the

program; (4) collecting data on the implementation and analyzing results; and (5) contemplating the emerging evidence and its implications for program design changes and for research directions.

The paper aims to make three contributions. It shows how participatory action research is a useful methodology for applying research knowledge in technology transfer and academic entrepreneurship programs and in gaining a deeper level of understandings of their outcomes. It identifies key contributions and challenges in the discussed postdoc program and their possible contribution to research. It also provides a template and guide for a structured programmatic approach to university spinoffs.

The initial results of the postdoc startup program look promising in terms of survival, funds raised, employment and career options for the postdocs. Since the start of the program in 2014 through to May 2019 (the paper's cutoff date), 25 postdocs were admitted to the program. These budding entrepreneurs incorporated 25 companies across a wide range of deep technologies. Their companies raised $47M, employ 171 and have filed 26 patents, of which six were issued. Ten companies have demonstrable social impact beyond commercial impact, mainly in healthcare applications. Four companies were dissolved. Their postdoc-entrepreneurs joined high-tech companies in leading product development positions.

The outcome of the program was measured through data provided by the companies, a survey completed by all 25 postdocs, and interviews with Cornell Tech faculty, investors and mentors. There was a consensus by all parties that the program makes a significant contribution to the objectives of Cornell Tech, the Jacobs Institute and NYC, and to the postdocs, and that a similar startup postdoc program could be beneficial to other research universities.

The remainder of this paper is organized as follows in line with the stages of an action research. Section 2 describes the needs of the clients of the proposed research commercialization program: NYC, Cornell Tech, the Jacobs Institute and the nascent academic entrepreneurs, and the objectives of the program derived from these needs. Section 3 describes the program's key elements and their theoretical underpinnings. Section 4 describes the program implementation. Section 5 presents the initial results and their analysis. Section 6 reflects on the design and implementation of the program and its challenges. It offers recommendations for improvements and discusses implications for research. Section 7 concludes with additional recommendations.

2 The changing role and objectives of universities and their students in innovation ecosystems

The establishment of an applied research university in New York City was a key part of the plan to enrich technology and talent in the fertile and growing tech ecosystem in NYC. Following the financial crisis in 2008, Michael Bloomberg, as mayor of New York City, decided to diversify its economy and to relaunch NYC as a Tech City. More technology education and connection to the startup world than the existing educational institutions offered was needed. In the summer of 2011, twenty leading universities submitted proposals for a graduate level applied Research University in New York City. The selected proposal advanced by Cornell Tech and the Jacobs Technion–Cornell Institute, the embodiment of the partnership between Cornell University and the Technion–Israel Institute of Technology (Cometto and Piol 2013), was selected. The Jacobs

Technion–Cornell Institute (hereafter Jacobs Institute) is a cornerstone of Cornell Tech, sharing its broad mission and, at the same time, remaining an independent entity, with autonomy that allows radical experimentation with novel research, academic programs and entrepreneurial initiatives.

Cornell Tech was tasked with the objective of creating technology leaders for the digital age through research and graduate level education with an emphasis on entrepreneurship and technology commercialization—aiming to create new jobs and new technology-based companies. An essential component of this mission is the integration of academic research with uses outside academic settings, both to achieve direct societal impact and to inform academic directions and research questions. Cornell Tech and the Jacobs Institute adapted and expanded their research and teaching missions, and developed new programs and procedures such as external engagement as one selection criterion of faculty; the cross-disciplinary Studio education program; and the industry focused 2-year Master Hub program. The Tata Innovation Center, established on the Cornell Tech campus, embodies the shared objective of Cornell and NYC of academia and industry collaboration to leverage technology for the greater good and functions as the initial home for Cornell Tech spinoffs. In addition to the traditional technology transfer channel through Cornell's TTO, two new commercialization programs were developed. One is the Spinout program for Master students that gives student teams, at the end of their studies, an opportunity to participate in the Cornell Tech Startup Awards competition, offering winning teams, after graduation, mentoring support, a 1-year co-working space and a $100K-investment. The second innovative commercialization program is the Jacob Institute's Runway Startup Postdoc Program.

The Runway Startup Postdoc Program was conceived and designed to enable NYC and Cornell Tech and its students to meet the following objectives: (1) The creation of new companies based on deep technology, solving hard problems that would enrich the NYC ecosystem capabilities and facilitate the integration of academic research having uses outside the academic setting. (2) Engagement of research students as agents of technology transfer acting as founders of university spinoffs. Research has shown that the very early stage of startups is often too risky for surrogate entrepreneurs but offers a great opportunity to students to apply and commercialize their research. Boh et al. (2016) found that 77% of the founders of spinoffs of leading US research universities were Ph.D. students or postdocs supported by their PI. (3) Providing career opportunities for Ph.D. graduates. According to a recent National Science Foundation (NSF) report (2015), the number of US STEM Ph.D. recipients increased by 42% since 2004 but only 60% had a job commitment on graduation. Other NSF data indicate that only 41% of employed STEM Ph.D. recipients pursued an academic career (Hoffer et al. 2011).

These three goals were translated into the following specific performance objectives of Runway:

1. Develop the maximum number of sustainable postdoc startups with sufficient funding and commercial validation to continue after the 2-year Runway program.
2. Create intellectual property to protect the knowledge of the startup postdoc as a critical asset of this startup.
3. Contribute to postdocs' education and career options.
4. Facilitate research spillovers between the startup postdoc program and the regular university research community, thereby encouraging use-inspired research.
5. Develop a startup postdoc program that is applicable in other universities.

3 The key elements in the design of the program and their underpinnings

Utilizing knowledge from technology transfer and academic entrepreneurship research, the following key program elements were designed by the authors of this paper, supported by the leadership of Cornell-Tech and the Jacobs Institute, and in consultation with Cornell and the Technion. The program was allocated to the Jacobs Institute, which, being an independent entity, was encouraged to initiate innovative experimental programs.

