

Hannah Debelius: Hello, and welcome, everybody. We are going to give folks just another moment to log in and join us on the webinar today before we get started.

[Silence from 0:00:22 to 0:00:58]

All right, welcome to today's Better Buildings webinar, dedicated to bringing you the latest actionable insights from leading industry experts. Better Buildings webinars are a chance to explore the topics, technologies, and trends that affect your organization. We're really glad to have you onboard with us this morning. I'm looking forward to this topic.

Let's go to the – let's jump in and go to the next slide.

Today's webinar is called "Preserving the Past, Protecting the Future: Strategies for Historic Building Retrofits." So, you are in the right place if you are here to learn a little bit more about historic buildings. I'm personally a homeowner of a house built in 1910 that I just did – just put a heat pump hot water heater into, so this is a topic near and dear to my heart and I'm really glad to have some great panelists onboard with us this morning.

A couple of housekeeping items before we jump in. The first is that as always this session is recorded and archived for our Solutions Center. So, if you signed up for this website – or, excuse me, this webinar, you'll get an e-mail when the recording is available and it will all be on our website, so you can share with a colleague or go back and pick up on things you might have missed. That also means that all of our attendees today are in listen only mode, so you're not able to unmute yourself. However, if you are having any AV issues or technical issues, you can go ahead and use the Q&A box that's in Zoom to open that up and speak to our technical staff. They'll get you straightened out. Then we'll use another platform to actually do Q&A for the platform, which I'll introduce in just a moment. Next slide.

My name is Hannah Debelius and I'm with the Department of Energy and I have the wonderful pleasure of working with all of our commercial partners on the Better Buildings program. And I'll be your moderator for the day. Next slide.

What we're going to be talking about today is, again, all of those historic buildings and how you can really dig in on retrofits and overcome some of those specific challenges. So, we'll do a couple of polls at the beginning to understand more about our audience

and what you're interested in. And then we'll go into two speaker presentations, both from the higher education sector. And then at the end we'll have plenty of time for Q&A and a little bit of a closing. Next slide.

With that, I'm going to introduce our platform for engagement. So, we are going to use the same platform to collect questions throughout the whole session so that we can get to those questions at the end and also to do our polls. So, right now go ahead and open up either a new browser or open up your phone and go to slideo.com. You're going to put in the event code DOE. Our team has also dropped a direct link for that into the chat if that's easier for you. And I'm going to repeat this all again just so that you have time to do it in real time. Open up a new browser or on your phone. Go to slide.com and enter the event code DOE because through this platform you'll be able to answer the polls and then also send in questions any time for our panelists that we'll then address at the end. Once you're in there you can also hit the little thumbs up button and that will upvote some of the questions so that we can be sure we're getting to our most popular questions first.

All right. So, with that we're going to launch into our first polls. The first one is that we are really curious just to know who we have on the line here and who's interested in historic buildings. Let me go ahead and launch that first poll. And again, if you're just joining us, slido.com with the event code DOE, or you can use the direct link that's in the chat.

All right. A lot of folks from the federal government, like myself. Contractors, nonprofits, and NGOs. As I mentioned, our speakers are from higher education and so glad to see some representation from higher ed. Local government, state government. That's surprising to me that folks who manage government buildings would also be looking at historic buildings. That makes a lot of sense and I'm sure we'll have some good tidbits to share from this.

All right. It's not too late to join us on slide.com but we are going to move forward to the next poll because the next thing we would love for you all to share with us is what challenges have you experienced in retrofitting historic buildings? This is open response, so it will be one word, a couple of words. Just let us know what's got you – what's been hanging you up on historic buildings? This will be helpful for our panelists because they're going to share some of their real world experience.

Funding. I had a feeling that it's probably not just for historic buildings; it's something we hear a lot about in the Better Buildings Initiative. Aesthetics. Tradeoffs. Bylaw restrictions. Preserving envelope while meeting sustainability goals. Crappy envelope. I appreciate the candid response there. A lot of compliance and cost. All right. I'm seeing a lot of themes here around cost and funding, addressing the envelope, and then also navigating call them bumpers, whether that's internal to your organization or maybe external laws and that sort of thing. Safety. Funky construction. Yep, yep. This is super helpful. All right. Excellent.

Well, I think this bodes really well for our panel today because I know these are a lot of the things that have been on the minds of our panelists. So, go ahead and leave Slido open on your browser or your phone because, again, you'll be able to use Slido to submit questions throughout the whole webinar for our panelists to answer at the end.

But with that, I'm going to switch back to the slides here because I'd like to introduce our panelists for today. We are being joined by Ethan from the University of Virginia and Elaine from the Community College of Allegheny County. So, we'll hear from both of them and we'll take questions and have a little bit of a discussion at the end. Next slide.

