Technology… Innovation and Integration
The Dr. Miriam and Sheldon G. Adelson Educational Campus

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Introduction

The educational landscape is evolving rapidly as technological innovations change the way students learn and teachers instruct. Traditional teaching models and settings are no longer sufficient to prepare learners for success in the knowledge economy of the 21st century. "Economic success is increasingly based upon the effective utilization of intangible assets such as knowledge, skills and innovative potential as the key resource for competitive advantage. The term 'knowledge economy' is used to describe this emerging economic structure." [1]

The Adelson Educational Campus (AEC) **innovates** cutting-edge new technological approaches to teaching and learning and **integrates** technology with the school curriculum and the purpose of providing students a relevant and progressive "Education for Life."

Components of the Technology Initiative

Our technology initiative for innovation and integration as implemented for the 2016-2017 school year is comprised of four components:

1. *The Startup Incubator* – At 5000 square feet, this innovation and entrepreneurial workshop is our centerpiece facility in which students and teachers bring ideas to life. Consisting of a Coding Lab, Digital Media Studio, and Fab Lab, the Incubator features twenty 3D printers, a laser cutter, a chroma key wall, digital cameras, and more. From programming mobile apps and shooting VR footage to crafting e-textiles and building drones, students find the tools, mentors, and teamwork required to create digital and physical artifacts that solve problems, convey information, or present artistic and cultural meaning. Students follow the Design Cycle and Lean Startup model as guiding practices in the Incubator. A dedicated Startup Incubator Coordinator position has been created to oversee Incubator operations and serve as lead teacher on Incubator courses.

2. *Curriculum integration and STEAM (science, technology, engineering, arts, mathematics) courses* – Technology-mediated access to tools for research, communication, collaboration, analysis, visualization and presentation – framed in common sense digital citizenship practices – is fundamental to every course we instruct. Additionally, weekly coding/maker courses in Lower School; core and elective Incubator courses in Upper School, as well as AP Computer Science

courses; and summer STEAM enrichment offerings provide extensive opportunities for engaging in a true, 21st century learning experience at AEC.

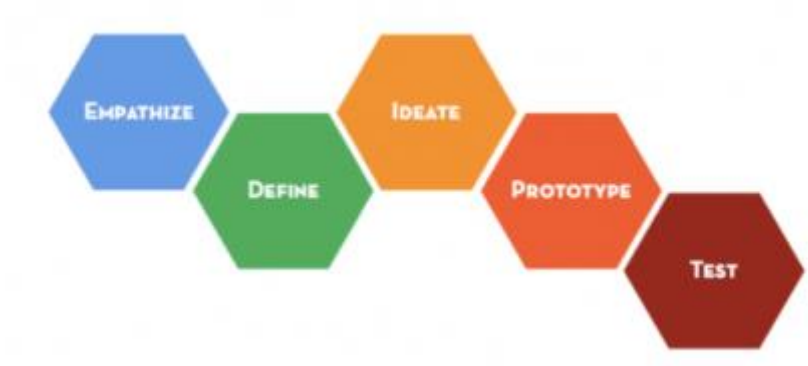
3. *One-to-world devices* – A mobile device (laptop or iPad) with fast and reliable network access is provided for every student and teacher, campus wide. Devices are used daily in all grades, and Upper School students take their laptops home for continued learning beyond the school day. As part of this component, an *IT Audit* has been conducted, and subsequently the school network upgraded, to ensure that technology infrastructure is powerful and reliable.

4. *Extensive technology professional development for teachers* – Because technology is ever-changing, ongoing PD ensures our campus is the exemplar, "school of the future," with every teacher possessing the content knowledge, pedagogical content knowledge, and mastery of appropriate technology use in her or her discipline required to provide the highest caliber of instruction in all subject areas. A dedicated Tech PD Coordinator position has been created to develop and implement a personalized technology professional development plan for every teacher in the school.

A fifth component, AEC Online – a branch of our school offering online courses – is planned for future implementation.