The design of Runway has five key elements that make it unique:

(1) *The program is framed and positioned as a postdoc program* Inspired by the translational research model of medical schools, for the following reasons:

- It fits within the boundaries of the research and education missions, and institutional arrangements of universities.
- It provides the time and environment for the transformation from a postdoc employee into an entrepreneur.
- It facilitates interaction between startup postdocs and regular postdocs and their research community.
- It provides an easy-to-understand value added interface with the university ecosystem and provides legitimacy to the postdoc and his or her company both vis-à-vis the university internal and external stakeholders, and customers and investors—a key condition for success in university spinoffs (Francois and Philippart 2019).
- It serves as a change carrier for technology transfer and academic entrepreneurship in universities.
- It fits within the time frame of a regular postdoc program. Postdocs can remain in the program for up to 2 years, with the extension to the second year contingent on reaching a milestone at the end of the first year. The 2-year program is deemed sufficient to create a sustainable startup company with market traction and a pathway to continued funding and resource building across a wide range of technologies including health tech.

(2) *The selection criteria for applicants* Candidates have to be committed to starting a company. Research by Vohara et al. (2004) showed that entrepreneurial intention is not sufficient. "[T]here is need for an individual to be emotionally committed full time to resolve the uncertainty and complexity surrounding the technology and application of that technology in a particular market" (2004, p. 170). In addition, candidates have to score high on entrepreneurial traits, skills, motivation and other characteristics described in research. Their scores enable us to gauge their innate entrepreneurial abilities and fit to the program (Baum and Locke 2004; Mueller et al. 2017; Shane et al. 2003).

(3) *The design of the education and progress review program* The design of the education program aims to leverage the postdoc's commitment and learning motivation combined with his or her technical competence to achieve a much steeper learning curve than achieved in standard university entrepreneurship education. Research suggests that entrepreneurial commitment is a much stronger multiplier for entrepreneurial learning and behavior than entrepreneurial intention (Adam and Fayolle 2015; Erikson 2002).

Building on the research of university spinoffs by Vohara et al. (2004), we identified and designed three development phases that postdocs and their companies have to pass

through during the Runway period and three critical junctures in terms of the resources and capabilities needed when progressing from one phase to the next.

- The first critical juncture is the acceptance to the Runway program with a cognition of an initial business opportunity and entrepreneurial commitment. The research phase preceding and leading to this critical juncture is a pre-Runway phase.
- The opportunity framing phase that examines whether the recognized opportunities have sufficient underlying value to warrant further commercialization effort.
- The pre-organization phase. In this phase, decisions over what existing resources and capabilities to develop and what resources to acquire now and in the future must be made. Decisions at this early stage may cause path dependence. According to Vohora et al. (2004), this phase represents the steepest learning curve for an academic entrepreneur.

The opportunity framing phase and the pre-organization phase are iterative and not sequential. Optimization of opportunities framed in Phase 1 and identification of the capabilities and resources needed for execution of these in Phase 2 is an iterative process. Phases 1 and 2 are designed to last between six to maximum 12 months through tailored education, mentoring and reviews, and incorporation, to be described in more detail later in the paper. During this period, Runway scientists become entrepreneurs, ready to make decisions on what existing resources and capabilities to develop and what resources to acquire.

- The critical juncture at the end of these two phases is credibility. The critical juncture pivots on the question of having sufficient/insufficient credibility to gain access to and acquire an initial stock of resources.
- The third phase, the re-orientation phase, involves acquiring and integrating resources, and subsequently reconfiguring them based on information from customers, competitors and investors. This phase starts at the end of the first year after a credibility review and approval for the extension for a second year and lasts until the end of the second year. The emphasis in education shifts to one-on-one mentoring, peer learning, topical workshops and quarterly review meetings by a 'mock board'.
- The end of the second year marks the end of the Runway program, with, as an objective, crossing the sustainability critical juncture with a roadmap for venture sustainability, qualified equity investments and first customer revenues.

(4) *The IP model* is the fourth key design feature of Runway. It determines the IP arrangements and legal agreements at the start and in advance to avoid often lengthy negotiations with a TTO and encourages and educates the postdocs to create IP. The TTO function is embedded in the program and is executed by the postdocs supported by the Runway director.

(5) *The financial model* is the fifth key design feature. It gives ownership of the startup to the postdoc. The Jacobs Institute pays the postdoc a regular postdoc salary, provides office space, education and a research budget. In exchange, the postdoc gives the Jacobs Institute a small stake in his company. The financial model is not aimed at profitability per se. Some reasonable return on investment is important for the sustainability and credibility of the program but impact of research, creating companies that would not have happened otherwise and postdoc education are the key performance criteria for the Jacobs Institute.

4 The implementation of the Runway Startup Postdoc Program

The Runway program was started in 2014 and aligned with the start of the academic year.

4.1 The process of selecting runway candidates

In a traditional academic transfer spinoff model, candidates are selected or emerge either because of their academic credentials, or because during their graduate work they have demonstrated entrepreneurial prowess. Even though these are important conditions, they do not ensure the success of candidates within a research spinoff program. Runway applies a comprehensive and rigorous selection process. Applications start in the fall and decisions of acceptance to the Runway cohort in the following fall are made by mid-April. The applicant is asked to submit the following documents:

- A standard academic CV including working experience outside academia, at least three references, and information on invention disclosures and filings.
- An opportunity statement describing at least one significant and real problem that the candidate's technology is intended to solve.
- A personal essay in which motivation for applying to Runway and entrepreneurial mindset and behavior are described.

Three rubrics are considered when selecting potential candidates.