So, Ethan – as a sustainability and energy engineer at the University of Virginia, Ethan works to promote human and ecological in the built environment. So, Ethan, if you want to turn on your camera? And we'll go ahead and jump into your presentation.

Ethan Heil:

Okay. Thank you, Hannah. I appreciate the invitation and opportunity to share a little bit about what UVA has learned in the last few decades of thinking about our historic buildings, our existing building stock, and how we think about sort of continuing them into the 21st century.

But first, a little bit about our university. We're located – we're a public university in Central Virginia. We have over 500 buildings and they range from very intensive use type spaces like hospitals and research labs to basketball stadiums to your typical classroom and dorm type facilities. We've also been around for over 200 years, and so we have a range of vintages and types of buildings as well. Some of them are informal cultural touchstones while others are designated by the UNESCO World Heritage site. And you can see from this drone's eye view what is the UNESCO-listed area,

what we call our Academical Village. And so, I bring that up to show that we have kind of a range of both informal and formal designations when it comes to sort of definition of "historic." Next slide.

And so, that kind of brings me to an interesting point, is that there – while there are official designations there's really no set definition of what a historic building is particularly in the context of a large portfolio. In many ways we kind of hope that the new buildings that we're building today., as you can see on the right of the screen, will eventually become the historic buildings of tomorrow. And there's not necessarily a single day when that happens. So, for example, our newest "historic" building was recently designated – was built in 1970. And so, there was a day where it wasn't designated and then it became a Virginia historic landmark. But the building itself, it evolves into that more slowly. And throughout the life of the building it needs – every building needs a range of different types of maintenance, renewals, and things like that. And so, with that in mind, my discussion today is going to focus on the best practices that we've learned that we can apply across the existing building spectrum regardless of there is a specific designation or not. Next.

And so, instead of focusing on the type of building or the designation itself, I think what can be helpful is to think about the type and depth of the renewal. And so, what this graphic is meant to illustrate is that there isn't necessarily a clear delineation of exactly what's going to happen to a building. But on end of this facility renewal continuum you have basically your light touches, your behind-the-scenes work that – we'll call it a little bit more than routine and preventative maintenance. These are opportunities to still continue to refresh and renew your building but in a way that is, again, less disruptive. On the right end, on the other extreme you have a building that has potentially reached the end of its life, or at least maybe part of the building has reached the end of its life, and we'll continue to talk about that hopefully later in the presentation. Next, please.

And so, at a high level what I'm going to talk about are identifying strategies and opportunities for any particular historic building that falls on this renewable continuum. And the particular of menu of items that you'll choose will, again, depend kind of on both the particular building and where you're falling on here. And what I'll do is I'll generally start with a best practice and strategies that we've learned are replicable and valuable within our stock of existing buildings, kind of where we are in the Southeast, and

especially – with a focus especially on those with particular historic or cultural value.

And what I'm going to do is I'm going to frame this presentation in terms of particularly the opportunity for efficiency, energy savings, and other co-benefits. And so, we'll just kind of put a fine point on it. On one end of the spectrum you have these kind of limited scope, light touch effort and on the right end you have basically these bigger, holistic opportunities. So, I think it's helpful even before you kind of consider what strategies are appropriate is understanding how deep into a renewal are you? And that will, I hope, help prioritize basically the biggest bang for your buck, so to speak. Next, please.

And so, as those of you with building portfolios or have worked with building portfolios know, each building is basically like a snowflake. It's unique in its own way. And so, again, there's no prescriptive recipe that will necessarily apply to every single building renewal or upgrade project. But I do believe we can draw from a common set of tools from our toolbox, things that, again, we've learned are relatively replicable, scalable, and provide a lot of value when you find yourself in a historic building with some opportunities to upgrade some things.

Again, this is kind of like a list of ingredients where every recipe is different and you do a little bit more of this and a little bit less of that. But the idea is it uses common ingredients, and so we can in many ways become experts on these sort of lists of things that we find are replicable – and we do a lot – and not feel overwhelmed by an infinite list of ingredients. So, these are tried and true opportunities that, again, we've learned in our context, and I'll basically also to go through them in rough order of increasing depth and increasing investment or disruption that's required. So, next slide.