1. The Startup Incubator – A Facility for Design Thinking

The centerpiece of our initiative is the construction and operation of a cutting-edge innovation and entrepreneurial laboratory in which students engage in design thinking, identifying real-world problems or needs, then implementing the design cycle to empathize, define, ideate, prototype, and test solutions (as per the Stanford d.school process).[2] In this process, students design and make digital and physical artifacts for exploration, aesthetic enjoyment, decision-making, and distribution in the marketplace. Unlike the traditional didactic learning model of decades past, the 21st century constructivist learning model views students as the generators of ideas with teachers and mentors serving as supportive guides. Emphasis is on bringing concepts and ideas to fruition, not passively acquiring the same knowledge of previous generations.



As noted by Paulo Blikstein in the Stanford School of Education, "Every few decades or centuries, a new set of skills and intellectual activities become crucial for work, conviviality, and citizenship — often democratizing tasks and skills previously only accessible to experts. Today, the range of accepted disciplinary knowledge has expanded to include not only programming, but also engineering and design.[3] I wonder what would happen if instead of waking up every day and going to school to learn yet another formula, yet another piece of information, kids would wake up every day to go to school to invent something new… every day, a new invention, every day, a big idea." [4] This is the premise of the **Startup Incubator**: the classroom is transformed into a large workspace with tools, materials, and mentors for inventing those big ideas.

<u>Skills and competencies developed in the Startup Incubator</u>

Using state-of-the art tools in conjunction with expert adult guidance, students:

- brainstorm apps and products
- research and analyze information
- design, develop, and revise plans
- evaluate concept feasibility
- consult and collaborate with peers and experts
- create, code, and prototype with a wide range of materials and tools
- share completed projects with the school and the world
- present and defend work
- compete finished projects
- enjoy and value bringing a concept to fruition
- share, monetize and market completed projects

Instead of the entirety of students' educational experiences remaining rooted in traditional instructional modes – listening, note-taking, memorizing, studying for tests, and engaging in primarily verbal/written modes of learning – students are replacing many antiquated school practices with dynamic, real-world experiences.

Designing and building actual products – our long-range vision for the Startup Incubator

In the Startup Incubator, students research, define, tangle with, and conquer messy challenges that excite and inspire them every day. Some challenges are large and world-changing in scope, such as the Grand Challenges for Engineering in the 21st Century.[5] These challenges consist of themes such as providing access to clean water; advancing health informatics; restoring urban infrastructure; preventing nuclear terror; and securing cyberspace.

Making an impact on these and other real challenges is a doable task for our students, as evidenced by other youth nationwide. In 2011, Taylor Wilson, age 16, built a highly-sensitive radiation detector that won him funding offers from the U.S. Department of Homeland Security who wish to use it for counterterrorism.[6] In 2014, Suvir Mirchandani, 14, demonstrated that the federal government will save $234 million annually by printing documents using a less ink-intensive font.[7] And in 2015, 16-year-old Olivia Hallisey, won the Google Science Fair for creating a fast, cheap, and no-refrigeration-required test for Ebola.[8]

However, not all real-world challenges and innovations are grand in scope, nor engineering focused. Wavelet, a Kickstarter product, converts the sound wave of a person's voice into a 3D model, which is then 3D printed as a silicone bracelet.[9] Videogames, including the Bubble Ball puzzle app coded by Robert Nay, 14, have been downloaded millions of times.[10] Many innovations are architectural, or artistic in nature. Champion Future Cities teams from Las Vegas, led by our own Director of Technology Innovations, have created scale models out of recycled materials and simple electronics – cities such as Vegas 2.0 and Alpha Luna Prime.[11] Dance troupes are now incorporating innovative mechanisms and LED lighting in their shows as evidenced by groups such as Fighting Gravity on *America's Got Talent.*[12] All aspects of the arts are ripe for innovation, and today's technological tools lower the entry floor and afford all students the opportunity to enter a world previously owned only by experts.

In the AEC Startup Incubator, students have the opportunity to produce:

- mobile apps and websites
- cybersecurity tools
- wearable electronics, e-textiles
- robots, rockets, and drones
- architectural blueprints and models
- engineered entertainment
- digital photography, video, animation
- augmented, virtual reality
- IoT (Internet of Things) devices
- green technologies

No other school in the Las Vegas valley features an inventor's workshop of this size and scope. As such, the Startup Incubator serves the students of AEC as the most unique, STEAM learning environment in the region.