1. *Academic Background* A standard of excellence in academic achievements comparable to what is required of a regular postdoc position at Cornell University or at Technion. Candidates must hold a Ph.D. from a top global academic institution, with peer-reviewed journal articles and academic recognition (prizes, fellowships, grants) related to their work. This work has to be in digital technologies—in a broad sense. Faculty at Cornell Tech and the Jacobs Institute must be familiar with the candidate's research area and be willing to act as her or his academic supervisor. For promising candidates, Cornell University including Weill Cornell Medicine and Technion faculty may be approached for their assessment and willingness to supervise the candidate. Faculty plays a key role in the selection process. Therefore, if no faculty willing and able to supervise the candidate is found, the application will be rejected.
2. *Personal background and traits* Ph.Ds graduates with the required academic background, regardless of nationality, who received their degree within the last 5 years may apply. During the selection process, the personal essay, the framing of the proposed opportunity and the interviews provide some indication of the entrepreneurial background, motivation, and innate entrepreneurial abilities and skills of the prospective postdocs. Some indicators of entrepreneurial skills are activities that the candidates have performed as volunteers, programs or challenges that required them to solve problems independently, and previous attempts at understanding commercialization or the startup world, such as joining an NSF i-Corps program. The candidates are scored from 1 to 5 by the interviewers, averaging the scores on each of the following characteristics:

- Entrepreneurial commitment to starting a company. Entrepreneurial interest, growing into entrepreneurial intention, often resulting from courses in entrepreneurship, following role models, and having instinctive entrepreneurial traits, is important but the gap between intention and behavior remains. A number of candidates were rejected because it appeared that their real commitment was research and not commercializing their research through a startup.
- Entrepreneurial motivation and drive.
- Persistence, having grit.
- Non-conformity and "out of box" thinking.
- Communication skills.
- Leadership skills.
- Radiates energy, engages, is pro-active and a quick learner.
- Business acumen, sharp, being street smart. This skill was often mentioned by Runway investors and mentors as being a key part of entrepreneurial competence and that because of lack of experience and sometimes personality, young scientists do not possess this skill. Based on the personal essay and interviews, candidates are assessed on their inherent ability to develop these skills.
- Fit of the founder/postdoc with the opportunity proposed. This assessment goes deeper than the typical assessment by investors of the product/market opportunity and the founder team. It assesses the motivation and personal fit and passion for the opportunity proposed in the opportunity statement.
- Balance between independence and willingness to learn and change, and of being coachable. Given that investors and mentors often commit more than just capital to a startup, they commonly stress how important it is for entrepreneurs to be "coachable" (Ciuchta et al. 2018).
- Team player/fit with Runway culture. Being part of the Runway team is key for peer learning. Candidates are assessed on their team fit through interviews by Runway postdocs.

3. *The proposed business opportunity* The opportunity statement should reflect a business opportunity that is bold, requires deep technological knowledge, and solves a hard but real problem. It is expected that the solution will be demonstrated by a minimum viable product (MVP) within 1 year. The business opportunity statement is neither a research proposal nor is it expected to be a polished pitch. The written statement and interviews should convey a credible product/market opportunity to be validated by experimentation and trial, and should show some business acumen.

In the selection process, in the first stage, based on the submitted applications and references, each of the above rubrics are—again—scored from 1 to 5. Each applicant gets a cumulative score and then all are ranked from the top score to the lowest score. The top 10 scoring applicants are considered for interviews. The present Runway budget allows for annual cohorts of a maximum six postdocs with a minimum determined by the quality of the applicants. The interview process is done using a stage-gate approach, where each interview is a gate that has to be passed. For each candidate selected for interviews, the first interview is regarding the item where the scoring was lowest. For example, if the lowest score is related to the business opportunity, the first interview is with our venture capital mentors and investors. Business mentors are a crucial element in Runway. Selected

mentors/investors are involved the selection process. Their main contribution is assessing personal characteristics, in particular business acumen, coachability and fit with Runway. No less than five interviews are conducted by mentors, the program director, faculty members (including the academic supervisor), alumni and current postdocs. The input from alumni and current postdocs is invaluable. They excel in identifying the people who would be good entrepreneurs and fit the culture. The program director also calls all references and works with an IP attorney to make sure that the potential candidates do not have any conflict or IP barriers in being accepted and forming a company in the subject that they have selected. This screening process may take up to 2 months.

Below are some data on the selection of the first six Runway cohorts (2014–2018):

- Total valid applications: 209 (average 35 per cohort).
- Accepted candidates: 25 postdocs (12% acceptance rate) of whom 3 are females.
- Nationalities: 36% US, 20% non-US citizens but whose Ph.D. is from a US university, 32% Israeli, 12% other nationalities.
- Four of the postdocs are Technion Ph.D. graduates and five are Cornell Ph.D. graduates.
- All non-US postdocs were granted a visa for postdoctoral students.
- The opportunities pursued by the 25 postdocs cover a wide range of technologies and application areas: Health tech, E-Commerce, Education and Research, Big Data and Networking, Construction and Infrastructure, AI and Productivity, Cyber Security, Law tech; ten of the 25 startups were healthcare-related, ranging from informatics and devices to drug development.

4.2 The runway journey: education, mentoring and reviews

The transformation from scientist into entrepreneur is planned to occur during the opportunity framing and pre-organization phases. These are the phases in which the postdocs identify product/market opportunities, validate them through customer discovery and with industry experts, and identify capabilities and resources needed for execution and the ways to acquire them.

The Runway journey provides the education, resources and time for the opportunity framing and pre-organization phases. From their postdoc's/scientist's comfort zone and legitimacy, they start exploring markets and competitors, leveraging both their postdoc and entrepreneur identities.

Here we allow three postdocs to describe in their own words the transformation from scientist into entrepreneur.

The founder of a SW company in server optimization conceptualized the difference between Runway as a postdoc program and alternative commercialization acceleration programs as follows: "Runway's primary benefit has been the time and space to push technology boundaries. Without Runway, I would have started a different company, with less technical risk. [Here] You have peace of mind, because you can work on something deep. It's okay for you to take a few months and figure something out."

The founder of a company developing smart patches and analytics for sleep disorder diagnostics and management articulated the transformation as follows: "We need time, funds, and professional networks that will help us leverage our expertise. This is exactly what the Runway program provides. With Runway we can get the depth and stability of the academic environment combined with the drive and spirit of the entrepreneurial world. We

have enough time to transition from the academic state of mind, to the business one, study different markets and needs, build our prototype, and get the initial funds for sustainable growth."

The founder of a company developing biological image analysis solutions expressed his mental transition as: "Having turned down an offer for an academic position—which was a very hard decision for me to make—I decided to follow my gut feeling and pursue what I now find to be an exciting and meaningful journey … My biggest challenge for switching my academic mindset to an entrepreneur was dropping ideas that interest me and only a handful of other people … and instead concentrating on problems that are central to bio-image analysis in terms of workload and impact. While good academic research requires being rigorous and elegant, good business in my domain requires all this plus profitability. "Profitability" was, until recently, an unused word in my vocabulary."