I'll start with a little discussion on retrocommissioning and controls, kind of grouping together the strategies that in many ways are these behind-the-scenes strategies, the ones that you can typically do without the occupants really noticing that you're doing them, but I do feel that there's a lot of value. And retrocommissioning, what we mean by that is really systematically just working through your building and identifying the major systems and pieces of equipment and trying to evaluate them, calibrate them, finetune them, and even just identify things that are broken. We found that this reliably offers us an opportunity to cut energy used by 10, 20 percent. Just because buildings, they drift,

things get changed, people forget to change set points back, there's a lot of value. It can be easy to forget about the drift, but if you can set a plan to come back to buildings regularly, we find this is a really low – this is the low-hanging group.

If you want to take it to the next level, there's often opportunities, particularly among the older historic buildings, to do some controls modernization. So, thinking particularly about the HVAC building automation systems, it's an opportunity to take a historic building and make it smarter. Just because the bones of the building are old doesn't mean that the nervous system can't be smart and modern. And we feel that if you're able to upgrade the control system, and particularly if you can pair it with some sort of sensors that provide insight into the occupancy and use of the building, you can really what we call right-size and right-time the systems of the building – so, the lighting systems, the HVAC systems – and make sure you're kind of not just blasting the building with more energy and impact that it needs and that you can give the building just exactly what it needs at the right time. And that, we've found, comes from an updated control system and some sensing into the environment. Also, where that's not appropriate, just even finetuning or scheduling buildings is something that can provide a lot of value. Next slide.

Lighting is a little bit more of a visible upgrade to a building, whereas the previous examples were really behind the scenes, but it can be upgraded in what can usually be a minimally invasive way. LEDs are really interesting, particularly because they introduce new capabilities and form factors that are often welcomed by occupants. In many ways, we sometimes provide lighting upgrades as part of our more behind-the-scenes building upgrades anyways, because they're almost like our Trojan horse. If we're going to disrupt a building a little bit, it helps to give the occupants something that they see – they can see directly. If we're just doing retrocommissioning and controls, it can be hard to know what exactly happened, but often when occupants are sitting in rooms with fluorescent lights that are flickering, they welcome us to come in and provide new, better-looking LED fixtures.

Another unique resource that a lot of these sort of buildings bring, particularly those built before the advent of cheap electric lighting, is their sort of inherent foregrounding of daylighting. And so, there are opportunities to return to leaning on this idea of daylighting, which now we know is – tends to make occupants happier and more productive. Or also, opportunities to even "rediscover" this concept of daylight where perhaps older windows have been

boarded up, or in some cases we even had to sort of build out the ceiling in a way that cuts off a lot of the light. If we can find a way to holistically consider this daylight again, it provides myriad benefits both through the programming and utilization of the space as well as energy efficiency. Next slide.

So, now moving towards a slightly more disruptive type of upgrade is thinking about windows. And windows are interesting because they have disproportionate contributions in many different ways – so, both through the historic character of the building, as well as the comfort of the occupants inside and the energy efficiency. So, we find that windows in many ways should be evaluated sort of on their own, whether it's looking at the – sort of the window system of each building independently or maybe even each window itself within the building independently.

It's a bit of an eye chart up at the top right, but you can see here's just an example of we've hired some experts to basically come through and evaluate our windows. And this is how we – this is usually where we start with a lot of our historic buildings, is thinking about our windows and balancing this list of parameters that you can see here on the left. So, windows are very important to the historic character of a building. Again, they're important to the comfort and energy use of building. They also have maintenance ramifications to both – to the windows themselves and the allowed – the amount of sort of air and moisture that they let into the building.

And of course, there's the most common concern – or topic from our Slido – is this idea of cost and where's the funding coming from? And what we found is it's helpful, again, to have sort of a big table conversation about what is driving the need in this particular building. Is this within our UNESCO World Heritage site bounds? Do we really need to foreground this sort of character and focus on that? Or is this an area where we can be a little bit more flexible and think about opportunities because perhaps this is a building where there's a lot of offices next to windows and our faculty or our staff that are sitting in them just find it really uncomfortable and they're not coming to work. There's a lot of contribution that windows have and so it's – again, there's no single recipe for these but I think there are ways to come to a good compromise and a good balancing of these parameters.

And in doing that can often leverage – when the scale is right – quantitative modeling and estimation. So, you can see on the bottom right here a recent renovation we did that had historic

windows. We basically compared the opportunity to keep – compare the baseline windows, refurbish them in place, refurbish them offsite, add window films – window film to them, or basically install new "modern" windows. And what we found was basically on this pareto optimal front we found that the best option was really – I thought it was going to be new windows. We found that the new windows didn't actually give us a ton of value when it came to comfort and energy savings. Just putting a window film on them because it was a southwest-facing corner in the building provided a lot of that value.

