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RE: Visualization, Digital Media, and Data Exploration, VT Creativity and Innovation District

As Virginia Tech forges a pathway toward systemic interdisciplinary innovation, it has become clear that a scalable, heterogeneous, and ubiquitous solution for exploring data and creating immersive simulations needs to be created. This proposal, a collaborative effort of the faculty at Virginia Tech who are the experts in this field and who are/will be charged to support such an effort, discusses the motivation and context for such a solution (or more appropriately, array of solutions) and a phased plan for piloting it, that will form the foundation for an array of studios unlike any in the world.

Motivation:  
Why is visualization (and other sensory representations of data referred to as data exploration) so important?

The ability to understand, analyze, and communicate the value of data in all its diverse formats is an essential 21st century skill. Establishing relationships between and across data to inform decision making cuts across all disciplines and media types. Students and faculty increasingly require spaces and services which enable them to engage, explore, and experiment with the technologies of data visualization (data storytelling) and immersion and, more broadly, media production, in order to remain competitive in their respective fields and professions. Technological literacy is a key ingredient of the VT-shaped student.
Context:
Virginia Tech is on a path to becoming a world leader in data exploration and immersive analytics. It already has an array of unique studios supporting various aspects of research, teaching, and outreach in this area. These include:

The ICAT Cube (see http://www.icat.vt.edu/content/cube-0), is the world’s preeminent environment for immersive audio and video. It contains an elaborate motion-capture system, audio infrastructure, cyclorama, and an array of HMD’s and hosts faculty and students from across Virginia Tech and the world. It has been the subject of numerous international articles as well as international festivals of creativity and innovation. While it is used for both classes and research, it is designed as a “high end” facility and not to support large numbers of students and faculty as is envisioned in this proposal.

The ARC Visionarium Lab provides diverse visualization hardware and services for students and faculty (from software to workstations to HMDs and a high-resolution CAVE) as well, but also does not have enough space or resources to serve at the massive scale we envision here, but can serve as a model for individual perspective environments.

The ICAT/Libraries DAAS Lab is a collaborative multimedia studio that supports animation and visualization in the library. While it handles large numbers of students, it is at its capacity. It is also designed for classes and not for individuals to come use the facility.

The Libraries Data Viz Studio is a space where students and faculty can learn how to present their data in beautiful and meaningful ways. The Studio provides consultations, workshops, ideation sessions, and group or individual tutorials covering data visualization, design, interaction, and communicating information graphically.

The Libraries Virtual Environments Studio is a place for students and faculty to experience virtual reality in a relaxed setting without having any prior knowledge of the technology. The Studio provides the hardware and software for games, movies, artistic experiences, and educational content.

These studios have helped inform this proposal and are critical components to the heterogeneous array of facilities necessary to be a world leader in data exploration. However, given the explosive need of our students and faculty to have access to such facilities (further fueled by the creation of the destination area initiative) and given the broad spectrum of requirements that these facilities need to support, a new scalable set of studios needs to be created. The recent closing of the TLOS InnovationSpace has made this need even more urgent.

Goal:
We propose three complementary studios — a digital media studio, visual analytics studio, and an immersive environments studio — that can meet a variety of user needs, from media production software and equipment to long-term project development for high resolution large-scale displays and high-performance computing. The studios would be a partnership between the University Libraries, the Institute for Creativity, Arts, and Technology (ICAT) and its Center for Human-Computer Interaction,
the Department of Computer Science, the Discovery Analytics Center, TLOS, and Advanced Research Computing (VT IT). These three studios together will support a major new initiative in immersive analytics between ICAT/CHCI/DAC Libraries involvement, in which immersive technologies are used to display, interact with, and analyze complex abstract data.