4.2.1 Educational curriculum

At the start of the program—i.e., during the opportunity framing and pre-organization phases—postdocs participate in intensive training to facilitate the transition from scientist to entrepreneur. Runway uses a variation of an academic training program developed by the National Science Foundation, which is based on the work of Steve Blank at Stanford (Huang-Saad et al. 2017). The Runway curriculum usually starts with a 1-week short course given by the current program director and the previous directors, in which they discuss the different challenges that tech entrepreneurs and their startup companies will face, followed by a shortened version of the NSF i-Corps training. The i-Corps training and the initial sessions educate the postdocs in customer discovery, identifying customer value propositions and understanding concepts such as a business model, customer archetypes and the role of partnership. A 1-week workshop called "The Market Opportunity Navigator" developed by Gruber and Tal (2017) complements the training in opportunity framing. The Market Opportunity Navigator methodology provides a wide-lens perspective to discover different potential market domains for a technology. The workshop can act as the front-end of customer development (Blank 2019). The Market Opportunity Navigator offers a methodology that helps the postdocs discover additional opportunities for their technology and capabilities across different market verticals, prioritize them and develop an agile focus strategy. This wide-lens opportunity framing is particularly relevant for the Runway postdocs who may too early become overly committed to their initial opportunity without exploring alternative or additional opportunities.

One Runway postdoc whose company applies computer vision analytics in building safety, a former i-Corps awardee, stresses the complementarity of these two approaches: "The Market Opportunity Navigator helped me to exit a local optimum market opportunity … It helped us take a step back from our laser-focused customer discovery and revisit our decision regarding the customer segments and the product–market fit before moving forward. I believe this is an excellent, crucial, and complementary method to Lean Startup by Steve Blank that should be implemented by all startups and especially for university spin-offs where the market opportunity is less clear than the core enabling technology."

The Market Opportunity Navigator also helped in pivoting at a later stage. From a survey, it appears that 66% of the Runway companies pivoted during the Runway period as a result of feedback from the market, mentors and investors.

The initial 2–4-month education period also includes a workshop with an executive coach, training in social skills, design thinking and other soft skill workshops. Additional

teaching topics are: legal and financial aspects, basics of IP protection, human resource aspects, marketing, and regulatory issues for healthcare startups.

In addition, the postdocs are invited to participate in the courses taught to Master's students in the Studio program on subjects such as product management, building a HW product and user experience/user interface product considerations.

Postdocs are also offered training and resources that are specific to their needs and their company needs. These could be in communication, product design, regulations, or other areas where they might need specific extra coaching. During the second half of the first year and in second year, workshops on effective decision making, team building and leadership are given. The education mode shifts to one-on-one mentoring with business mentors and program director, and peer learning through weekly "scrum" sessions. In the second year, postdocs have quarterly reviews with a 'mock board' consisting of experienced investors and Jacobs Institute representatives who act as a regular company board.

4.2.2 Peer learning, peers as resources

Peer learning is a core part of the Runway program. To stimulate peer learning, Runway cohorts have a mandated weekly 1-h scrum session. Even though not run in the traditional style of a standing-up scrum, these are intended to be up to a 10-min update for each company on their developments of the week and a discussion. First-year Runway postdocs are required to participate in the weekly scrum, while second-year companies participate every other week. During scrums, any topic can be discussed. Since postdocs are co-located in a Runway designated area in Cornell Tech, the peer learning goes beyond these scrums A survey of all postdocs showed that 90% found that the atmosphere of giving and helping each other was excellent.

4.2.3 Mentors as a source for learning and networking support

Each postdoc is assigned at least two mentors.

1. The academic mentor is, ideally, a Cornell Tech campus faculty member. In some instances, mentors from Cornell or from Technion in Haifa can also be selected. The faculty mentor should be a resource to be utilized by the postdoc to expand his or her knowledge, someone with whom to share ideas, act as sparring partner and offer his or her network. The academic mentor participates in first-year review meetings. In the case of co-invention of developed IP by an academic mentor, the co-inventor rights are covered by the Runway IP agreements.
2. Business mentors provide different types of knowhow and play different roles. A business mentor may have specific experience in the industry selected and/or have startup experience and/or have expertise in specific areas such as finance or marketing. They could fill the role of a personal coach, expert/consultant or surrogate board member. Business mentors are usually not assigned. A number of potential business mentors are introduced to the postdoc over time until there is one with whom the postdoc forms a good relationship. The program director meets and talks with the mentors regularly to ensure that there is a strategic alignment. If interested, the business mentor may invest in the company, provided that the investing mentor does not participate in postdoc reviews. To ensure availability of mentoring at the start of the program, the Runway director and members of the advisory board/visiting committee act as first-line mentors.

4.2.4 Runway reviews

For each postdoc, a number of reviews are scheduled for educational purposes and to track progress.

The first two reviews, by a committee consisting of the Runway director, the Jacobs Institute director, the academic mentor, and a business representative, are dedicated to identifying an initial product/market area and industry domain, showing some evidence of market attractiveness and readiness to incorporate. These reviews provide feedback on progress in the opportunity framing and pre-organization phases of the startup development. During this period, the startup is incorporated as part of the credibility and legitimacy building of the postdocs and the need for a legal entity for the next phase of the startup development. Typically, a company is incorporated within 6 months from the initiation of the program (or later with the approval of the Runway Director).

In the third review, towards the end of the first year, a credible business plan has to be presented with a description or demo of an MVP. The Runway postdoc has to show a credible and scalable product/market/founder fit and the ability to build a company. The guiding questions of this review are: Is this a company or a research project? And can the postdoc execute his plan?

Of the twenty postdocs who passed the first-year review, fifteen (75%) were offered a second-year extension, in some cases conditioned on passing certain milestones. Two did not need a second year. In the second year, reviews continue on a quarterly base.

4.3 The runway IP model

The Jacobs Institute, supported by its partners, Cornell and the Technion, developed a new IP model that establishes the IP arrangements upfront to avoid the typical lengthy and often acrimonious negotiations with the TTO.