And so, again, is it appropriate to do this depth of modeling on every single building? Maybe not. But it can be really helpful to really inform these sort of rules of thumb that we've been keeping with us because, again, every building is unique. Sometimes you'll be surprised that the gains to comfort or energy can be a lot bigger or a lot smaller than expected, and that helps you in the end with your investment in the windows.

And then, in terms of the options we're usually thinking about in order of sort of increasing depth, at a high level you can always reseal or even lock close. So, typically in all of our non-residential settings we tend to lock close our windows. Because we have fresh air coming in usually through a central system we don't need the windows for fresh air. And what we find is it introduces a big risk. So, someone opens the window and then they leave for winter break. That's, of course, when it's going to freeze and we're going to have a snowstorm and then we have pipes freeze inside. Or vice versa during summer break. Of course, the day that someone leaves their window open and leaves for summer vacation is going to be the most humid. And so, we just find that sealing and locking our windows can provide a really low-hanging fruit, super good value to both energy and the maintenance and operations of our buildings.

At the other end of the spectrum, there are opportunities to replace windows that can really introduce a lot of comfort and energy savings to a building. And even – there are even some vendors out there that can do great what's called restoration glass that mix – in many ways they even mimic the process of creating the glass from the era that's appropriate for your building but they can make them in sort of this this double-paned, modern-style performance. And so, there's a range of options here and then generally increasing costs. Windows is always a fun topic when it comes to the historic buildings. Next slide, please.

So, zooming out a little bit, we're talking about the wider opaque envelope. A similar approach can apply but we've realized that that just the lever here is not quite as strong. There's typically less opportunity, just because windows are – can be such a big contributor to basically the movement of heat, cold, air, et cetera. And so, what is important to think about it, again, is to think about what is appropriate for the particular project. Is it – so, is it an opportunity to just rehabilitate the exterior of a building? And that's a good time to think about is this a good opportunity to seal an insulated building where quantitative analysis, an energy model can help you weigh the trade-offs.

In many cases, in our context, we push a lot of air through our buildings, a lot of fresh air. And so, because of that the insulation to our opaque envelope often doesn't give us the payback that we might like to have – so, for example, like in a less than, say, occupied space or residential context. And so, we've learned that in many cases, we've actually foregone the opportunity to insulate a building, even after realizing that there may be some energy savings and payback, because we find that there's bigger opportunities looking at other systems, and there's a potential increased risk to condensation. If you're taking, again, a historic building that's never been sealed to water and you're applying sort of a waterproof barrier, there's – in some cases we've learned the hard way that that can introduce entirely new sustainability challenges and maintenance challenges.

At one end of the extreme, though, occasionally a building will need to be reskinned. And so, you can see our Gilmer Hall lab facility here on the left and that is – that's the once-in-a-lifetime opportunity to really think about creating, modeling, and designing a high-performance envelope package. Again, you probably get this maybe once or twice in the life of a building, and so I believe it's an excellent time to really think about opportunities to inform the design across the multi facets that we saw on the previous slide, including how does this really affect the comfort of the occupants, the use of the occupant – how the occupants are going to use the space, as well as the historic character? In many cases we've found that bringing daylight into space and the current way we use buildings can actually make it harder for occupants to use the space if it's a computational lab, for example, and everyone's using computers. So, again, thinking about the multi facets can be really helpful. Next slide.

So, now we're moving over to our HVAC systems. We've found that our buildings – most of our buildings generally and historic

buildings in particular really respond well to decoupling our HVAC systems. And that's basically where you pull the V out of the HVAC and provide fresh air with a different system than the system that you're providing heating and cooling. And this essentially allows you to deliver fresh air when and where you want it separately from controlling heating and cooling.

This is particularly helpful in very dry or very humid conditions, which we have both here in Virginia, where a coupled system is liable to dump dry air into your building when it's really cold outside or humid air into your space when it's really hot outside. And I think Elaine is going to talk about both of these systems, DOAS and VRF systems, in her talk here in a bit.

And finally, to wrap up, I think it's helpful to consider the climate impact in historic building renewals as well if possible. These events are great times to get rid of all those small fires that you're burning inside your building. Burning fuels are a great way to produce heat cheaply, quickly, efficiently, but they also come with risks to the building and the occupants' health and safety as well. Electricity is also a more flexible fuel, so you can do more with less, including what I have here on this bottom left is an image of a heat recovery chiller, which in many ways, it gives you free cooling as a byproduct of heat production. And so, that's something we're leveraging with every building renewal. Is this a good opportunity to get small fires out of our building and make it a healthier, cleaner building?