Long-term vision:
We envision visualization centers in each of the neighborhoods of campus that share common attributes:

- **Flexibility:** The proposed studios can meet a variety of needs, both simple and complex. Some sections of the space can be physically rearranged based on current user needs.
- **Always on:** The technology must be easily accessible and easy to interface with. Users should not have to figure out how to boot up a complex system in order to use it. They should just be able to plug in and start working.
- **Concierge services:** Some users just need space and equipment, and they can develop their own projects. Other users have expert knowledge in other fields but require extensive assistance in bringing their ideas to fruition. A significant aspect to this proposal is a concierge service of dedicated staff who can assist at all levels, from short individual software assistance sessions, to workshop (or course session) instruction, to lead project development, to studio infrastructure development.
- **Format conversion tools:** To move between the stages of the studio, and to transition projects to other visualization facilities within or outside the university, there must be a system for converting projects between formats, both open and closed source. The studio staff will develop tools and guidelines for converting between as many systems as possible.
- **Virtualization:** One possible approach to user engagement is that instead of providing powerful desktop computers for each workstation, users will bring in their own laptops, connect to a local monitor or touch screen, and log in to a virtual machine (VM) served from a powerful server. Each user’s VM instance will be spawned with the appropriate software for their needs, and will be more powerful than a standard desktop computer because it is hosted on high-end centralized hardware. This allows users to perform high-end visualization tasks, and removes the requirement for moving files from a local machine to a remote cloud for computation or rendering. It should also save money in the long term by reducing hardware purchasing costs.
- **Visibility** (should be in high-traffic areas, should present interesting things to passers-by, should give a sense of constant activity)
- **Serves a wide range of users and needs** (everything from permanent faculty researchers, to grad students working on a multi-year dissertation project, to students working on a one-semester class project, to faculty who need visuals for a seminar or class, to students who just want to play around with technology)

**Centers associated with specific DAs/SGAs:**
We also envision visualization centers that support the relevant DA’s

- Each one is configured differently to serve the needs of the relevant domains
- Each one has common elements (see the goals above), and each one uses a layered approach:
  - **Outermost layer:** public-facing displays and “portholes” (ways for the public to see inside the center)
  - **2nd layer:** open studio available to anyone with VT ID, housing latest consumer technologies and software, staffed by knowledgeable student workers
3rd layer: reservable workspaces with a range of sizes, plus a concierge desk where equipment/software can be checked out, staffed by a full-time person who is experienced in working with the technologies and can help/advise on projects

Innermost layer: dedicated lab spaces for ongoing faculty/student research involving visualization in the DA/SGA

Pilot proposal:
In order to achieve this vision, we propose a phased iterative design approach to developing this network of data exploration studios. The focus of this first work would be an example center designed for Creativity and Innovation:

- Theme areas: digital media production, immersive environments (VR/AR), visual analytics (intersection of VR and visual data analytics)
- On the 4th floor of Newman Library, with a high-traffic pathway going to/from the Torgersen Bridge
- Specifics for inclusion are as follows:
  - Within the studios, we propose the spaces be separated into multiple areas that can serve a range of simple to complex needs. Each area serves a different segment of the community, ranging from open access to all students and faculty to open only to experts committed to long-term development of the studio itself.

Digital Media Studio:
The proposed Digital Media Studio would support student use of digital media production technologies by offering easily accessible services for digital imaging and editing, video and audio production, and 3D modeling for all students on campus, regardless of discipline or major. Located in Newman Library, the following technology would be available for use this fall:

- 8 dual-boot iMacs with audio and video mixing/editing software.
- Digital HD video and audio recorders.
- Scanning and digitization equipment.
- Digital media production software, including Adobe Creative Cloud, iMovie, iDVD, Final Cut Pro, Unity, and Tableau.
- Lendable, reservable technology, including DSLR cameras, GoPros, wireless audio kits, recorders, portable green screens, light kits, laptops and tablets.

With a peer-to-peer, informal learning service model at its core, the Digital Media Studio’s mission is to foster an environment in which students can experiment with vital 21st century technologies and create content for both course-related and independent research projects:

- Bookable, student-driven consultation services for training in digital media production.
- Workshops (both regularly scheduled and customizable) teaching beginner/advanced digital media technology fluencies.
- Dedicated lab space and state-of-the-art equipment for reservation and checkout.
- Partnerships with faculty and student researchers for extended access to the Studio.
- Hardware and software students need to complete assignments and stay competitive as future professionals.