Runway takes a founder-friendly approach to the rules that govern intellectual property. All IP developed during the Runway Program is assigned to the Jacobs Institute, and the Jacobs Institute grants the respective Runway startup a royalty-free, exclusive, perpetual and transferable license for this developed IP. The rationale for the assignment of IP and related costs to the Jacobs Institute is, firstly, the safe guarding of the IP when a startup ceases operating. Secondly, it supports inexperienced postdocs in IP management, encouraging them to identify and protect their IP, and, thirdly, it saves costs on patenting and IP protection.

The Jacobs Institute is responsible for all aspects and costs of the preparation, filing, prosecution, maintenance, and enforcement of protections for this developed IP. Runway IP administration is the responsibility of the Runway director, supported by an IP Management Service Provider. The choice of an IP legal firm is made jointly by the postdoc and the Jacobs Institute. Licensing any background IP related to his or her Ph.D. research or other sources is the responsibility of the Runway postdoc entrepreneur. During the selection process, access to background IP as a condition for the proposed opportunity is discussed, and in cases where such exists, candidates are requested to provide evidence that the background IP owner is willing to license the IP.

At the start of the program, the postdocs receive tutorials in IP strategies and licensing. All actual preparation for IP filing is done by the postdoc in consultation with the Runway director. The postdoc takes the lead in the IP filing process after the choice of an IP legal firm has been made.

The regular TTO commercialization and IP management tasks as such have been embedded into the program and program management.

The IP model incentivizes the postdocs to create and file IP.

One postdoc, the developer of a search and testing engine for algorithms who filed three patents, expressed his appreciation for the IP model as follows: "Thank you (director of Runway). Without you pushing this and making the IP funds attractive as part of the Runway, I'm not sure we would make the effort of even submitting". Another Runway postdoc, founder of a biotech company who filed five patents, made the case for the Runway IP model in Nature Nanotechnology (Dumont 2015).

4.4 The runway financial model

4.4.1 The runway award

Once candidates are accepted, they are onboarded as postdocs at the University. The onboarding process is the same as with any postdoc at Cornell University, and it includes an offer letter explaining the salary and benefits, and the appointment terms including the IP policy and financial arrangements for the first and potential second year. The salary level and benefits are competitive with the salary for computer science postdocs in the NYC area. The award includes a research budget that is managed by Cornell University Finance until a company is established. Once a company is formally formed, the research budget is transferred to the company's bank account.

In addition, the Runway award includes academic training as elaborated above, monetary and training support in IP registration, perks such as cloud computing valued at $100,000, software, legal and accounting support, working space, and other services. Beyond the personal working space, amenities are meeting rooms, free coffee, a lunch cafeteria and all resources available at the Cornell Tech campus.

The costs of the Runway award for the Jacobs Institute are valued at $175,000 for the first year and $102,000 for the second year.

In return, the Jacobs Institute takes a small stake in the Runway companies.

In exchange for the first year $175,000 investment, the Runway company, following its incorporation about 6 months after the start of the program, issues a SAFE (Simple Agreement for Future Equity)—similar to what Y Combinator communicates publicly—to the Jacobs Institute for $175,000 with a valuation cap of $3 million. If the postdoc remains at Runway for a second year, the additional investment is valued at $102,000, and the postdoc's company issues a second SAFE to the Jacobs Institute for that amount with a valuation cap of $4.7 million. The filing of the first patent is free of charge to the Runway startup; for any additional patent, the startup will issue to the Jacobs Institute a small convertible security in the form of a SAFE of $25,000. These SAFEs convert into preferred shares if and when the company closes an equity financing round. To maintain their proportional pre-money share in equity financing events, the Jacobs Institute and its affiliates have pro rata rights to invest.

This financial model and the IP model sidestep challenges that startup founders commonly face at universities. Startup postdocs are not bogged down by license and equity negotiations. For Runway, the deal terms are simple and specified as part of the acceptance as a postdoc to the program rather than negotiated on an individual basis for each company.

The financial model and the IP model have been well received by the postdocs, the Jacobs Institute and its parent institutions, and by the investment community. Equity-based

compensation has gained ground in TTOs because the latter as well as firms have started to appreciate of the benefit of aligning university–firm interest. Further, they are also attractive because TTOs believe that equity provides more legitimacy and prestige and because it provides a potential return on the firm's total assets (Feldman et al. 2002).

4.5 Runway management and oversight

4.5.1 Runway director

The function of the Runway director is to be both a mentor and the administrator of a portfolio of companies. In his mentoring capacity, the director is required to maintain the established set of guidelines so that companies can have a unified Runway experience. He is also the liaison with Cornell Tech faculty. The director works to ensure that the practitioner-led curriculum is delivered and that the companies get the support they need. The director is neither required to run any of the companies nor to make decisions on their behalf. The director provides guidance and is a resource for each company.

The director also acts as a technology transfer officer for the Jacobs Institute and Cornell Tech. He is required to report on the progress of the companies and on the necessary metrics so that the Visiting Committee, the Jacobs Institute, Cornell University and Technion can track the program's progress.

The Runway Director reports to the director of the Jacobs Institute.

4.5.2 Visiting committee

The Runway Program has a Visiting Committee whose mission is to provide guidance on the program structure, to establish policies and rules, and to track the program's progress. The Visiting Committee comprises a variety of members including the Chairman of the Board of Directors of the Jacobs Institute, the Director of the Jacobs Institute, the Director of the Runway Program, venture capitalists, early stage investors, and entrepreneurs. The Visiting Committee meets at least once a year. Since 2018, the Visiting Committee also participates in quarterly 'mock' board meetings of Runway companies, which are designed to teach second-year companies corporate governance.

5 Initial results and analysis

To assess the initial outcomes of the Runway experiment as related to the stated objectives, the following information was collected and analyzed in terms of how it helped Runway achieve its five major objectives (see Sect. 2):

1. Data on the 25 Runway companies.
2. Interviews with investors and mentors of the Runway companies and partners of leading NYC law offices working with Runway.
3. A survey completed by all 25 Runway postdocs during May 2019.
4. Interviews with three Cornell Tech faculty members who have been academic supervisors in the Runway program and two faculty members of Weill Cornell Medical who are co-founders of two Runway companies.

Objective 1 Develop the maximum number of sustainable postdoc startups with sufficient funding and commercial validation to continue after the 2-year Runway period.