Facilities and tools of the Startup Incubator

The Startup Incubator consists of three areas: a **Coding Lab**; a **Digital Media Studio**; and the largest and most expansive zone – the **Fab Lab**. The Fab Lab also includes a ventilated and secured Heavy Duty room for high-noise and dust-producing devices.

The following nonconsumables are available to students in the Startup Incubator:

- state-of-the art computers
- powered workbenches
- smartboards and televisions
- network connectivity 3D printers
- software (programming, design, animation, editing)
- whiteboards
- lighting grids for video production
- digital still and video cameras
- large stage chroma key screen
- adjustable lighting and gels
- die cutting machines
- color printers
- microphones, sound booth
- soldering irons
- glue guns
- goggles and eyewash station
- ventilation hood
- electronics kits (Arduino, Raspberry Pi, Makey Makey)
- rubber mats for grounding
- robotics kits (Mindstorms EV3, VEX) and robot arena
- drone components
- CNC milling machine
- sewing machines, mannequins
- blow dryers and fans
- sink, vacuum, and trash cans
- hand tools (hammers, screwdrivers, drills, saws)
- storage cubbies and shelves
- electronic multimeters

Consumables, including filament (ABS, PLA), wood, adhesives, nails, and other items are recycled and replenished as needed. Rechargeable batteries are used when possible.

Construction and inauguration of the Startup Incubator

The Startup Incubator is sited in a large, central, highly visible location on campus. With decreasing need of a traditional library,[13] the space that previously served as a library and media center was renovated and reinvigorated for use as the Incubator. A portion of the center had already been transformed for digital arts classes; transformation of the remaining space for coding and maker purposes was a natural progression. (A new, small, classroom-based Reading and Research Room replaced the former library.) Reconfiguring this space of approximately 5000 square feet cost $110 per square foot (construction and fixed furnishings) to offer an inviting, collaborative, project-based learning environment.

Attention to aesthetics has been critical in building a welcoming, gender-neutral, functional workspace with a modern feel. Internal, windowed walls provide extensive visibility to the students and their creations, showcasing the cutting-edge facility to peers, teachers, parents, visitors, press, and potential new students; external windowed walls provide natural lighting to the facility. Finally, an RGB (red-green-blue) theme, tempered with neutral grays, provides technologically relevant color accents to the space.

Design and construction of the facility occurred from June through August of 2016, with a ribbon-cutting in September 2016. Daily operations are managed by the Director of Technology Innovations and the Startup Incubator Coordinator, with additional teachers and collaborative mentors working in the facility.

2. Curricular Integration and Incubator Courses

New curriculum and instruction are offered in the Startup Incubator, specifically courses in coding, digital media, and fabrication. **Coding**, also known as computer programming, is the language that mediates communication between humans and technology; this fourth literacy is taught following curriculum models established under the direction of Judith Gal-Ezer of the Open University of Israel.[14,15] **Digital media** courses include photography and image manipulation via tools such as the Adobe Creative Suite; 3D rendering and architectural blueprinting via CAD tools; animation, augmented reality, virtual reality, and video editing via video productions tools; and audio production, mixing, and sound editing via audio production tools. **Fabrication** (design, engineering, and making) courses extend the abstraction of creating in the virtual world of the computer to the concrete, physical world via textiles, electronics, robotics and other high-interest applications.

As Seymour Papert of the MIT Media Lab notes, “Construction that takes place ‘in the head’ often happens especially felicitously when it is supported by construction of a more public sort ‘in the world’ – a sand castle or a cake, a Lego house or a corporation, a computer program, a poem, or a theory of the universe… the product can be shown, discussed, examined, probed, and admired. It attaches special importance to the role of constructions in the world as a support for those in the head, thereby becoming less of a purely mentalist doctrine.” [16]

Curriculum development and examples

Curriculum is designed and implemented by our Incubator staff, under the direction of our Director of Technology Innovations. Supporting content is delivered through our school learning management system, Edsby. Example content and materials are available on our Startup Incubator website, startupincubator.site on the web.