Similarly, it's important to remember the great asset that any existing building is, particularly a historic building, beyond their historical and cultural value they can contain within them the embodied energy and carbon that it took to make those materials in the first place. And so, it's helpful to when you're considering how to reduce or reuse a building leverage both the quantitative aspects – I've talked about doing energy modeling in the past – but also qualitative analysis to really work in tandem to get to the situation that makes best – the most sense for the institution and the organization and the building itself.

So, I'm getting close to time here. I have a couple of case studies I just wanted to introduce. There's a lot more information about these projects online. Basically, these are two buildings where we've leveraged a lot of the strategies that I've mentioned before. If you can see in my picture this building behind me, that's our rotunda. That's really – that's literally the iconic symbol of UVA. It's in our logo. And we had the opportunity to rehabilitate this

project about a decade ago. The interesting thing about it is the total design effort was really concentrated on the envelope and the materials, whereas the energy and the efficiency opportunities was concentrated in sort of the "invisible" parts of the building, the MEP systems.

And so, I feel like the project team reached a really successful historic preservation and rehabilitation and an incredible energy efficiency and green building story because we took this big table approach, a very collaborative design that brought the historic preservationists and the sustainable building folks together at the same table and found what is the pathway that we can all get what we want? And you can see in the end we were able to reduce the energy consumption of the building by over 75 percent. We're also proud that this is, so far as we know, the first LEED-certified building on a UNESCO World Heritage Site.

Again, here's a couple of highlights. This webinar will be posted. So, please feel free to come take a look at this, reach out to me, or look up some of the information that we have online on this, I think, really exciting renovation. One quick thing I'll point out is sometimes you even discover new things. So, we discovered this old chemistry earth from the early 1800s when we are doing our restoration. So, there's always – someone, I think, said "funky construction" in the Slido, so I think that certainly resonates with some of our experience.

And then finally, another case study that I'll just pin, if you're curious, is the other – probably the second-most popular building on our campus was recently renovated. And that was completed. And that was driven by an effort to basically go from a library that was made for books and storing books to a library for the 21st century, which was really intended for people. And so, again, I think my takeaway here is to distinguish – is to really focus on this big table approach. Think about what you want from the building and what's appropriate. And so, in the end, we found that essentially the midcentury portion of the building. was not appropriate for reuse and had essentially reached the end of its useful life because it was designed for books and not people. Well, that didn't mean we had to throw the baby out with at the bathwater and lose the entire building. We're able to keep the pre-war portion of the building. And so, that – again, I'll mention that there's a lot of great features. I'd love to talk about it in more detail if you'd like to reach out. And I will pass it on to Elaine. Thank you.

Hannah Debelius: Great, thank you so much, Ethan. I really appreciate how much detail you provided on envelope, especially since that was something that came up so significantly in the word cloud. And also, at the beginning you mentioning about how historic buildings – the buildings you have are the historic buildings of the future. That resonates a lot. I come from higher ed, but also I know in the Better Buildings Network we also have folks with the Empire State Building or Rockefeller Center and, yeah, the whole lifetime and lifespan of buildings. Great. Thanks, Ethan.

Next up, I'm really glad to have Elaine join us. As the Director of Energy and Sustainability at Community College of Allegheny County, Elaine oversees the energy procurement and management, as well as the development and implementation of energy and cost-saving programs and projects across four campuses. And as Elaine gets set up here, I will also just mention that at any time you can submit your question in Slido. We have a couple of questions in there but we'd love to see some upvotes and some more and we'll get to those at the end. So, with that, Elaine, go ahead and take it away.

Elaine Sadowski: Thank you. First slide, please.

I'm talking about a building called Chalfant Hall, and this is a case study in the renovation of a historic building. Next slide, please.

This is just a brief agenda of what I'll be talking about. The Community College of Allegheny County. Next slide, please. Is a rather large community college in Allegheny County, Pennsylvania centered around Pittsburgh. We have four campuses and two centers – three centers, sorry, and about 1.6 million square feet of buildings and our annual energy and water bill is about \$3.5 half million. We are members of the Pittsburgh 2030 district and the Department of Energy's Better Buildings Challenge and the Better Climate Challenge. One thing that I always like to point out is that community colleges generally don't have huge endowments so cutting costs or is always a priority for us. Next slide, please.

Chalfant Hall is an interesting building and it actually became more interesting the more I learned about it. It was built around 1900 as a mansion on the main street running through our largest campus, Ridge Avenue, and in the late 19th, early 20th century this was known as Millionaires Row. A lot of the steel magnates, other rich people lived along this street. So, we've taken over several of the old mansions that these people built and are using them for classrooms and offices.