Table 1 lists all 25 Runway companies, their application area, starting date, funding status on a scale from being dissolved to no funding yet, to angel/grant funding to seed, A-round, B-round equity funding to acquisition, their customer/revenue status—often a pre-requisite for additional funding, and lastly, their IP status. One can argue that companies that received grant or angel funding passed the opportunity and pre-organization phases and crossed the credibility juncture, and that companies that received VC equity funding and have first revenues passed the re-orientation phase and crossed the sustainability juncture. Based on that assumption:

- 40% (10) of the companies crossed the sustainability juncture.
- 20% (5) passed the credibility juncture.
- 24% (6) are still in the pre-organization, initial fundraising phase.
- 16% (4) were dissolved.

Ten of the 25 companies are in the area of healthcare across a wide range of technologies and products. Runway companies raised $47 M and employ 171 employees. The average time to angel funding was 10 months and the average time to venture investment or other structured funding was 25 months.

Four of the 25 companies were dissolved within or immediately after the Runway period. All four founders joined high-tech companies in their field in senior development positions. The reasons for closing these companies were:

1. Not crossing the juncture from the opportunity framing phase to the pre-organization phase and struggling with the transformation from scientist into entrepreneur.
2. Struggling with the pre-organization phase and credibility threshold; preference for a development/CTO role over being a founder/entrepreneur.
3. Difficulties in finding a funded roadmap from advanced product development to market acceptance.
4. Getting stuck in the opportunity framing phase and MVP development.

Comparable benchmark investment data on similar companies such as university spinoffs or Small Business Innovation Research (SBIR)-granted companies are lacking. AUTM, the Association of University Technology Transfer Managers, reports the number of spinoffs but does not provide performance data. It was surprising to learn that while accelerators and academic spinoffs programs proliferate, there is little relevant and comparable data available. We, therefore, asked eleven experienced high-tech investors and mentors and two partners of leading law firms in NYC to benchmark Runway's performance against other very early stage tech companies. The consensus was that Runway performance is significantly above average, taking into account that the start of Runway is a pre-company with a single founder. The founder of an early stage venture fund remarked that: "The startup postdoc program is uniquely leveraging tenacity, commitment and smartness of Ph.Ds with the reputation capital of Cornell and the Technion and offers a great value proposition compared with accelerators that take a lot of equity for marginal contributions" and a partner in a high-tech law firm added: "Runway is an

Table 1 Performance of the runway companies

	Application area	Starting date	Funding status	Customers/revenues	Number of patent applications
1	Health Tech	Feb. 2014	Grants/Angels	Paid pilots	5 of which 3 granted
2	E-commerce	Feb. 2014	Seed funding	Paying	3
3	Welnes/IoT	Feb. 2014	B-round	Paying	1 granted
4	Education	Feb. 2014	Acquired	Paying	–
5	Construction	Feb. 2014	Dissolved	–	
6	Health Tech	Feb. 2014	Dissolved	–	2
7	Research and Education Tools	Aug. 2014	A-round	Paying	3 of which 2 granted
8	Sustainability	Aug. 2014	SBIR grant	Paying	1
9	Health/Wellness Tech	Aug. 2014	Dissolved	–	–
10	AI and Productivity	Aug. 2014	Dissolved	–	–
11	Health Informatics	Jan. 2015	Angels	Paying	–
12	Health Tech	Aug. 2015	Grants and seed round	Paid pilots	2
13	Data center/cloud optimization	Aug. 2015	Seed funding	Paying	2 of which 1 granted
14	Construction	Aug.2016	Seed funding	Paying	2
15	Big Data/Networking	Aug. 2016	–	–	–
16	Health Tech/IoT	Jan. 2017	Angel	Paid pilots	1
17	Health Tech	Aug. 2017	–	Paid pilots	–
18	Big Data/networking	Aug. 2017	Grants	Pilot	–
19	Health Tech	Aug. 2017	–	–	–
20	Cyber Security	Jan. 2018	Seed funding	–	–
21	Law Tech/NLP	Aug. 2018	Seed funding	Pilot	–
22	Health Tech	Aug. 2018	–	Pilots	–
23	Health Tech	Aug. 2018	–	Paying	2
24	Cyber Security	Aug. 2018	–	–	1
25	Construction	Aug. 2018	–	Paid pilot	1
	Total		8 VC equity rounds, 1 acquired Total $47Minvestment	8 paying customers 8 pilots	26 of which 6 granted

amazing success. The key is to create an environment in which the entrepreneurs are not only builders but owners. That's the difference with a TTO handling it."

The postdocs responded positively to the program. The responses of the survey completed by all 25 postdocs showed that 82% rated the atmosphere/culture as very positive and, for 72%, Runway met their expectations.

To summarize, a cautionary initial assessment of Runway's performance data shows the promise of such a program as a technology transfer channel and enabler of new companies. It is interesting to note that there seems to be no significant difference between healthcare-related companies and others. The complexity of business, technology and regulation in non-health tech is often no less than in health tech. It seems that the Runway period of 2 years is sufficient to create a platform for continuation and growth after the Runway period but more data and analysis are needed.

Objective 2 Create intellectual property to protect the knowledge of the startup postdoc as a critical asset of his startup.

Table 1 shows the number of patents filed per company and the number of issued patents. As of May 2019, 26 Utility Patents and their related PCT have been filed, of which six have been granted, and three trademarks have been issued. These relate to technologies in IoT, health tech, e-commerce, big data and networking, construction, AI and productivity and cyber security. The number of claims of the published patents range from 6 to 39. Interestingly, the number of patents differs considerably per company. One health tech startup filed five patents as part of an exit strategy. Others decided not to file but protect their IP through trade secrets, an increasingly accepted practice in the software industry.

Investors have welcomed the simple and postdoc-friendly IP model. The embedding of the regular TTO and IP management tasks into the Runway program accelerates fast learning by postdocs and enables informed decision making.

Following requests by Runway companies who raised capital and have recurring revenues, and their investors, the Jacobs Institute is presently developing a procedure by which the IP ownership can be transferred to the Runway companies, when certain conditions are met.

Objective 3 Contribute to postdocs' education and career options.