Incubator courses, required

All sixth graders and all ninth graders enroll in a required, Startup Incubator course. Required courses focus on grade-level appropriate skills in the design cycle, coding, digital media and fabrication. Startup Incubator curriculum is structured as multi-week, project-based, ever-changing, thematic workshops somewhat similar to those featured at NuVu Studio (Cambridge).[17] Nine sequential units of study, each approximately two weeks in duration (approximately 7 hours of study per topic), transpire during a semester of study in the Incubator. As all students are starting at "square one" this first year, we are currently establishing a baseline of instruction for all student groups. Ongoing tool utilization and safety instruction are provided as new tools are needed and introduced.

- *Unit 1: Introduction to Design Thinking*

This unit introduces students to Design Thinking through active processes featuring the Marshmallow Challenge; 50 Problems in 50 Days; and the Wallet Challenge.

- *Unit 2: Introduction to Computational Thinking and Coding*

This unit emphasizes concepts fundamental to all programming languages, laying the foundation of computation thinking for future coding. Standard practices, including simplicity, modularity, abstraction, and debugging are addressed in the easy-to-use Scratch environment through projects including searching, sorting and simulation.

- *Unit 3: Mobile App Development (emphasizing game development)*

This unit elevates students' design and coding skills, applying them in a game development context. Using GameSalad, students create real game apps featuring collection, dodge, and platformer genres, using professional graphics and sound effects. Completed apps are emulated on mobile Apple or Android devices.

- *Unit 4: 3D Design and Fabrication*

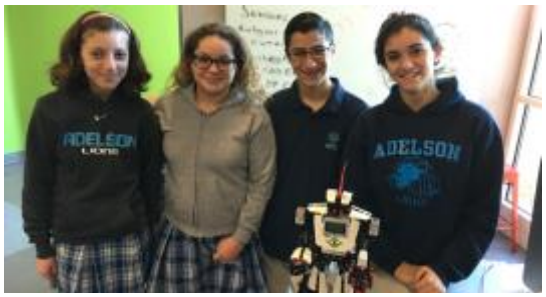
This unit migrates students from reading design diagrams and building with existing structural components to drafting their own designs and fabricating them. Using TinkerCad and Fusion 360, participants build skills in three-dimensional design, then output their creations via 3D printing, milling, and laser cutting.

- *Unit 5: Robotics – Software Development*

This unit applies coding concepts to the field of mechanical engineering. Students command sensors, motors, LEDs, speakers and other robotics components in the execution of performance tasks such as orientation reporting, obstacle avoidance, and maze navigation. The Finch robot, as well as the virtual environment, Coderz, focuses students on the software aspects of robotics prior to engaging in robot construction.

- *Unit 6: Robotics – Basic Hardware Development*

This unit challenges students to design and construct robots for specific performance tasks, such as rolling over terrain to deliver supplies, or scooping up and launching a ball. Using Mindstorms EV3 participants bring their robots off the screen and into the physical world.



- *Unit 7: Digital Media Design and Production*

This unit explores methods and tools associated with digital media. Sample topics are drawn from photography, videography, video editing, animation, video special effects, Claymation, digital image editing and digital audio production. Special emphasis is placed on the use of digital media tools in business and marketing, for example, designing a logo and recording a satellite radio advertisement.

- *Unit 8: Electronics*

This unit focuses on the development of fun and functional electronics, coaching students to move fluidly between schematics and wiring circuits. Using the CIJE (Center for Initiatives in Jewish Education[18]) Electronics unit, students work with Arduinos, electronic components, and code to create functional circuits such as a pool pump that activates according to temperature readings. Basic electronics skills, such as soldering, are also developed.

- *Unit 9: Aloft in Aerospace*

This unit introduces an array of investigations in aerospace, with selections from aerial photography, rocketry, drone flight, space exploration, and space habitation. Currently, students employ 3D printing, electronics, and coding to construct a small quadricopter to fly an obstacle course above the school field. Future projects may feature the design of a package delivery drone that moves between pickup and dropoff locations on campus, or synchronizing drones in pre-programmed flight patterns in an elegant "drone dance."

- *Culminating Project: Putting it all Together*

Students culminate their one-semester survey experience with a small, design challenge that is appropriate to the interests of each student. One task features the opportunity to develop a concept and initial prototype for a specific need, such as an adaptive technology or ability-enhancing tool for a differently-abled person or pet. Another task features designing a 3D printing a dreidel for the dreidel competition.