This particular building was built for Henry Chalfant. He was a wealthy Pittsburgh lawyer and businessman and the scion of an old and prominent Western Pennsylvania family. His father – and this was, I thought, an interesting coincidence – his father, John Chalfant, was a steel manufacturer. And his plant, the Etna Iron Works of Spang, Chalfant and Company in Allegheny County was the first industrial facility to use natural gas exclusively in manufacturing. And I thought that it was fittingly appropriate because this is the first building on any of our campuses that we have completely electrified, so I guess that the Chalfants would have approved of the renovations we've made in this building.

The building after it was finished being a mansion became a convalescent home and halfway house. The college purchased it in 1981 and it was added to the Pittsburgh History and Landmarks Foundation historic landmarks list and it was used for offices and partially also as a halfway house. The building, as is true of many of our other buildings on this campus, is located in the Allegheny West historic district, so we are very much restricted in what we can do to the exterior of the building. In the 1990s and afterwards, the building was used mostly for storage. We moved our offices out of there, so it was just a storage facility. It was allowed to run down quite a bit. Next slide, please.

It's a four-story 17,000-square foot brick building. It has a slate roof, a lot of ornate tile flooring, and fireplace surrounds. And every fireplace in every room in the building was unique. It was a little different from the others. It had a unique type of tile and unique carving. There was beautiful plaster work, woodwork, stained glass windows. The HVAC system was a gas-fired hot water boiler and radiators. When we used the building for storage, it was heated only for freeze protection. There was no cooling actually used, although there were a bunch of old window units left from when it was used for other purposes. But we stopped using those and the lights were rarely on. Next slide please.

We knew almost nothing about the original building involved. There were no drawings, so a lot of the things that we did were not easily quantifiable. For instance, we know what our new R-values are but we don't really know what the original R-values for the roof and the walls were, and the construction of the walls varied by floor to floor.

This is a typical room in the in the building pre-renovation. You see the two radiators and the window units sitting there. You also

see some of the lead – excuse me, the lead and glass windows and some of the very ornate plaster work that – those leaves that you see in the photograph are actually plaster work and they're – somebody at one time painted them green, but they're – they've been restored since then. Next slide, please.

Here's another room. You can see it's not in very good condition. Everything has pretty much deteriorated. Next slide, please.

This is one of the original tile floors, much of which was destroyed and those all had to be rehabilitated. Next, please.

The new use that was identified for the building was a state-of-the-art facility design to enhance teaching and learning. It contains instructional classrooms, a cutting-edge digital learning lab, and specialized areas. It's intended to be a collaborative hub for faculty, staff, and the entire CCAC community. So, we're really bringing this into the 21st century with a lot of high-tech learning devices, electronics in the classrooms.

To enable us to do this, the original MEP systems were removed. The walls that were not covered by the irreplaceable woodwork were stripped back, and some of that woodwork was actually removed and replaced. The walls were filled with insulation and vapor barrier. Some of the decorative work was removed and replaced. And in other cases, molds were made from the original carvings and the original plaster work and new decorations were fabricated and applied. Even though the historic designation only applies to the exterior of the building, the college wanted to preserve as many of the historic elements within the building as well. Next slide, please.

Next.

We wanted an energy-efficient system and our chief facilities officer decided that the VRF system would be most appropriate rather than a more conventional design. There were concerns on the design team's part about moisture transition through the masonry walls and the ability of the VRF system to remove that, so we added a vapor barrier wherever the walls were replaced. We added insulation at the same time. And the building's windows were mostly replaced. The more ornate stained glass windows were taken offsite and rebuilt. We were able to replace a lot of the windows with new, although custom-made units. And there were 30 different types and sizes of windows throughout this building. So, that was a considerable project, just getting all the window

types identified and then replaced. We were allowed by the Historic Commission to replace the windows. Next slide, please.

We couldn't alter the exterior of the building in any way. The only changes that we made were the addition of a louver in the mechanical equipment room as well as an additional door to comply with the water and egress codes. As I said before, the stained glass windows had to be rebuilt. The basement mechanical equipment room got very crowded because we didn't have a lot of space to put the new HVAC system in. During the removal of the old radiators and the work on the walls, it was discovered that the radiator wall cavities were lined with asbestos. That had not been anticipated and we removed that as well, which was an additional considerable expense. We also found asbestos in the old kitchen. There was lead-based paint throughout the building. Next please.

We estimate the previous R-value was about 3.9 and it was brought up to 9.4. And the single-pane windows were replaced with high-performance glazing. We also did significant sealing of the building envelope, which was very leaky. Next please.

The entire third floor was severely damaged by water infiltration. And you can see some of the damage in this photograph. The windows had lots of broken panes. The wood frames were deteriorating. The metal muntins were rusted and in poor condition. And air infiltration was a problem. This is the reason we had to replace most of the windows. They simply couldn't be restored; they were too far gone. Next, please.