When asked whether they would have started a company even if not accepted by Runway, 11 of the 25 postdocs responded "no". One responded "Absolutely not. I did not have a good idea or strategy before starting the program. I may have joined another startup, but with very little chance of starting my own successful company. I was also thinking about entering academia at the time. Runway truly enabled Maalka.[1]" The other 14 respondents would have started anyway on their own or in an accelerator/incubator. When asked whether they would recommend a startup postdoc program at other universities, 23 of the 25 postdocs responded absolutely "yes", with comments such as "Yes because my colleagues coming out of Ph.D. programs have been looking for alternative career paths and I think many people would benefit".

[1] The postdoc's company.

Increasingly, universities and research funds such as NSF recognize the potential of engaging graduate students in commercializing their technology and in offering them other career options. MIT offers a staged Translational Fellows program as an educational program for postdocs. Cornell Engineering offers a funded half-year Commercialization Fellowship program for Ph.D. students who are nearing completion of their studies and NSF promotes the i-Corps program. Runway takes this training one step further, offering a similar but more learning-on-the-job education framework.

Objective 4 Facilitate research spillovers between the startup postdoc program and regular university research community, thereby encouraging use-inspired research.

This objective was based on the premise that achieving real-world impact has increasingly become a challenge for university research. The conservatism of academic and corporate R&D programs has led to a "gap" in use-inspired basic technology research with reduced academic and corporate effort in the very early stages of technologies and products. An essential component of the Cornell Tech mission is to support the integration of academic research with uses outside academic settings, both to achieve direct societal impact and to inform academic directions and research questions. The Runway program was designed as an innovative institutional element to bridge this gap. Cornell Tech faculty supports the program. They do not consider Runway postdocs to be "failed academics"—quite the opposite. They are considered role models for applied and translational research fitting the research mission of Cornell Tech.

Nevertheless, interviews with faculty and survey results show inherent challenges. In Runway candidate selection, faculty as academic supervisors play a well-defined and leading role to ensure that candidates have the academic credentials and the right fit for the Cornell Tech research community. During the initial Runway period, the postdoc reports both to his academic supervisor and the Runway director. Interaction with academic supervisors, however, varied considerably. 60% of the postdocs met their academic supervisor less than once a month, while 12% did so once a week. This last group attended research seminars, gave lectures and provided internships to Cornell Tech Master's students.

The main reasons for lack of interaction mentioned by postdocs were their focus on business and building a prototype in which faculty could not help or was not interested, or when the supervisor's knowledge became less relevant after pivoting to a different technology. Cornell Tech faculty mentioned their workload in the "startup" Cornell Tech. Indeed, there was a higher level of interaction with the established Weill Cornell Medicine faculty and students. Both Cornell Tech faculty and Runway postdocs showed interest in a continuing research- and teaching-related affiliation after the initial 2-year Runway period. A number of suggestions were made for improvement, such as applied research hackathons, joint research and internships when companies mature, seminars and adjunct teaching in the graduate program. These suggestions are to be incorporated in upcoming design cycles of the Runway program.

Objective 5 Develop a startup postdoc program that is applicable in other universities.

92% of the postdocs recommended establishing a Runway startup postdoc track in other universities. "Definitely, it is good for the economy, the graduate students and the university." The interviewed investors and visiting committee members were strongly in favor of establishing similar programs in other universities. Typical comments were:

"Runway for research universities makes a lot of sense from a strategic point of view. There are many incubators but Runway aims at Ph.D., deep technology level. Runway is closer to translational research." "Do not restrict to Ph.Ds at one university but offer a regional program to encourage variety. Look for alignment with the SBIR/STTR programs." "The presence and support of a strong local ecosystem as in NYC has to be considered but the location should be less of a constraint than a way to shape the program."

Faculty interviewed were in favor of the program as a good route for translational research. They would recommend the program to other universities, but suggested that preferably, these should be established in universities in large cities or in smaller cities with a medical school, or in a large university hospital, with an emphasis on healthcare related postdocs.

6 Reflecting on the emerging evidence and its implications for program design, contribution to research, and research directions

The Runway program met most of its initial objectives except the intended knowledge spillovers between Runway postdocs and regular postdocs and their research community. Whilst both faculty and the Runway postdocs are in favor of such a spillover effect, the divergence of interests and time pressure during the Runway program make it problematic. The causes of the problematic (non)spillover effect between research and commercialization of research, however, may be more fundamental. Kolympiris and Klein (2017) showed that academic incubators negatively affected the quality of innovations at US research-intensive universities because of their drain on university resources. Toole and Czarnitzki (2010) showed the trade-off between academic knowledge accumulation and commercialization of university discoveries in the case of life scientists joining SBIR granted companies. These studies, however, highlighted the costs of spillovers from academic research to application and commercialization in terms of an academic brain drain. Not studied was the spillover effect from applied, use-inspired research to basic science (Stokes 1997). The premise of the research mission of Cornell Tech is that integration of academic research having uses outside academic settings would both achieve direct societal impact and also inform academic directions and research questions, encouraging a two-sided spillover effect. In future Runway cycles these two-sided spillover effects should be designed for and include affiliation of postdocs and their companies with faculty and the Jacobs Institute after the Runway period.

Initial results of a startup postdoc program as a technology transfer channel and postdoc education vehicle are promising. We suggest that the following properties were key contributors to its success:

- Designing and framing the program as a 2-year postdoc program, leveraging the institutional arrangements for postdocs, and allowing for a sufficient transition period from scientist to entrepreneur and sufficient time to build a sustainable platform and company irrespective of the technology.
- Selection of postdocs committed to starting a company and eminent in their area of research.
- Ensuring a structured education and review program, guiding the postdocs during the three main phases of their startup development: opportunity framing, pre-organization and re-orientation.

- The fit of the program with the research and education mission of Cornell Tech in the NYC ecosystem, which provides it with legitimacy vis-à-vis stakeholders in the university and NYC. Runway demonstrated the potential impact of research and early on made a visible contribution to the objectives of Cornell Tech and the Jacobs Institute.
- A transparent and entrepreneur-friendly IP and financial model in which postdoc employment costs were compensated through a small stake in his or her company.