Incubator courses, elective

Students in grades seven and eight, as well as grades ten through twelve, may enroll in elective Startup Incubator courses. Elective courses afford students a project-based, studio environment – applying the basics they learned in the required Incubator courses – with students identifying and defining projects of their own interests, then working through the design cycle with mentors from research and industry to bring their concepts to fruition. Elective courses at the high school level also emphasize lean startup practices to assist students with entrepreneurial interests in taking developed products and services to market. These courses also include weekly tech seminars addressing progressive research and current events.

High schoolers with specific interests in computer science may also choose to take AP Computer Science Principles and AP Computer Science A courses.

Projects underway… and school wide collaboration

Adelson students have already begun creating a wide range of creative products in the Incubator. One senior is designing and 3D printing a rocket, and programming a microcontroller to control its flight profile during a forthcoming competition. Another senior is designing her own custom line of gladiator sandals, fashioned from 3D printed soles embedded with LED lights. Another group of high schoolers is creating a custom mount to execute high speed digital photography from a drone; they are planning to merge the photos with Google satellite images to create a promotional video for the school. Another pair of students crafted a custom backgammon board, then fabricated it using the laser cutter. Many of these Upper School students have begun formulating plans for developing their own lean startups during the spring; our partnerships with the University of Nevada, Las Vegas department of Engineering and the UNLV Center for Entrepreneurship will continue to cultivate and direct their planning.

Additionally, via collaboration with subject-matter courses throughout Adelson, the Incubator is being used increasingly for projects that could not previously have been executed in the classroom. Lower School science students are planning to design and build, as per parameters set out in the Torah, a scale model of Noah's Ark – then test the "seaworthiness" of their models at the school natatorium. Fifth graders in Project Beyond are modeling Mars habitation modules in Sketchup, then exporting their designs to Lumion where they are applying textures and terrain, ultimately creating a video flythrough for submission to a Lockheed-Martin competition. A Judaics teacher is leading her sixth graders in the construction of the "Ten Plagues of Egypt" in Minecraft. Seventh grade life science classes are working on a simulated bioprinting project: mentored by a UNLV biotechnology professor, students are using Sculptris and flexible filament to design and print lifelife, full scale human organs. Freshmen in Arts Odyssey are programming in MIT App Inventor to create a soundboard app featuring music samples of famous composers. Finally, students in Judaics and Hebrew courses school wide are preparing for Hanukkah celebrations by designing and printing dreidels for a forthcoming "Best Spinner" competition.

3. One-to-World Devices

One-to-world devices are necessary to ensure that daily teaching and learning at AEC are keeping pace with comparable, elite, independent schools internationally. Successful integration of technology within schools requires that both teachers and students possess easy access to the tools needed to instruct and learn. But as educational blogger Alan November points out, "The critical question is not, 'What technology should we buy?' The more important questions revolve around the design of the culture of teaching and learning. For example, how much responsibility of learning can we shift to our students? How can we build capacity for all of our teachers to share best practices with colleagues in their school and around the world? How can we give students authentic work from around the world to prepare each of them to expand their personal boundaries of what they can accomplish?" [19]

<u>Investing in a one-to-world paradigm</u>

In a successful, tech-integrated campus community, all students and teachers require regular, reliable access to technology. Every child possesses a device for accessing a wide array of learning tools, including the Internet. Lower School students and teachers (grades K-5) use iPad or iPad Mini tablets, with all devices loaned by the school. Upper School

students and teachers (grades 6-12) use MacBook Pro (13", 2.5GHz, 500 GB) laptops. Upper School individuals may use either a bring-your-own-device (BYOD) or a school-supplied device. A four-year lifetime is predicted for each device, and an annual repair fee is included in the budget.

Teachers no longer have to schedule a laptop cart, which was not always possible, to conduct a technology-integrated learning activity. Students and teachers are able to use their devices anytime, anywhere, at school, and – for the Upper School – at home. Most importantly, the technology tools necessary for designing, creating, producing, researching, exploring, modeling, collaborating, discussing, analyzing, reflecting, evaluating and presenting – critical components of any modern educational experience – are always available by every member of the AEC learning community.