This is just a shot of some of the windows. You can see the exterior and the interior of just one of the window types. Next, please.

We replaced the old system with VRF and a DOAS, just as Ethan mentioned. This was a good way to retrofit the building. We have heat recovery in the DOAS, both sensible and latent recovery. We're using a heat wheel. We have high capture rate filters in the system. We do some humidification to protect the wood paneling. And the new lighting is all LED with a sophisticated control system with occupancy and the lighting control. We commissioned the HVAC system as well as part of the project. And I have some after photographs here. Next, please.

This is the building directory and you can see some of the gorgeous woodwork that was in the original building. Next, please.

Some of the lighting and this is one of the modern conference rooms. Next, please.

This is another conference room that has preserved a great deal of the woodwork and the windows and gotten a sympathetic lighting upgrade. Next, please.

This is one of the many fireplaces in the building and you can see the plaster work above the fireplace in the blue area, as well as all the carving on the fireplace itself. Next, please.

These are some of the stained glass windows, although these are not the most ornate windows in the building. Next, please.

These are some of the buildings – or, some of the windows you saw earlier in their replaced form. And you can see one of the VRF units in the shot as well. Next, please.

There's another VRF unit and one of the work rooms. Next, please.

This is the grand staircase at the entrance of the building. We really wanted to preserve this. It's a really magnificent feature. And again, we have a very sympathetic lighting upgrade as well. And I've got just a couple more shots of the new – next, please – of the new rooms. Here's another fireplace. And – next, please – here's a closeup of the fireplace and some of that woodwork carving. And you can see the tiling on this fireplace, and the tile work on each fireplace was unique. Next, please.

This is another area – another shot of the entrance area and the grand staircase. The bottom line for this is – next, please – that we've reduced the EUI of the building from about 0.63 to 0.69. When we were heating the building only for freeze protection, since it was used for storage, the lights were rarely on, just a few security lights, the major electrical use was the pump for the heating system. We've reduced that to about 0.53. And we're now in full occupancy of the building. The people are in it every day. Lights are on all through the day. And the heating system and cooling system are functioning to keep people comfortable. And next slide please.

I just put in a quote from the mechanical designer. And the reason I'm including this is that I think one of the keys to coming out with a successful project is to work with a design team who view the project as a challenge and a lot of fun rather than as something to be resisted and fought with. So, we wanted – we went out from the

onset that we were going to make this building more energy-efficient, and this was the initial task given to the design team and they responded very, very well to the challenge.

And I thank you for the opportunity. If you have any questions, please feel free to call on me. This is my e-mail address. And we appreciate the chance to tell you about our building.

Hannah Debelius: Thank you so much, Elaine. I really appreciate it and I really enjoyed in particular all of those photos that you included at the end, some really beautiful spaces and all of that woodwork. And I think what you had to say resonated with a lot of folks because we did have a lot of Slido of questions come in during that time asking for some follow-up and some specific details.

So, with that, we will go ahead and switch over to our questions. So, Elaine and. Even, if I could have you – you're already on video, great. And our tech team, you can just, yeah, great take down the slides there. And it's not too late if you want to go to slido.com to either add a question or, again, you can hit that thumbs up and it moves the question up our priority list so we'll be sure to get to the most popular ones first.

Ethan and Elaine, some of these are – I know who specifically they're asking, but sometimes not, so we'll just do it popcorn style where you can jump in. And don't both feel like you need to react to both of them if it's not relevant to you. So, one of the first questions is in regards to workforce, which is were you able to find craftspeople with suitable skills to complete the retrofit and preserve historic fabric or did you have to bring folks in from outside your local area?

Elaine Sadowski: We found a stained glass firm that was fairly local. I think they were in Ohio. And I'm not really sure who did the plaster work because that that involved making molds from the original plaster and then reconstructing it and applying it back onto the walls. I'm not sure did the plaster work, but I know that the stained glass was fairly within our –

Hannah Debelius: Regionally attainable maybe. Yeah.

Elaine Sadowski: Yeah. Yeah.

Ethan Heil: Yeah, and for us it's a little bit of both. Our campus is large enough and we have enough buildings that in some cases we have those folks on staff. So, we employ historic masons, for example. That's

probably relatively unique to UVA. But in other cases, we do often – we're a small market, so we tend to have to pull people from out of – pull folks from out of town. That last case study that I zip through really quick there was a – this room with a lot of historic woodworking in there and so, we actually – they hired a company from not too far away, from Alayne up in Pennsylvania to basically come down and work onsite for several months. And I think it's all about – it's part of the procurement process right. That's certainly going to be a more expensive ask than if you could get local craftspeople who maybe just don't have the specific skillset. And so it kind of comes down to a tradeoff and, again, kind of sitting around that big table and deciding "What's the value proposition here?" But unfortunately it's a little bit of kind of "Yes and."