This space will be supported by an on-going and unique partnership between ICAT and the University Libraries. The University Libraries is uniquely positioned to manage the Digital Media Studio:
- **Experience in studio/lab creation and management:** current library studios include 3D printing, interdisciplinary undergraduate research, virtual/augmented reality, and data visualization.
- **Managed over 30,000 equipment checkouts** during the 2016-2017 academic year.
- **Harnesses the Libraries’ expertise** in creating service-rich learning environments and utilizing our position as an interdisciplinary hub on campus.
- With its longstanding work with partners such as ICAT and TLOS and its ongoing development of a suite of innovative, technologically-rich services and spaces on the 4th floor of Newman Library, the Libraries are ideally situated (both physically and organizationally) to create a studio that serves as a point of entry into the emerging Creativity and Innovation District.

ICAT, and its Center for Human Computer Interaction, are uniquely positioned to be the technical lead in the design and development of the studio as well as driving forward with the Libraries the required “concierge” aspect of support including content co-creation and technological innovation.

- Experience in supporting faculty and student research and teaching across 10 studios and, now, the Media building
- Providing “concierge” support with the Libraries for students on projects that need interdisciplinary innovation at the nexus of science, engineering, art, and design.
- Supporting iterative design in facilities that will need to evolve
- Solicit external funding through federal and corporate research grants

**Visual Analytics Studio:**

- **Theme:** Using a combination of machine learning and interactive visualizations on a variety of advanced displays to improve data analytics
- What might be in it:
  - Large, high-resolution desktop and wall-mounted displays
  - Tabletop touch-screen displays
  - Wall-sized projection displays
  - Conference room
  - Student bullpen (desks for long-term graduate students and rotating project students)
  - Two faculty offices
    - Public-facing displays showing off the latest work and making the projects visible
- **Who would use it:** The visualization-oriented faculty and graduate students of DAC (probably 8-10 people total) would be the “permanent” occupants. Their collaborators and student project groups would use the space on a rotating basis. Rotating projects might come from CS classes, classes in the DD and CT+E minors, classes in the HCD curriculum, etc.
- **Why this fits the strategic plan of the university, the Libraries, and ICAT:** Data analytics is a central theme of Beyond Boundaries, with the Data & Decision DA seen as a critical component that links to all the other destination and strategic growth areas. Virginia Tech is a national leader in visual analytics, which makes data analytics visible and combines the strengths of human intelligence and machine intelligence. 21st century libraries are all about data/information/knowledge, not just storage and access to data but more importantly making sense of data.
- **Within the visual analytics studio is a self-service visualization computer studio** with single unit touch screen displays at each of 10-20 stations. This studio is open during
Library hours and is available on a first come first serve basis. Students and faculty can come here to work on simple projects, or do preliminary development on projects that will later move to the other stages of the visualization studio. Available software might include: Adobe CC, Unity, Maya, ParaView, Processing, Tableau, R, Sci2, and Matlab, among others. This space doubles as instructional classroom that can be used for visualization workshops, with a teacher station and an overhead projector. The workshops would be led by visualization experts or concierges, covering topics on how to use software and hardware available in the various stages of the studio, as well as general visualization techniques. This area includes high resolution, large-scale displays, including display walls and display tables, available upon reservation.

**Immersive Environments Studio:**

- **Theme:** Designing user experiences with advanced immersive virtual reality (VR) and augmented reality (AR) technologies for a variety of application domains
- **What might be in it:**
  - The latest consumer VR, AR, input, capture, and tracking technologies (e.g., Oculus Rift, HTC Vive, Microsoft Hololens, optical motion capture, gesture-sensing cameras, eye trackers, physiological sensors for measuring emotion and workload, brain-computer interface devices, 360-degree cameras, laser scanners, spatial audio capture devices, loudspeaker arrays, etc.)
  - Open spaces for tracking and motion capture
  - Workstations for 3D artists/developers working on modeling, animation, audio processing, and game engine programming
  - Rotating project rooms
  - Conference room
  - Student bullpen
  - Four faculty workspaces in the bullpen area
  - Public-facing windows and/or displays showing off the latest work and making the projects visible

- **Who would use it:** Some of the 3D Experiences faculty in CHCI and their graduate students (probably 12-16 people total) would be the “permanent” occupants. Their collaborators and student project groups would use the space on a rotating basis. Rotating projects might come from classes in the CT+E minor, classes in the HCD curriculum, the graduate virtual environments class in CS, classes in SOVA, etc.