Auditing to validate the AEC technology infrastructure

To ensure the successful rollout of a one-to-world program, a school wide IT audit was conducted. This audit employed an experienced outside firm to review the current AEC technology infrastructure – hardware, software, security, MIS, LMS (Edsby), logistical procedures – and management. Outcomes and an action plan resulting from the IT audit were communicated to the Information Technology (IT) Director and Head of School, and actions taken to upgrade the school network to ensure success with one-to-world implementation.

Further, exemplary information technology staff are needed to maintain the school network, devices, and database. An IT Service Team possessing significant, relevant training and experience in the field, operates onsite to service the daily technology needs of the school. At the direction of the IT Director, the IT Service Team manages the operational details of the school network, hardware, and software to ensure that the school's technology is functional, up-to-date, and secure. Most critically, the IT Service Team provides "rapid response" assistance for classroom technology problems that inevitably arise during the school day.

4. Professional Development for Teachers

Exemplary teachers use technology when it inherently enhances instruction in specific contexts. There is no single tool that applies to all subjects, and thus no single method of quickly training all instructors "to teach technologically." Teachers best hone their technological teaching skills by interacting with peer teachers and observing best practices. To this end, all teachers must be provided regular opportunities to attend professional development conferences and enroll in professional development courses that emphasize best technology practices in their respective fields. Our initiative includes an annual investment in school wide coaching in cross-curricular technology practices (such as flipping classrooms), as well as funding by division for teachers to participate in courses and conferences. Additionally, as EdTech Magazine points out, "Teachers respond to the people who evaluate them, who they see every day and who set expectations for

their school. If we could get principals on board, surely these teachers who have been sitting on the sidelines would join in." [20] To this end, division heads play an active, hands-on role in promoting, modeling, and holding teachers accountable for the integration of technology in instruction.

To provide strategic management and support to teachers in technology professional development, an exemplary Technology Professional Development Coordinator has been appointed. The Tech PD Coordinator ensures teachers, K-12, understand and implement best educational technology integration practices in their subject areas, including appropriate use of hardware, software, online tools, and the school wide Edsby learning management system. The Coordinator also works directly with teachers and possesses significant relevant training and experience in the field – in both technology and Judaics instruction – thereby providing an integrated experience customized for our Jewish day school.

Personnel Organization

Personnel responsible for executing the initiative are: the Director of Technology Innovations; the Startup Incubator Coordinator; the Technology Professional Development Coordinator; the Computer Science Teacher; the Digital Media Teacher; the Digital Music Teacher; and the Lower School Technology Teacher. Each of these individuals serves as a lead teacher for his or her own subject matter or grade level, as well as serves as a mentor for all Incubator activities. All teaching staff are high-impact instructors with extensive experience in STEAM – science, technology, engineering, art, and mathematics – and expertise in coaching all students and teaching staff to achieve success in using technology. Along with the daily support of our Facilities Director and our IT Service Team – as well as the exceptional leadership of our school Headmaster – the Adelson Educational Campus is fortunate to possess the human infrastructure required for implementation of this unique technology initiative.

Budget

Establishing one-to-world connectivity, empowering highly trained teachers, creating technologized classrooms across the curriculum, and building and operating the Startup Incubator provides our students the most unique learning environment in the world – and stands as a showcase example of how a forward-thinking Jewish day school can evolve to provide an exciting, progressive, and relevant education for the 21st century.

Our technology initiative has been funded with an initial $1M grant, with recurring expenses to be evaluated, adjusted, and budgeted annually according to school needs. Key initial expenses consist of the one-time design and construction of the Startup Incubator; outfitting of the Incubator; and initial purchase of one-to-world devices school wide. Key recurring expenses consist of personnel; professional development expenses; software licenses; consumable materials used in the Incubator; and replacement of one-

to-world devices. As our team develops the vast majority of our curriculum, we incur minimal annual expenses in this category. Other schools seeking to create similar STEAM experiences may do so with far more restrictive budgets. We are happy to share our experiences with other schools seeking to add progressive technologies to their schools in an effort to elevate the STEAM opportunities of as many students as possible.

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