Hannah Debelius: Yeah, that makes sense. And I'm sure just like in other areas there – we could be on the cusp of increased workforce issues there. Thanks. I think, Ethan, we'll start with you with the next question, which is how are you navigating envelope retrofits with occupancy?

Ethan Heil: So, typically, it's a bit of musical chairs. We often don't do it with occupancy. We try – and, again, we've have some luck. It seems like we're always full but there's always some space somewhere we have the luxury of leasing or pushing folks into. And so, we find it's disruptive enough that we try and get folks out of the building, refresh the space entirely, and then bring them back in. Alternatively, we'll try and do it during the summers or winter breaks

Hannah Debelius: Yeah, and I know in some ways higher ed is uniquely positioned for that since there are breaks, although I know a lot of also higher institutions do rent out space and summer camps and things like that, so it can still be difficult. Great. I think we'll go ahead and move on to the next question then. And I believe this one came in while you were speaking, Elaine, so we'll start with you. And that question is how did you fit duct work for ventilation systems?

Elaine Sadowski: Because we did – we basically ripped most of the walls out and replaced them, we were able to fit the ductwork in. It was basically we disassembled a lot of the building and then put it back together again and we were able to incorporate the ductwork. And the ducts were smaller since it was a DOAS, and the heating – batch heating and cooling is provided by the VRF system, so that's only piping. So, the ducts were smaller. And if we managed to do it by deconstructing the walls.

Hannah Debelius: So, maybe the harder way but got it done. That makes sense. Do you have anything to add on that, Ethan, or should we go to the next question?

Ethan Heil: I'll just echo what Elaine said. That's kind of why we like the DOAS. It just makes it that much easier to find somewhere to fit them in.

Hannah Debelius: Yeah. All right, for the next question – either of you are welcome to jump on this one – which is do you find that preserving historic buildings for aesthetics or organizational culture is justifying cost? Or do you need to make the case for that?

Elaine Sadowski: Well, in our case, the buildings that are located in historic areas, we really can't do anything to the exterior of the building. We have to preserve it as it is. The making the case for interior preservation is another thing and we do have to justify that. So, there were some areas that were just – in this particular building just too costly to maintain and preserve, so we tried to do as much as we could in a practical way. But as far as the exterior of the building, we can't slap solar panels on the slate roof of this building.

Hannah Debelius: Make sense. That's an interesting distinction about the external historic qualities versus internal. I hadn't really considered that before. Ethan, anything to add on that?

Ethan Heil: Yeah, I think Elaine, again, hit on some good points. In some cases you have a regulatory backstop but I think it really is hard and maybe definitionally impossible to put a price on it. And I think – it's interesting, I come from the – more of the energy space where in the back pocket, we can always do a life cycle cost analysis or something. You can kind of put the money – put the figures up. And I think in many ways we rely on folks who can speak more eloquently than myself about this sort of intangible value. And so, again, it's kind of – it's a combination of things. In addition, we're – I think we have a developing vocabulary around the environmental impact of preservation too that maybe we didn't have five or 10 years ago. There's discussion about embodied carbon and things like that that I think help add to like the multifaceted reasons why it might make sense to preserve the space. But the cost piece though is kind of hard, I think, in my experience.

Hannah Debelius: Yeah, and I think a lot of those points you just mentioned, Ethan, will resonate certainly outside of the higher ed sector as well.

Well, with that, we are wrapping up here. So, I want to just say I thank you again to Ethan and Elaine, both of our panelists who were able to offer such great insights and also specific case studies that really did address so many of those challenges that we heard from you all in the beginning. So, thank you both so much. As a reminder, this whole session will be posted onto our – the Better Building Solutions Center, where you can share it with a colleague or access the information again.

I also want to invite everyone to join us for the Better Buildings Summit in Washington, D.C. this spring, April 30th to May 2nd. You can check out our agenda at a glance but I'll give you the spoiler that we actually have another session, a follow-up session on historic buildings there. So, more to share even on this topic if you join us in person at the summit. And with that, next slide.

Thank you again to all of our panelists for taking the time to be with us today. I know that we didn't get to everybody's questions, so if your question's still lingering, you can reach out to our panelists directly, or me if you have questions or comments about Better Buildings and the webinar series. Everyone will receive an e-mail when this recording is available, and thank you so much to our attendees as well for coming out and listening about historic preservation.

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