The startup postdoc program faces several challenges. The startup must acquire critical resources early but avoid path dependence and keep options open. The program starts with a single postdoc founder who has to get fully engaged in the opportunity framing and pre-organization phases and, at the same time, has to develop an MVP. Six postdocs teamed up with a technical co-founder at the beginning of the program to have initial development resources. Two of the postdocs teamed up with a commercial co-founder early but both had to separate because the company pivoted and his specific experience became irrelevant. The challenge of identifying and matching business mentors can be daunting, in particular at the beginning of the learning curve and when uncertainty is high.

A related challenge is defining and ensuring the interaction with and support needed by the ecosystems within and surrounding the university. Cornell Tech, the Jacobs Institute and NYC were ideal support systems that were aware of the potential contribution of a startup postdoc program to their ecosystems. Institutional logics of traditional research universities may be less forthcoming in supporting a startup postdoc program.

The program's financial sustainability is another challenge. Achieving a sufficient return on investment for the Jacobs Institute's stakes in the Runway companies will be quite a challenge, given that these are risky early stage high-tech companies. This risk is compounded by Runway's given preference for high impact ventures over potential high return ventures. At the startup phase of such postdoc programs, a large cash outlay is needed for a number of years. In the Runway case, donations provided this cash. Possible government supported funding is an additional option to jumpstart a postdoctoral technology transfer program, in addition to SBIR/STTR grants and the NSF Partnership for Innovation Initiative in the US and similar programs in other countries.

6.1 Contribution to research and proposed research directions

The Runway program will continue and so will the action research as part of learning from this experiment. Its contribution to research has been the application of research findings of academic entrepreneurship and technology transfer by spinoffs in an experimental setting of a greenfield university that offered a large degree of freedom for experimentation. Reflections on the initial results have raised a number of research questions to be investigated during future Runway cycles and by scholars in the field:

1. The transformation process of the postdoc from scientist into entrepreneur has been highlighted as being key in the development of the spinout but additional fine-grained research on the dynamics of that transformation is needed. Open questions that must be answered are: What are the effects and interactions of postdoc characteristics, the technology/industry area, the opportunity pursued, the education offered, the program structure and mentor resources in that transformation and how do these interactions affect the startup performance? As a first step, longitudinal qualitative research as part of the action research is proposed.

2. Related to the above, more understanding of resource building in a spinoff is needed, e.g., the profile of the resources and the appropriate timing for acquiring these resources, including co-founders, during the development phases of the startup and their effects on the startup's too-early path dependence must be clarified.
3. In the research literature on venture creation and blogs on accelerators, mentors are considered a key resource. To date, however, there is little rigorous research on mentors, the way they are matched with entrepreneurs, their interaction and their actual contribution to venture creation. This lacuna must be filled.
4. More understanding is needed on the interaction between university spinoffs and their academic founder and the university and its surrounding ecosystem as a context and as a key contributor. The case of NYC and Cornell Tech is arguably an exceptional one. A better understanding of the critical characteristics of the university and its ecosystem necessary to launch a successful student-driven academic entrepreneurship program such as Runway is needed, building on the work done by Wright et al. (2017). Ideally, a Runway-like startup postdoc program would be tested in different academic and ecosystem settings.
5. While accelerators and academic spinoffs programs proliferate, little relevant and comparable data are available. Comparison with future similar Ph.D./postdoc programs at other universities with different ecosystems and with Ph.D./postdoc-founded spinoffs in academic incubators where contact with academia is looser and education is less structured would provide added insights into the pro and cons of a postdoc startup program compared with other approaches.
6. A deeper understanding is needed regarding the two-sided spillover effects between applied/translational research and basic research and is a subject for action research in following Runway cycles. The relation between basic and applied science has been a continuous subject of discussion in universities and corporate labs (Stokes 1997). Further action research in the Runway program offers the opportunity to investigate this relation and interaction on an operational level.

7 Conclusions and recommendations

This paper presents action research on the Runway Postdoctoral Startup Program as a case of academic entrepreneurship and technology transfer, fitting the research and education missions and programs at Cornell Tech, a greenfield applied research university. It makes the case for a successful research commercialization pathway and transformative postdoctoral education, and it also shows opportunities for cross-fertilization of the program with faculty research, graduate student education and community engagement.

The pathway to academic entrepreneurship will differ from one university to the next. Designing and implementing a Runway-like program for postgraduate students at other universities could serve as a change carrier for technology transfer and commercialization programs and graduate student education. It would link faculty to broader economic engagement and societal impact.

The present technology transfer programs and initiatives aimed at individual faculty members and students range from TTO supported spinoffs, the national i-Corps and STTR/SBIR programs in the US and individual initiatives of faculty and students often inspired by entrepreneurship courses. While these individual initiatives for spinouts by scientist

founders are and remain an option for academic entrepreneurship, a formal and recognized university startup postdoc program offers additional advantages:

1. It formalizes academic entrepreneurship and adds to the diversity of entrepreneurship programs. As a postdoctoral program, it is a formal academic program feeding on curricular programs in entrepreneurship but also on extracurricular activities such as hackathons and business plan competitions. The program has clarity of purpose for faculty and graduate students, lowering the barriers for rapid transformation of technology into marketable products.
2. It complements, enhances and incorporates TTO supported technology transfer. As a formal, structured university program of translating and commercializing early stage research discoveries, it promises a higher success rate because of the organized, transformative learning, the committed postdoc top talent, and access to university networks and resources.
3. Initial results of the Runway case show that 2 years, following a technology invention, is sufficient to build a sustainable company irrespective of the type of technology.
4. The program connects to the university's broader economic and societal engagement, beyond patents, licensing and transactions. It integrates tech transfer and commercialization within the research and teaching missions of universities. As such, it aligns well with NSF/NIH initiatives such as SBIR and the recently launched, by NSF, Partners in Innovation program and similar programs in other countries.
5. It offers a new approach to postdoc training for non-academic career options and offers faculty the opportunity to learn and get engaged in applied research and research commercialization as part of their education and research missions.
6. For universities with a well-established postdoctoral program, institutional procedures and resources would be available to duplicate and adapt the Runway Startup Postdoc Program provided that initial funding in some form is available.

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