- **Why this fits the strategic plan of the university and library:** Immersive environments is a key theme of the CT+E strategic growth area. It is a highly transdisciplinary area, and is an entirely new medium for artists/designers to work in. Students across the university, in almost every domain, are interested in learning about the technology and applying it to their own areas of interest. It also has a high potential for innovation and entrepreneurship, which is increasingly important across the university. Note: an I & E cluster collaboration area for faculty, students, and external partners is being planned for construction in Newman Library 4th floor.

- Within the immersive environments studio is a medium scale (~30’x30’) tracked AR / VR space, available upon reservation. Standard consumer AR and VR devices, such as the Vive, Rift, and Hololens are available for shared use, with
any necessary external devices, such as Vive lighthouses, permanently installed. Users may use the space on their own, or with the assistance of a concierge. 3D visualization software may include Unity and Unreal Engine.

The studio areas do not need to be physically separated or walled off from each other. The self-service area would have to always be monitored by a student worker who would ensure that each section of the studio is only used by those who have access. An open layout would have the positive effect of exposing the various stages of visualization complexity to each other, while having the detrimental effect of increasing noise levels. All areas of the space would be open to visiting sessions from classes around the University, providing lessons on visualization design principles, software, and hardware. In some cases, classes might engage the space by working with a concierge to development a semester-long project.

Serving the studios will be a hardware/software visualization maker space for developing solutions intended for the studios. For example, visualization experts could use this space to prototype large-scale multi-screen touch panel displays or a rendering cluster that would later be installed in another part of the studio for common use. As each technology is developed and deployed, new prototypes could enter the space.

**Required Support**

To properly support these three studios and provide the concierge services, we propose:

- **Resources needed - 1st phase**, Digital Media Studio (immediate, with cost estimates):
  While utilizing existing equipment from InnovationSpace and reallocated library space in order to minimize costs, the Digital Media Studio requires funding for a studio manager, a technical lead, and student staff in order to maintain adequate operational hours and robust consultation services for studio users:
  - **$60,000 for a manager (faculty position)** - in addition to overseeing day-to-day operations, the manager for the Digital Media Studio will coordinate after-hours studio access for student research groups, provide specialized digital media expertise for high-level research projects, and can teach introductory-to-advanced workshops and course sessions.
  - **$35,000 (¼ position cost-shared with ICAT) for a data exploration lead (faculty position)** - this position will lead the design of this facility and the creation of the data exploration and immersive analytics resources that will be needed. This position will also support the visualization content creation necessary to establish an array of short courses on immersive analytics and will be **responsible for the piloting of phase II** as described below. This position will work closely with the two positions that are being supported at ICAT and one position being supported by the Libraries in the areas of immersive environments. Together, they will form a team that will be able to support this studio and the next phases of development.
  - **An additional $50,400 for student assistants**. The Library has allocated $50,400 to hire six student assistants in the 2017-18 academic year to provide core technology lending services and is seeking $50,400 more for studio support.
- **Resources needed - 2nd phase**, Visual Analytics and Immersive Environments studios (2018-19, detailed costs to be determined):
  - These positions will initially be fulfilled by the ICAT data exploration lead - position to eventually be migrated from 50% time to full-time and then to multiple positions:
    - Lead design and specification of space, equipment, software
    - Systems administration - Expertise in VM servers, HPC
    - Visualization design - Expertise in UI/UX
    - Visualization programming - Expertise in C++, Python, Unity, ParaView
    - 2D visualization development - Expertise in Photoshop, Illustrator, Tableau, R
    - 3D visualization development - Expertise in Maya, Unity, VR
- Studios Manager (for the Visual Analytics and the Immersive Environments studios)
- Student workers for monitoring space and fielding questions

**The Data Exploration Working Group**

This proposal was put together by a team of faculty experts from across Virginia Tech who will form the working group for enacting and supporting this effort. Specifically, this working group will be composed of the three faculty from the Library (including their new immersive environment lead, their new VR/AR specialist, and the new hire), three faculty from ICAT (including their research faculty position in immersive environments, the director of CHCI, and the new hire), and one faculty member each from CHCI, DAC, and ARC.

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